Students’ benefit from video with interactive quizzes in a first-year calculus course

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Context for this study

- First year calculus course in an engineering programme
- Videos used for student preparation
- Videos of worked examples
- Some of the videos were augmented with mini quizzes
Noninteractive video (VT1)

\[
\begin{pmatrix}
1 & 2 & -1 & 1 \\
0 & 1 & 1 & 3 \\
0 & -3 & 5 & 0 \\
\end{pmatrix}
\]

\( R1 - 2R2 \rightarrow R1, \quad R3 + 3R2 \rightarrow R3 \)

\[
\begin{pmatrix}
1 & 0 & -3 & -5 \\
0 & 1 & 1 & 3 \\
0 & 0 & 8 & 9 \\
\end{pmatrix}
\]
Blooms taxonomy

Bloom’s Taxonomy

- **Remember**: Recall facts and basic concepts
  - define, duplicate, list, memorize, repeat, state
- **Understand**: Explain ideas or concepts
  - classify, describe, discuss, explain, identify, locate, recognize, report, select, translate
- **Apply**: Use information in new situations
  - execute, implement, solve, use, demonstrate, interpret, operate, schedule, sketch
- **Analyze**: Draw connections among ideas
  - differentiate, organize, relate, compare, contrast, distinguish, examine, experiment, question, test
- **Evaluate**: Justify a stand or decision
  - appraise, argue, defend, judge, select, support, value, critique, weigh
- **Create**: Produce new or original work
  - design, assemble, construct, conjecture, develop, formulate, author, investigate

Picture from https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/
Interactive video (VT2a) - complete intermediate results

\[ \frac{d}{dx} f(x) = \frac{df}{du} \cdot \frac{du}{dx} \]

\[ = \frac{d}{du} (u^7) \cdot \frac{d}{dx} (3x^2 + x) \]

\[ = \square \quad \cdot \quad \square \]
Interactive video (VT2a) - complete intermediate results

\[ \frac{d}{dx} f(x) = \frac{df}{du} \cdot \frac{du}{dx} \]

\[ = \frac{d}{du} (u^7) \cdot \frac{d}{dx} (3x^2 + x) \]

\[ = 7u^6 \cdot (3x + 1) \]
Interactive video (VT2b) - choose solution strategies

\[ \int x^6 \ln(x) \, dx \]

A subst
B partial
## Videos

<table>
<thead>
<tr>
<th>Video title</th>
<th>Type</th>
<th>Duration (m:s)</th>
<th># questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration by substitution, example</td>
<td>VT1</td>
<td>5:44</td>
<td>0</td>
</tr>
<tr>
<td>Integration by parts, example</td>
<td>VT2a</td>
<td>7:48</td>
<td>4</td>
</tr>
<tr>
<td>Partial fractions</td>
<td>VT1</td>
<td>7:18</td>
<td>0</td>
</tr>
<tr>
<td>Choose integration technique</td>
<td>VT2b</td>
<td>6:36</td>
<td>4</td>
</tr>
<tr>
<td>Long division of polynomials</td>
<td>VT2a</td>
<td>6:16</td>
<td>1</td>
</tr>
<tr>
<td>Separable differential equation</td>
<td>VT1</td>
<td>10:33</td>
<td>0</td>
</tr>
<tr>
<td>First order linear differential equation</td>
<td>VT2a</td>
<td>11:39</td>
<td>4</td>
</tr>
<tr>
<td>Types of differential equations</td>
<td>VT2b</td>
<td>9:09</td>
<td>3</td>
</tr>
</tbody>
</table>
“Videos have given me a clearer understanding of content we read in Calculus. Book seems somehow complicated at times and it is nice to have a media which quickly and precisely clarifies how things are connected. if I could choose I would like this kind of videos in all of my courses”.
Goals of this study

1. Are there any differences in how students estimate the learning benefit from three types of videos?
2. Are there differences in how students use the three types of videos? (see paper)
3. Do interactive videos support deeper learning?
4. Do students value the idea of flipped classroom, face2face elements and integration of the different learning resources.
Methods of this study

Questionnaire (n = 47 / 79)

- Locked responses, according to a Lickert scale
- Free text responses

Statistics from the site hosting the videos

- views of individual videos
- interactions with the interactive elements
Which video type helps you the most?

- Noninteractive (VT1)
  - 4% no effect (0)
  - 21% some effect (2)
  - 75% large effect (4)

- Interactive (VT2a)
  - 2% no effect (0)
  - 2% some effect (2)
  - 96% large effect (4)

- Interactive (VT2b)
  - 0% no effect (0)
  - 4% some effect (2)
  - 96% large effect (4)
Difficulty of videos

- Partial fractions (VT1): 65% easy, 35% difficult
- Long division of polynomials (VT2a): 66% easy, 34% difficult
- First order linear diff. equations (VT2a): 69% easy, 31% difficult
- Choose integration technique (VT2b): 70% easy, 30% difficult
- Types of differential equations (VT2b): 74% easy, 26% difficult
- Separable differential equation (VT1): 80% easy, 20% difficult
- Integration by parts, example (VT2a): 80% easy, 20% difficult
- Integration by subst, example (VT1): 83% easy, 17% difficult

Percentage
Viewing statistics

Date

Number of views

sep  okt  nov  dec  jan
Learning effect of different learning resources

- Interactive videos (VT2a): 98%
- Interactive videos (VT2b): 91%
- Lectures: 89%
- Exercise sessions: 84%
- Noninteractive videos (VT1): 74%
- Textbook: 67%

Response: low effect (1) - (2) - (3) - (4) - high effect (5)
Conclusion

- Videos helps students feel more prepared for face2face session
- The interactive videos are estimated significantly better than both non-interactive videos and the book.
- Higher learning levels
  - Indicated but not proved
Next steps

To fully utilize the potential of interactive videos in future courses at the University of Southern Denmark we plan to apply the following adjustments.

1. produce additional videos with interactive elements,
2. clearly state that the videos only give an overview of a topic and that the textbook have additional details and

Long term interests

1. students’ perception of feedback both during interactive videos and during face2face sessions.
Questions and discussion