

Can we better understand educational video through Large Language Model?

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```
video_schema={
  "properties": {
    "video_topic": {"type": "string"},
    "skills_covered": {"type": "string"},
    "style_of_teaching": {"type": "string"},
    "pauses_for_reflection": {"type": "boolean"},
    "unanswered_question_for_viewers_reflection": {"type": "boolean"},
    "entertaining_content_irrelevant_to_video_topic": {"type": "boolean"}
  }
}
```

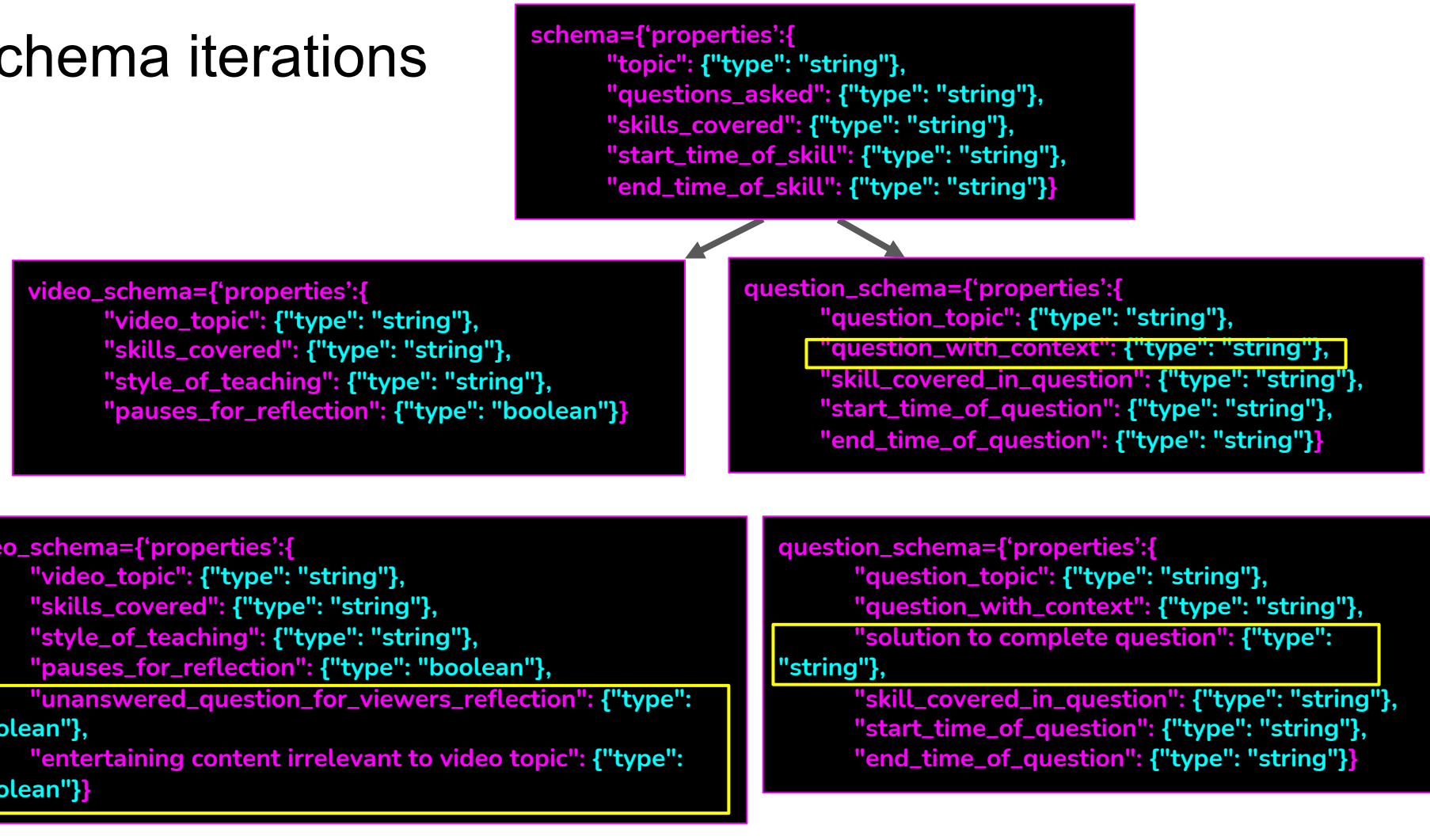
```
{
  "video_topic": 'solving word problems',
  "skills_covered": 'addition, subtraction',
  "style_of_teaching": 'using number families',
  "pauses_for_reflection": True,
  "unanswered_question_for_viewers_reflection": False,
  "entertaining_content_irrelevant_to_video_topic": True,
  "question_topic": 'swim trunks',
  "skill_covered_in_question": 'addition',
  "complete_question": 'How many beams did the crane deliver?',
  "complete_question_context": '...',
  "solution_to_complete_question": 'The crane delivered 11 beams.',
  "start_time_of_question": '1:00',
  "end_time_of_question": '1:04'
}
```

Research questions

- How do Large Language Models assist in extracting informative video features to enhance the understanding of content that optimizes learning outcomes?

Schema iterations

```
schema={'properties':{  
  "topic": {"type": "string"},  
  "questions_asked": {"type": "string"},  
  "skills_covered": {"type": "string"},  
  "start_time_of_skill": {"type": "string"},  
  "end_time_of_skill": {"type": "string"}}
```



```
video_schema={'properties':{  
  "video_topic": {"type": "string"},  
  "skills_covered": {"type": "string"},  
  "style_of_teaching": {"type": "string"},  
  "pauses_for_reflection": {"type": "boolean"}}
```

```
question_schema={'properties':{  
  "question_topic": {"type": "string"},  
  "question_with_context": {"type": "string"},  
  "skill_covered_in_question": {"type": "string"},  
  "start_time_of_question": {"type": "string"},  
  "end_time_of_question": {"type": "string"}}
```

```
video_schema={'properties':{  
  "video_topic": {"type": "string"},  
  "skills_covered": {"type": "string"},  
  "style_of_teaching": {"type": "string"},  
  "pauses_for_reflection": {"type": "boolean"},  
  "unanswered_question_for_viewers_reflection": {"type":  
    "boolean"},  
  "entertaining content irrelevant to video topic": {"type":  
    "boolean"}}
```

```
question_schema={'properties':{  
  "question_topic": {"type": "string"},  
  "question_with_context": {"type": "string"},  
  "solution to complete question": {"type":  
    "string"},  
  "skill_covered_in_question": {"type": "string"},  
  "start_time_of_question": {"type": "string"},  
  "end_time_of_question": {"type": "string"}}
```

Dataset: 10 videos from Youtube

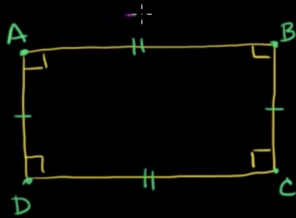
Topic	Sub-topics	Videos
Math	Geometry Area	3
Math	Word Problems	2
Math	Solving two-step equations	3
Chemistry	Conversion of units	2

Reliability

- We identified the hardest feature extraction would be the extraction of questions or problems that the presenter is solving in the video.
- To measure how reliable LLM generated questions from the video were, we manually tagged the “question” “context” and “solutions” properties returned by LLMs as either correct or incorrect.
- Based on Cohen’s Kappa coefficient, the inter-coder reliability for this coding showed $\kappa = 0.60$.

Findings context of questions are hard

Perimeter



$$AB = 7 \quad BC = 5$$

Perimeter of ABCD =

'question topic': 'perimeter',
'skill covered in question': 'finding the perimeter of a rectangle',
'complete question': 'What is the perimeter of ABCD?',
'complete question context': 'And we want to know, what is the perimeter of ABCD?',
'solution to complete question': 'The perimeter of rectangle ABCD is just going to be equal to the sum of the lengths of the sides.',
'start time of question': '1:12',
'end time of question': '2:07'

Geometry: Finding the Area of Various Shapes

Video

Quiz

Course

PROBLEM 1: SUE'S CARPET

Sue is getting new carpet for her house. She can choose between two carpet installers. One will install any amount of carpet for a flat fee of \$100. The other charges \$0.85 per square foot.

Sue's living room is ten feet long and 14 feet wide.
Which carpet installer should she choose?

'question topic': 'area of shapes',
'skill covered in question': 'area of rectangle',
'complete question': 'Which carpet installer should she choose?',
'complete question context': 'Sue is getting feet wide',
'solution to complete question': 'Sue should choose the flat fee installer, which would save her \$19',
'start time of question': '1:12',
'end time of question': '2:07'

More Trouble with Context

W9CW1

Converting Between Metric Units

1) 6.88 m to cm ¹⁰⁰ _____ K H D U D C M

2) 7,637 cm to m _____ m

3) 5.53 m to mm _____ g

4) 4,590 mm to m _____ L

5) 3.74 km to m _____

6) 3,184,400 m to km _____

7) 24.47 L to mL _____

0:59 / 3:10

LLM generated attributes:

'question topic': 'converting between metric units',

'skill covered in question': 'converting from meters to centimeters', 'complete question': 'Convert 6.88 meters to centimeters.',

'complete question context': "entire video transcript",

'solution to complete question': '688 centimeters',

'start time of question': '0:00',

'end time of question': '3:06'

Impossible Context

Method of Elimination

$$3x + 2y = 7 \quad \text{---} \textcircled{1} \times 3$$

$$5x - 3y = 37 \quad \text{---} \textcircled{2} \times 2$$

$$9x + 6y =$$

LLM Generated attributes:

Complete question: How do you get rid of the Y's in the example?

Context: in this example we will be trying to get rid of the Y's

Solution: by making the coefficient in front of the Y the same in both equations

Complete question: What is the result of multiplying equation 1 by 3 and equation 2 by 2?

Context: we multiply equation 1 by 3 so that 2y times 3 is 6y and

we multiply equation 2 by 2 so that negative 3y turns into 6y

Solution: equation 1 becomes $9x + 6y$ and equation 2 becomes $10x - 6y$

Method of Elimination Steps to Solve Simultaneous Equations



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Wrong solutions?

The sandwiches problem

we want to know how many 1:08 slices of bread 1:09 are needed to make

eight sandwiches

15 slices

**Wrong solution
detected**

3:16 we need sixteen slices of bread

Correct answer - missed

Missed questions? -multiple short questions in unit conversion

0:11 on the surface we have six point eight 0:13 eight meters to centimeters this seems
0:15 like a really intimidating thing yeah I 0:16 think oh there's a hundred centimeters
0:18 in a meter and we have to convert that

Question detected

688 centimeters

Solution detected

going let's do number three me
there's 1:34 two millimeters I'm going from my unit 1:36 my m2 my millimeter going
one two three 1:40 spaces to the right so I'm going to go 1:42 one two three spaces to
the right now I 1:45 ran out of space so I have to add a 1:47 placeholder zero 5530
millimeters now

Question not
detected

Entertainment or Pause for Reflection?

**Presenter Paused
for viewers
reflection and NO
entertaining off
topic contents
present**

**Presenter Paused
for viewers
reflection and
video has
entertaining off
topic contents**

FIVE YEARS FROM NOW, THE AGE OF JACOB WILL BE 3 TIMES THAT OF HIS SON. FIVE YEARS AGO, THE AGE OF JACOB WAS 7 TIMES THAT OF HIS SON. FIND THEIR PRESENT AGES.

How can
you
understand
a word
problem?

Try repeating the problem in your own words
to help you understand.

