Student Usage and Behavioral Patterns with Online Interactive Textbook Materials

Alex Edgcomb, Daniel de Haas, Roman Lysecky, Frank Vahid

1Dept. of Computer Science and Engineering, University of California, Riverside (USA)
2Dept. of Electrical and Computer Engineering, Univ. of Arizona
3zyBooks, Los Gatos, California

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1.9 Equations to/from circuits

An equation is just one way to represent a Boolean function. Another way is using a circuit.

An equation can be converted to a circuit by converting each operation to a gate. Conversion is done first for items within parentheses. NOT is converted before AND or OR.

1.9.1: Convert equation to circuit.

1.9.2: Converting an equation to a circuit.

<table>
<thead>
<tr>
<th>#</th>
<th>Question</th>
<th>Your answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>AND</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NOT</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>n</td>
</tr>
<tr>
<td></td>
<td></td>
<td>m'</td>
</tr>
<tr>
<td></td>
<td></td>
<td>i</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a</td>
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Use the figure above to determine the missing value. Original equation: \( y = i \lor mn' \).
Interactive textbook – Simulators
Interactive textbook – Animations

3.4.2: Timing diagrams for FSMs.

- 1 2 3 4 5
- 6

Inputs: none  Outputs: x

Timing diagram

Inputs: g  Outputs: x

Timing diagram

At each rising edge, an FSM changes to a next state pointed to by a transition whose condition evaluates to true (1).
Interactive textbook – Learning questions

5.2.5: HLSM introduction.

Complete the timing diagram.

Inputs: j, k
Outputs: Z(8)
Variable: M(8)

State

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>a</td>
<td>t</td>
<td>t</td>
</tr>
<tr>
<td>b</td>
<td>(c)</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td></td>
<td>54</td>
</tr>
<tr>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d)</td>
</tr>
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</table>

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<thead>
<tr>
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<th>Question</th>
<th>Your answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(a) The initial state is graphically indicated by a transition coming</td>
<td>s</td>
</tr>
<tr>
<td></td>
<td>from nothing.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>![Correct Answer]</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>(b) The initial state is s, which sets M = ?</td>
<td>![Incorrect Answer]</td>
</tr>
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Research: Online textbook vs. zyBook [1]

UCR, C++, Fall 2013, 128 students

Students randomly assigned zyBook/textbook
Improvement score = post-test minus pre-test

16% more improvement

Textbook: 5.5
zyBook: 6.4

64% more

Initially lowest quartile

Textbook: 4.5
zyBook: 7.4

86% more time voluntarily spent

2014 Best Paper Award

Research: Switching from textbook to zyBook
(no other change)
2,000 students, 3 universities, 4 classes [2]

Univ. of Ariz., CS2 C/C++, 124 - 133 students

Univ. of Ariz., CS1 C, 140 - 166 students

Univ. of Mich., CS1 C++, 399 - 527 students

UC Davis, ENG1 Matlab, 211 - 245 students

14% ↑ Letter grade (4.0 scale)
14% ↑ Exams
8% ↑ Projects


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Student usage/behavior patterns?

- Good study behavior?
  - How often do students use the books?
  - How much time per study session?
  - How is time spent?

- 581 students across two research universities
  - 282 in intro to computer science (CS1)
    - Included interactive homework
  - 299 in intro to discrete math (DM1)

- Assigned-reading completion: 90% interactive
- Acquisition: 99.8% interactive vs. 70% traditional [3]

How often do students use the book?
How much time per study session?
(with interactive homeworks)

CS1: Average session length (min) per week

Average session length (min)
How much time per study session?
(without interactive homeworks)
How is time spent?

• Categories: Activities, or reading (text/figures)
  – Reading includes time away from computer
• CS1: 31% activities / 69% reading
  – Activities included homework
• DM1: 17% activities / 83% reading
Conclusion

• 99.8% acquisition
• 90% reading completion
• 4.5 accesses / week
• 20 mins / access

• Future work: Improve usage patterns, measure impact of each interactive element type (ex: animation) compared to a static element (ex: multi-part figure)

We are grateful for support of this research by the NSF and Google.
Questions?