An online platform for teaching upper secondary school computer science

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Raspberry Pi Computing Education Research Centre
Welcome Jane!

Welcome to Isaac Computer Science, the free online platform for students and teachers.

- Use it in the classroom
- Use it for homework
- Use it for revision

We also offer free teacher CPD events and student workshops. Isaac Computer Science is proud to be part of the Department for Education's National Centre for Computing Education.

https://isaaccomputerscience.org/
There is a shortage of appropriately qualified computing teachers in secondary schools. Recruitment targets for computing teachers have consistently not been met. (The Royal Society, 2019)

“The discipline is completely new to me. It’s like a linguist having to teach a different language but with no resources or preparation time.” Head of ICT and Computer Science, Secondary School (Pye Tait Consulting, 2017)

Department for Education. 2020. A level and other 16 to 18 results in England. (DfE, 2020)
Lack of robust evidence and conflicting views on effectiveness of online learning platforms (Barbour, 2019, Education Endowment Fund, 2019, OECD, 2020)

- Process such as Arena Blended Connected are popular for designing online learning activities balancing Laurillard’s (2012) Learning Types

Reasons for augmenting classroom activities are given
- Broadening access
- Facilitating small group and 1:1 teaching
- Serving diverse needs
- More opportunity for practice
- Adding variety and enhancing engagement
- Supporting learning of complex abstract ideas (Means, Bakia & Murphy 2014)

Functionality to support online teaching of computer science is suggested
- General pedagogy tools e.g. collaboration
- Augmented learning e.g. student differentiation
- Computer science adaptations e.g. IDE
- Algorithm & program visualisation (Rößling et al., 2008)

(Young & Perovic, 2016)
Models to support educators to appropriate new tools and working practices are available e.g. Knowledge Appropriation Model

Literature

Pedagogy to support online teaching of CS to high school students suggests:
- No one pedagogy fits all
- Multiple pedagogy should be considered
- Automatic feedback on programming
- Visualisations of algorithms
- Representation of concepts in animations
- Offline physical activities

(Anohah, 2016)
Main Features of Isaac CS

• Free
• For teachers and their students
• Builds on Isaac Physics
• Web-based
• Content filled - centrally created material
• Suggested teaching order but teachers are expected to integrate into blended teaching and learning
• Full CS A-level (16-18 upper secondary) curriculum
• Awarding board specific display of content and questions
• Question design features
  • Multiple tries
  • Hints
  • Tailored feedback (including explanation videos)
• Question types for CS
  • Parsons problems
  • Boolean algebra editor
  • Text matching
  • Multiple choice questions (MCQ)
• Teacher professional development and student events
Using the laws of Boolean algebra, simplify this Boolean expression:

\[(A \cdot B) + A + B + C\]

The expression simplifies to:

- A + B + C
- False (0)
- (A \cdot B) + C
- \(\overline{C}\)

https://isaaccomputerscience.org/questions/sys_bool_07
Hints, Tailored Feedback

Using the laws of Boolean algebra, simplify this Boolean expression:

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The expression simplifies to:

- A + B + C
- False (0)
- \((A \cdot B) + C\)
- \(\overline{C}\)

Hint 2

Goal
Simplify the expression shown to one of the four options provided.

Information given
- A Boolean expression.

Knowledge assumed
- Rules of Boolean algebra
- How to simplify Boolean expressions

Incorrect

Anything NOTed twice is just itself. \((\overline{A}) = A\)

https://isaaccomputerscience.org/questions/sys_bool_07
Testing and Evaluation

Functionality testing
- Prototyping
- Automated tests
- Regression testing

Content testing
- New content quality assurance process
  - Internal and external reviews
  - Pilot with teachers
- Annual review
- User issues are ticketed and resolved

Pedagogy testing
- Hard to test
- Answer reviews

Platform evaluation
- Advisory group
- Teacher and student surveys
- Platform usage
<table>
<thead>
<tr>
<th>Functionality</th>
<th>Pedagogy</th>
<th>Instructional Approaches (Anderson &amp; Dron, 2011)</th>
<th>Constructivism</th>
<th>Constructivism (socio constructivism)</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cognitive Behaviourism</td>
<td>Learning types (Laurillard, 2012)</td>
<td>Acquisition</td>
<td>Practice</td>
<td>Investigation, Production</td>
</tr>
<tr>
<td>General Pedagogy tool</td>
<td>Accessing content pages e.g. text &amp; video material</td>
<td></td>
<td></td>
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<tr>
<td>Augmented (including Computer Aided Assessment (Carter, 2003))</td>
<td>Student's Awarding Body specific content displayed</td>
<td></td>
<td>Questions with common answer types • multiple-tries • episode-related hints • tailored feedback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer Science Learning Management Specific</td>
<td>Boolean Algebra notation</td>
<td></td>
<td>Questions with CS specific answer types • parsons problems • Boolean • text-matching</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Functionality of offline resources</td>
<td>Answer workbook questions – a subset of online questions</td>
<td></td>
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</tbody>
</table>
Lessons learned

1. Not all functionality is easy to apply or the same cost: questions involving natural language processing are difficult to set up and explanation videos are expensive to create and replace.

2. Student practice through answering questions can be augmented by multiple tries, self-selected hints and tailored feedback

3. To ensure that teachers and students use an online platform, careful and sustained effort is needed through marketing, teacher professional development, student events etc.

4. What upper secondary CS content looks like is not yet agreed but teachers are looking for content that fits their requirements.
Next steps

Pedagogy matrix
- Theoretical foundation
- Produce examples
- Compare tools and patterns of pedagogy

Teachers and Isaac CS
- Impact on
  - Subject knowledge
  - Knowledge of alternate conceptions
  - Self-efficacy
  - Community of practice
- Use in class
  - Blending with other tools
  - Unplugged activities
  - Learning types (collaboration, production, discussion, investigation)
  - 1:1 groups, differentiation etc

Students and Isaac CS
- Impact on
  - Subject knowledge
  - Knowledge of alternate conceptions
  - Self-efficacy
  - Community of practice

Question types
- Student preference
- Multiple try rate and usefulness
- Desirable difficulty
Questions and Answers

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Next slides are for Q&A

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References


A digital circuit can include many types of logic gate. However, these gates combine the fundamental functions of Boolean logic: AND, OR, and NOT. This means that when you are asked to use Boolean algebra, you need only consider the operators $\wedge$, $\lor$, and $\neg$.

https://isaaccomputerscience.org/concepts/sys_bool_boolean_algebra
Parsons problems

https://isaaccomputerscience.org/questions/prog_pas_06_v2
Laura has planned to go hiking in Snowdonia. She wants to take photos and videos of her trip with her digital camera and then show them to her friends, but her camera is running out of space.

Which **type of storage** is the most suitable in this case?

Type your answer here.

https://docs.moodle.org/dev/The_OU_PMatch_algorithm

https://isaaccomputerscience.org/questions/gcse_sys_04
Wrap Around Support

Teacher CPD
Algorithm Complexity and Computational Thinking
When:
Tue, 31 Aug 2021
10:00 — 17:00
Location: Online
View details

Teacher CPD
Assembly Language
When:
Thu, 23 Sept 2021
14:00 — 17:00
Location: Online
View details

Student Booster
Functional Programming with Haskell
When:
Wed, 22 Sept 2021
15:45 — 17:15
Location: Online
View details

Student Booster
Boolean Algebra
When:
Tue, 28 Sept 2021
15:30 — 17:00
Location: Online
View details

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