An Observation Study on the Use of an Interactive e-book in a Data Structures and Algorithms Course

CHUNYAN WANG, PATRICK LAMBRIX
IDA
Project Members

- Tommy Färnqvist, IDA (PI)
- Fredrik Heintz, IDA
- Patrick Lambrix, IDA
- Linda Mannila, Åbo Akademi
- Chunyan Wang, IDA

- Pedagogiska språnget 2014: Pedagogiska aspekter på införandet av e-läromedel i datastruktur och algoritmkurs (all)
- PUG 2014 (Chunyan Wang)
Outline

- Motivation
- OpenDSA
- Observation Study
- Preliminary conclusions and future work
Data Structures and Algorithms

- Study of basic building blocks in programming
  - Abstract data types
  - Sorting algorithms
  - Complexity

- Current courses
  - Lectures, labs, exercise sessions
  - Visualization of algorithms on course pages
Current courses

• Lack of practice
  • Too few problems per topic
  • Assignments aren’t comprehensive

• Feedback
  • Disconnected (received long after submission)
  • Variable-quality (depends on grader)
  • Sometimes none provided (especially if homework is optional)
Current E-textbooks

• Electronic versions of paper books

• Cheaper
• Easier to distribute
• Easier to access

• Content is static and identical to paper version
  • No videos
  • Not interactive
  • Not updated
Introduce

- active learning
- continuous examination and feedback

in a data structures and algorithms course

by using an e-book that provides

- interactive examples and visualizations
- many exercises
- automatic assessment and immediate feedback
Outline

• Motivation
• OpenDSA
• Observation Study
• Preliminary conclusions and future work
What is OpenDSA?

- E-book
  - Textbook-quality text
  - Interactive examples
  - Randomly generated instances of exercises
- Provides much practice
- Provides automatic assessment and immediate feedback
- Web-accessible
- Free and open source
• OpenDSA used in TDDD86 Data Structures, Algorithms, and Programming Language Paradigms
  • 130 students from D and U programmes
  • OpenDSA assigned for (extensive) homework and for (part of) exam
• Data collection
  • Data logging by OpenDSA system
  • Comparison of exam results to old course
• Questionnaires
• Observation study
Outline

• Motivation
• OpenDSA
• Observation Study
• Preliminary conclusions and future work
Method

6 students
2 observers
1 session = 25+5 minutes

3 sessions
- Complexity analysis
- Sorting
- Graphs
What are your expectations about this tool?

- Not carrying a book.
- Same as text book but modernized (e.g. interactive exercises).
- Makes me learn; Helps me learn.
Questions

What are your worries about this tool?

- None.
- Bugs.
- A lot of text.
- May guess the answers to questions.
- Student skips large parts of text and worries the exam may require students have read everything.
Usage of the tool at home vs the observation.

- Same.
- One student usually works together with another student (discussion, easier to remember).
When do you use the tool?

- Usually after the lecture.
- One student does several chapters at the same time.
Questions

Do you use any other materials?

• Most do not use other materials.
• One student uses wikipedia as a complement.
• One student looked at other books in the beginning but found the tool to be better.
Questions

How do you feel about the tool? (positive)

- dictionary
- exercises
- (code) examples
- visualizations
- overviews/introductions
How do you feel about the tool? (negative)

- **text format**
- **bugs**
- **exercises**
- **’mini-content’ pages; pop-up dictionary**
- **more links to refer to other parts in the book**
- **Hard to focus on screen when getting tired**
### Questions

#### Difference with traditional course book.

<table>
<thead>
<tr>
<th></th>
<th>Traditional Book</th>
<th>On Line Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reading</strong></td>
<td>usually don’t read books/don’t like to read books</td>
<td>have to read; active</td>
</tr>
<tr>
<td></td>
<td>wouldn’t read until before the exam</td>
<td>throughout the course</td>
</tr>
</tbody>
</table>
### Difference with traditional course book.

<table>
<thead>
<tr>
<th>Exercises</th>
<th>Traditional Book</th>
<th>On Line Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skip exercises</td>
<td>do exercises only some exercises</td>
<td>do exercises (active=credits+interesting)</td>
</tr>
<tr>
<td>Do exercises</td>
<td>do the exercises only before the exam</td>
<td>do exercises throughout the course</td>
</tr>
</tbody>
</table>
### Questions

#### Difference with traditional course book.

<table>
<thead>
<tr>
<th></th>
<th>Traditional Book</th>
<th>On Line Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deeper learning</td>
<td>----</td>
<td><em>(Students think)</em> deeper learning (use more senses)*</td>
</tr>
</tbody>
</table>
## Questions

### Difference with traditional course book.

<table>
<thead>
<tr>
<th>Visualizations</th>
<th>Traditional Book</th>
<th>On Line Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>student would visualize with paper and pen, but would not be sure it is correct</td>
<td>immediate feedback on correctness</td>
<td></td>
</tr>
</tbody>
</table>
Questions

Did you change your way of using the tool?

• Most did not change their way of using the tool.
• One student:

  Guess  Answer
Observation

• Some students mark/mouse pointer to follow the text while reading.
• Several students adjust the screen.
• Some students use pen and paper, but several do not.
Observation

Reading

• Many read from beginning to end.
• One student skims through the whole chapter to get an overview and then starts from the beginning.
• One student reads the whole text first and then does the exercises.
• Several students skip text.
Observation

Others

• Dictionary is used a lot.

• Students like the code examples. (pseudo-code / Java)
Observation

Visualizations

• Some go back and forth between visualization and text/code.

• The students do not take the opportunity to run own examples with the visualizations.

• Some go very fast through some visualizations ("just clicking").
Exercises

• All use the hints. Different strategies to use the hints.
• Some students try to guess the answers; others go back and forth between exercise and text.
• Sometimes students just click on all possible answers (“takes too long to figure out”).
Outline

- Motivation
- OpenDSA
- Observation Study
- Preliminary conclusions and future work
Preliminary Conclusions

• Students prefer tool over traditional book.
• Dictionary, visualizations and exercises (interactive parts of the tool) are appreciated and help understanding.
• Makes students work during the course.

• Several students skip text.
• Guess answers to exercises; Interaction in the visualizations without learning.
Future Work

- Analyze the log data from openDSA and the questionnaire data (students and teachers).