Properties and Applications of Wrong Answers in Online Educational Systems

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Adaptive Learning
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Wrong answer

Wrong answer

Learner input to wrongly answered question
Wrong answers

Feedback for teachers

common mistakes of a class
Wrong answers

Detecting level of knowledge

\[ 5 \times 5 \neq 30 \]
\[ 5 \times 5 \neq 24 \]
\[ 5 \times 5 \neq 17 \]
Wrong answers

Question construction

What is highlighted?

- Albania
- Bulgaria
- Croatia
- Italy
- Luxembourg
- Serbia
Wrong answers

Problem in user interface

10 ÷ 1 =

[Numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
Wrong answers

... and much more
matmat.cz
basic arithmetic
elementary school

outlinemaps.org
geography
high school

practiceanatomy.com
human anatomy
university
- simple tasks
- adaptivity - selection of questions
- > 200,000 answers
Wrong Answers - Geography
Common Wrong Answers

Countries

- common border, similar size, same first latter
- importance of practice context - Madagascar
Wrong Answers

Common Wrong Answers - Geography

- Bulgaria
- Romania
- Finland
- Norway
- Sweden
- Czech Rep.
- Hungary
- Russia
- United Kingdom
- Croatia
- Switzerland

Ratio of wrong answers

Legend:
- Most common
- 2nd most common
- 3rd most common
- 4th most common
- 5th most common

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Confusion Graph

Iceland

Ireland

United Kingdom

Albania

Macedonia

Moldova

Montenegro

Kosovo

Bosnia and Herz.

Switzerland

Finland

Sweden

Belgium

Luxembourg

Netherlands

Denmark

Norway

Sweden

Croatia

Slovenia

Slovakia

Serbia

Hungary

Romania

Bulgaria

Belarus

Ukraine

Lithuania

Latvia

Russia

Poland

Germany

France

Spain

Portugal

Italy

Adaptive Learning
Cross-system Comparison
Categories of Wrong Answers

- **TopWA** - most common wrong answer
- **CWA** - other common wrong answers - > 5%
- **Other**
- **Missing** - question skipped by learner
System comparison

<table>
<thead>
<tr>
<th></th>
<th>TopWA</th>
<th>CWA</th>
<th>Other</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>0.2</td>
<td>0.3</td>
<td>0.3</td>
<td>0.1</td>
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<td>Geography</td>
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<tr>
<td>Human Anatomy</td>
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</tr>
</tbody>
</table>
System comparison - Response time
System comparison - Probability of Leaving

Basic Arithmetic
Geography
Human Anatomy

Correct  TopWA  CWA  Other  Missing

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System comparison - Future Success

- Basic Arithmetic
- Geography
- Human Anatomy

Correct | TopWA | CWA | Other | Missing
---|---|---|---|---

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Categories of Wrong Answers

- TopWA, CWA, Other, Missing
- equally distributed
- linear behaviour
- similar behaviour in different domains
- good measure of wrongness - interval variable
Wrong answers

- are easy to collect
- has many applications: question and hint construction, feedback and inspiration, . . .

Contributions

- item clustering
- measure of wrongness