Concise Graphical Representations of Student Effort on Weekly Many Small Programs

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Introduction

› CS1 students code a lot
  › Many small programs approach: 5-7 programs /week
  › Lots of missing information

› Need insight into students’ coding process
  • Time spent?
  • Days worked?
  • Order of completion?
  • # Runs?
  • Score earned?
  • Took breaks?

› Goal: Quick & concise to gain this insight
  › “Programming workflow charts”
Background – MSP teaching approach

› MSP - Many small programs
  › 5-7 programs per week

› Characteristics
  › Concise prompt
  › 20-50 lines of code (solution)
  › One topic per lab

› Benefits\(^{[1,2]}\)
  › Earlier starts
  › Reduced stress
  › Additional practice


Background – Program auto-grader

- Modern day auto-graders (ex. zyLabs by zyBooks)
  - Easy to use
  - Immediate score feedback
  - zyBooks: built-in IDE

- Log file
  - Develop: testing
  - Submit: grading

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>lab_id</td>
<td>user_id</td>
<td>timestamp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>LAB: Sample 1</td>
<td>1103</td>
<td>1/1/2021 17:23</td>
<td>1 <a href="https://xyz.zip">https://xyz.zip</a></td>
<td>8</td>
<td>10</td>
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<tr>
<td>3</td>
<td>LAB: Sample 1</td>
<td>1103</td>
<td>1/1/2021 17:32</td>
<td>0 <a href="https://xyz.zip">https://xyz.zip</a></td>
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<td>0</td>
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<td>4</td>
<td>LAB: Sample 2</td>
<td>1103</td>
<td>1/1/2021 18:11</td>
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<td>0</td>
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<tr>
<td>5</td>
<td>LAB: Sample 3</td>
<td>1103</td>
<td>1/2/2021 12:00</td>
<td>1 <a href="https://xyz.zip">https://xyz.zip</a></td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>LAB: Sample 7</td>
<td>1103</td>
<td>1/2/2021 12:09</td>
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<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>
Version 1: Calendar view (2017)

**Features**

- Weekly calendar view
  - Labs on y-axis, Dates on x-axis
  - Horizontal lines to indicate time spent

**Tradeoffs**

- Pros: weekly view
- Cons: data too small

Features

- Total time view
  - Labs on y-axis, Time spent on x-axis
  - Horizontal lines to indicate time spent
  - Score earned (%)

Tradeoffs

- Pros: data representation
- Cons: readability
Version 3: Clarity & readability (2018)

Features

› Colors
› Data summary labels
› Grid
› Updated logic

Tradeoffs

› Pros: readability
› Cons: readability (slight)
› Considerations: line colors & styles
Version 4a: Run type (2019)

Features

- Develop & submit indicators
- Text & solid points
- Minor update to labels

Tradeoffs

- Pros: more information
- Cons: clutter, readability, & data representation
- Considerations: indicator shape
Version 4b: Run type details (2019)

Features

- Develop & submit indicators
- Text & solid points
- Character ‘tails’
- Minor update to labels

Tradeoffs

- Pros: more information, data representation
- Cons: extra clutter & readability
Version 5: Tick marks (2020)

Features

› Develop & submit indicators
  › Tick marks

Tradeoffs

› Pros: more information & readability
› Cons: minor clutter
Version 6: Pivot indicators (2020)

Pivot: A switch between lab activities without completing the current lab activity.

Features

- Pivot indicators
- Arrow to indicate pivots
Current uses

› Understanding student effort
  › Normal, struggling, suspicious
› Basic student classifications
› Interactive website
Conclusion

- Evolution over 3 years

- Useful in CS1
  - Gain insight on student behavior
  - Recognize typical patterns
  - Instructor & TA

- Future
  - Auto detect struggle
  - Improved classifiers
  - Interactive website for instructors
    (hopefully soon 😊)

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## Appendix A: Website Summary Table

### SIGCSE Sample Programming Workflow Charts

#### Assignment 2

<table>
<thead>
<tr>
<th>Assignments</th>
<th>Timespent (sec)</th>
<th># Runs</th>
<th>Score (%)</th>
<th># Develops</th>
<th># Submits</th>
<th># Pivots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment Total [298 students]</td>
<td>1h 2m 58s</td>
<td>57</td>
<td>98</td>
<td>42</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>- Lab 1 (LAB: Divide by x) [298 students]</td>
<td>12m 35s</td>
<td>14</td>
<td>99</td>
<td>10</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>- Lab 2 (LAB: Driving costs) [298 students]</td>
<td>12m 44s</td>
<td>10</td>
<td>99</td>
<td>7</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>- Lab 3 (LAB: Expression for calories burned during workout) [298 students]</td>
<td>11m 58s</td>
<td>9</td>
<td>99</td>
<td>7</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>- Lab 4 (LAB: Using math functions) [297 students]</td>
<td>12m 50s</td>
<td>10</td>
<td>98</td>
<td>7</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>- Lab 5 (LAB: Phone number breakdown) [294 students]</td>
<td>9m 45s</td>
<td>12</td>
<td>99</td>
<td>10</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>- Lab 6 (LAB: Simple statistics) [56 students]</td>
<td>14m 29s</td>
<td>15</td>
<td>74</td>
<td>10</td>
<td>5</td>
<td>0</td>
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<tr>
<td>- Lab 7 (LAB: Musical note frequencies) [23 students]</td>
<td>12m 44s</td>
<td>13</td>
<td>78</td>
<td>11</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

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Appendix B: Website Chart View
Appendix C: OLP Chart View

Assn 6 Workflow (100%; 143min 46sec; 89d; 27s; 0p)