An SE Approach for CoCo Learning of Virtual Labs
32nd IEEE International Conference on Software Engineering Education & Training (CSEE&T 2020)

Lalit Sanagavarapu, Mrudhvika Damaraju, Ravi Shankar Pillutla, Venkatesh Choppella, Y R Reddy, Priya Raman
IIIT Hyderabad, India
November 9-12 2020
Motivation

In the current pandemic, did you figure out alternatives to make students practice lab experiments?

Do you believe in peer learning, collaborative and cooperative learning?

Do you still believe making students view videos or practice simulations is good enough to learn from online environment?

How can we make experimental learning scalable?

Traditionally, Software Engineers adopted practises from other Engineering streams. It is time to say that Software Engineering practices brings rigour and enhances learning.
Agenda

• Context Setting
• CoCo Learning Approach
• Experiment with Virtual Labs
• Results and Analysis
• Conclusion
Existing Learning Methodologies

• Teacher/Student Centered
• Blended – Flipped, Problem Solving, etc
• Online and Game-based
• Collaborative and Cooperative
Collaborative and Cooperative Learning Comparison

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Cooperative Learning</th>
<th>Collaborative Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>Foundational</td>
<td>Non-foundational; A social artifact</td>
</tr>
<tr>
<td>Epistemological Orientation</td>
<td>Structured Instruction</td>
<td>Social Construction</td>
</tr>
<tr>
<td>Process</td>
<td>Achievement-Oriented</td>
<td>Course of Action</td>
</tr>
<tr>
<td>Group Structure</td>
<td>High/Positive Interdependence</td>
<td>Low/Individualistic</td>
</tr>
<tr>
<td>Teacher’s Role</td>
<td>Micro Manager</td>
<td>Moderator/Facilitator/Guide</td>
</tr>
<tr>
<td>Student’s/Participant’s Role</td>
<td>Cooperative/Agreeable</td>
<td>Dissident/Independent</td>
</tr>
<tr>
<td>Goals</td>
<td>Develop Social Skills and Learning for All Members</td>
<td>Knowledge Construction through Conversation; Concern for Problem Solving</td>
</tr>
</tbody>
</table>
An SE Approach for CoCo Learning of Virtual Labs
# Activities in Proposed CoCo Learning

<table>
<thead>
<tr>
<th>Activities</th>
<th>Individual</th>
<th>Cooperative</th>
<th>Collaborative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read Procedure</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conduct Experiments</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify Issues</td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Log Issues</td>
<td></td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Fix Issues</td>
<td></td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Validate Fix</td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Deploy Fix</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

An SE Approach for CoCo Learning of Virtual Labs
Tools available for CoCo Learning

Collaboration Tools
- Slack
- Trello
- Asana
- JIRA
- GitHub
- Zephyr
- TeamCity
- Sonar

Other repositories
- Bitbucket

Students Community

Other Open Source Labs
- OpenModelica
- Virtual Labs

An MHRD Govt of India Initiative
CoCo Experiment – Virtual Labs

258,763 PARTICIPANTS ATTENDED
1,166 NODAL CENTRES
1,598 WORKSHOPS RUN
3,472,298 USAGE

An SE Approach for CoCo Learning of Virtual Labs
Results of Experiment - Virtual Labs

• About 145 students participated in the experiment for 6 months duration
• Students identified 1,026 issue including 96 enhancements
• A total of 545 unique issues were identified

<table>
<thead>
<tr>
<th>Issue Type</th>
<th>CSE</th>
<th>Non-CSE</th>
<th>Sciences</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functionality Issues</td>
<td>108</td>
<td>47</td>
<td>29</td>
<td>184</td>
</tr>
<tr>
<td>Broken Links and Code Clean-up</td>
<td>132</td>
<td>81</td>
<td>53</td>
<td>266</td>
</tr>
<tr>
<td>Enhancements &amp; New Features</td>
<td>58</td>
<td>24</td>
<td>13</td>
<td>95</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>298</td>
<td>152</td>
<td>95</td>
<td>545</td>
</tr>
</tbody>
</table>

- Velocity of identification and fixes tapered
- Eleven students dropped for various reasons
- Fixed issues were also validated by students
- Functional issues took longer period
- More CSE lab issues were fixed

<table>
<thead>
<tr>
<th>Fix Type</th>
<th>CSE</th>
<th>Non-CSE</th>
<th>Sciences</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functionality</td>
<td>61</td>
<td>39</td>
<td>19</td>
<td>119</td>
</tr>
<tr>
<td>Operational</td>
<td>113</td>
<td>74</td>
<td>49</td>
<td>236</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>174</td>
<td>113</td>
<td>68</td>
<td>355</td>
</tr>
<tr>
<td>% of Fix</td>
<td>58%</td>
<td>74%</td>
<td>72%</td>
<td>65%</td>
</tr>
</tbody>
</table>
## Validation of CoCo Learning - Survey

<table>
<thead>
<tr>
<th>Survey</th>
<th>Survey Questions</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>Student name, Institute name, Engineering discipline, Year of study</td>
<td>To bring seriousness to the survey and validity to the data for any future reference</td>
</tr>
<tr>
<td>5</td>
<td>How many labs (a rough count) have you tested to identify issues?</td>
<td>Insight on the exploration and usage of Virtual Labs</td>
</tr>
<tr>
<td>6</td>
<td>How many lab experiments (a rough count) have you fixed or resolved defects?</td>
<td>To obtain information of students who would have fixed issues but not raised a pull request in the software repository of the lab</td>
</tr>
<tr>
<td>7</td>
<td>How often have you interacted with students from your or other institutes to complete the task?</td>
<td>To obtain an insight on the need for cooperation and collaboration amongst students.</td>
</tr>
<tr>
<td>8</td>
<td>How much has your understanding of labs improved because of testing, fixing and interacting with other students?</td>
<td>Insight on the effectiveness of our approach</td>
</tr>
<tr>
<td>9</td>
<td>What did you like the most in these activities?</td>
<td>Textual response to capture comments on activities</td>
</tr>
<tr>
<td>10</td>
<td>What could have been better to motivate students for active contribution?</td>
<td>Textual response to understand other concerns or inputs on the approach.</td>
</tr>
</tbody>
</table>
• Active collaboration by 77% of students
• More than 92% of students mentioned that their understanding had improved
• Wanted Leader board and Bootcamp for better contribution

• About 65% of students participated in the survey. 58% of the students were junior undergraduate students
• Count of experiments conducted in Virtual Lab were more
• Sophomores were more enthusiastic as compared to others in identifying and fixing issues
Approach Validation - Faculty Survey

- A total of 24 faculty participated in the survey
- 90% of the faculty confirmed that students understanding of courses had improved
- Faculty liked the flexibility of “learn anytime and anywhere” with Virtual Labs
- Faculty want more Virtual Labs experiments
Conclusions

• CoCo Learning is effective and aids in teaching
• Students has flexibility to perform lab experiments
• Students learnt basics of Software Engineering and collaborative working

Lessons learnt

• Clarity is required on usage of the resources
• Students have different skill sets, tiering of tasks enhances contribution
• Train faculty and lab assistants on usage of Virtual Labs and CoCo Learning

Future Work

• Increase the count of students from other engineering or non-engineering disciplines
• Allow students to develop new labs as well, apart from using/fixing existing code base
• Validate learning effectiveness → Physical vis-à-vis Virtual
KeyReferences and Artifacts

Key References

• Teaching in Virtual Worlds: Opportunities and Challenges by S. K. L. Riley and K. Stacy
• Does Active Learning Work? A Review of the Research by M. Prince
• Collaborative vs. Cooperative Learning: The Instructor’s Role in Computer Supported Collaborative Learning by O. J. Olivares
• Computer-supported Collaborative Learning by G. Stahl, T. D. Koschmann, and D. D. Suthers

Artifacts Developed

• Virtual Labs. Available at https://vlab.co.in/
• Source code repositories of Virtual Labs. Available at https://github.com/virtual-labs/
• GitHub CoCo. Available at https://tinyurl.com/GitHubCoCo
An SE Approach for CoCo Learning of Virtual Labs