Assessment: The silent killer of learning

University of Waterloo
Waterloo, ON, Canada, 11 December 2014
Assessment: The silent killer of learning

@eric__mazur

University of Waterloo
Waterloo, ON, Canada, 11 December 2014
kosten
1. die Kosten (pl.)
2. kostbar

das Kind, -(e)s, -
1. kindisch
2. kindlich

kennen
kannte-gekannt
1. kennen-lernen
2. erkennen
3. bekannte
4. bekennen

magnificent
splendid
glorious

kranke
1. die Krankheit, -en

cow

tick of

377
430
455

magnificent
splendid
glorious

kranke
1. die Krankheit, -en

cow

tick of

377
430
455
35% retained after 1 week
we only guarantee they’ll pass the test
assessment focussed on ranking and classifying, not on developing 21st century skills
purposes
1 purposes
2 problems
3 improvements
how many different purposes of assessment can you think of?
1. rate students
2. rate professor and course
3. motivate students to keep up with work
4. provide feedback on learning to students
5. provide feedback to instructor
6. provide instructional accountability
7. improve teaching and learning
1 purposes
2 problems
inauthentic tests

1 purposes

2 problems
what is the meaning/definition of...?
inauthentic problem solving
problem

1 purposes

2 problems
problem

outcome

1 purposes

2 problems
1 purposes

2 problems

problem

outcome

KNOWN
1 purposes
2 problems
1. purposes
2. problems
1 purposes
2 problems
1. purposes
2. problems
purposes

problems

problem

solution

outcome

problem

procedure

answer

1

2

UNKNOWN

KNOWN
1. purposes
2. problems
On a Saturday afternoon, you pull into a parking lot with un-metered spaces near a shopping area. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces.
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How long do you have to wait before someone frees up a space?
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How long do you have to wait before someone frees up a space?

Requires:
Assumptions
Developing a model
Applying that model
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Developing a model
Applying that model
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**Assuming people leave at regularly-spaced intervals, how long do you have to wait before someone frees up a space?**

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- Assumptions
- Developing a model
- Applying that model
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- Assumptions
- Developing a model
- Applying that model
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$$t_{\text{wait}} = \frac{T_{\text{shop}}}{N_{\text{spaces}}}$$
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How long do you have to wait before someone frees up a space?

\[ t_{\text{wait}} = \frac{T_{\text{shop}}}{N_{\text{spaces}}} \]
computers can do this!

1 purposes
2 problems
1 purposes

2 problems
purposes

problems
REAL problem solving

1 purposes
2 problems
grading incompatible with real problem solving

1 purposes
2 problems
isolation
We will use spherical coordinates: $0 \leq \phi \leq \frac{\pi}{4}$, $0 \leq \theta \leq 2\pi$, $\leq \phi \leq \frac{\pi}{2}$. The integral is thus:

\[
\int_{\phi=0}^{\phi=\frac{\pi}{4}} \int_{\theta=0}^{\theta=2\pi} \int_{\rho=0}^{\rho=\frac{\sqrt{2}}{2}} \rho^2 \sin(\phi) d\rho d\theta d\phi
\]

\[
= \left\{ \int_{\rho=0}^{\rho=\frac{\sqrt{2}}{2}} \rho^2 d\rho \right\} \left\{ \int_{\theta=0}^{\theta=2\pi} d\theta \right\} \left\{ \int_{\phi=0}^{\phi=\frac{\pi}{4}} \sin(2\phi) d\phi \right\} = 0
\]
high-stakes examinations promote cramming

1. purposes
2. problems
information stored in short-term memory
1 purposes
2 problems

no retention
information stored in short-term memory
no transfer
grades: measure of standing relative to others
grades: measure of standing relative to others
feedback: reflection on what has been learnt

1 purposes
2 problems
assessment produces a conflict
assessment produces a conflict

coach or judge?

1 purposes

2 problems
conflict resolved by:

objectivity (fairness, reliability)
List the three important concepts that the Law of conservation of Energy leads to:

- Equilibrium (boring)
- Thermodynamics (boring)
- Kinetics (bow-chicka-wow-wow)

describe the Law of definite composition (Dalton’s Law):

1. purposes
2. problems

... but ...
only lowest order thinking skills can be judged objectively
and then there is...

- grade inflation
- cheating
1. purposes
2. problems
3. improvements
1 mimic real life

1 purposes  2 problems  3 improvements
open-book exam

1. purposes
2. problems
3. improvements
1. purposes
2. problems
3. improvements
REMEMBERING
UNDERSTANDING
APPLYING
ANALYZING
EVALUATING
CREATING

1 purposes
2 problems
3 improvements
REMEMBERING
UNDERSTANDING
APPLYING
ANALYZING
EVALUATING
CREATING

1 purposes
2 problems
3 improvements
<table>
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**IMMEDIATE FEEDBACK ASSESSMENT TECHNIQUE (IF AT)**

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<thead>
<tr>
<th>Name</th>
<th>Team</th>
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<table>
<thead>
<tr>
<th>Subject</th>
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<tr>
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<td>23</td>
</tr>
</tbody>
</table>

SCRATCH OFF COVERING TO EXPOSE ANSWER

1. purposes
2. problems
3. improvements
Session 389314

This is the individual round; work on these questions on your own.

expression question

What is the derivative of $f(x) = 3x^2 - 6x$?

Submit response

Enter an expression, e.g., $x^2$ for $x^2$, $\ln(y) - \sin(x)$ for $\ln y - \sin x$, $x/(y+1)$ for $\frac{x}{y+1}$, $(1/2)x$ for $\frac{1}{2}x$. Do not enter a complete equation.

Current team: Blue team  🕯️ Change team  ✆ Change seat  ☑️ Send a message to the instructor  ❯ Join another

1 purposes  2 problems  3 improvements
This is the individual round;

**expression question**

What is the derivative of $f(x) = 3x^2 - 6x$?

Enter an expression, e.g., $x^2$ for $x^2$, $\ln(y) - \sin(x)$ for $\ln y - \sin x$. 

1 purposes 2 problems 3 improvements
This is the individual round;

**expression question**

What is the derivative of \( f(x) = 3x^2 - 6x \)?

\[ 6x - 6 \]

Enter an expression, e.g., \( x^2 \) for \( x^2 \), \( \ln(y) - \sin(x) \) for \( \ln y - \sin\ x \).
expression question

What is the derivative of $f(x) = 3x^2 - 6x$?

Enter an expression, e.g., $x^2$ for $x^2$, $\ln(y) - \sin(x)$ for $\ln y - \sin x$. 

purposes

problems

improvements
2 focus on feedback, not ranking
objective ranking: a myth
2 metrics, 2 results

- **Final grade** vs. **Conceptual understanding**

  - **Y-axis**: Final grade
  - **X-axis**: Conceptual understanding

**Legend**:

- 1 purposes
- 2 problems
- 3 improvements
Aristotelian thinkers

Purpose: 

Problems: 

Improvements: 

Diagram: Scatter plot showing the relationship between conceptual understanding and final grade.
top performers, broad grade distribution
objectivity or injustice?

1. purposes
2. problems
3. improvements
3 focus on skills, not content
Grant Wiggins and Jay McTighe, *Understanding by Design* (Prentice Hall, 2001)

1. purposes
2. problems
3. improvements
Traditional approach to course planning

1 purposes  2 problems  3 improvements

course content
Traditional approach to course planning

1. purposes
2. problems                  3. improvements

- course content

- assessment
Traditional approach to course planning

1. purposes
2. problems
3. improvements

Course determined by content

Course content → assessment
Backward design

1. purposes
2. problems
3. improvements

desired outcomes
Backward design

acceptable evidence → desired outcomes

1 purposes
2 problems
3 improvements
Backward design

1 purposes
2 problems
3 improvements
Backward design

- instructional approach
- acceptable evidence
- desired outcomes

Course defined by outcomes

1. purposes
2. problems
3. improvements
Backward design

1. purposes
2. problems
3. improvements

Instructional approach
Acceptable evidence
Desired outcomes

Course defined by outcomes
resolve coach/judge conflict
use external evaluators

1. purposes
2. problems
3. improvements
peer- and self-assessment

1. purposes
2. problems
3. improvements
Calibrated Peer Review

cpr.molsci.ucla.edu

1. purposes
2. problems
3. improvements
Step 1: assignment & rubric

purposes

problems

improvements
<table>
<thead>
<tr>
<th>Structure</th>
<th>Title</th>
<th>Opening</th>
<th>Paragraph length</th>
<th>Organization</th>
<th>Closing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wordy, long, unimaginative, or inappropriate title</td>
<td>Missing a &quot;hook&quot; or a lead in the first paragraphs AND does not orient reader to subject</td>
<td>Many paragraphs are long (6 or more sentences)</td>
<td>Lacks organization, no logical headings, no transitions between paragraphs</td>
<td>Does not end compellingly or with an important idea AND does not tie back to opening</td>
</tr>
<tr>
<td></td>
<td>Basic title</td>
<td>Hook or lead present OR first few paragraphs orient reader to subject</td>
<td>Some paragraphs are long (6 or more sentences), most are short (1-5 sentences)</td>
<td>A few headings OR most paragraphs linked by transitions</td>
<td>Summary-like closing, but does not tie back to title or opening hook</td>
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<table>
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<th>Content/Ideas</th>
<th>Sources/evidence</th>
<th>Scientific facts</th>
<th>Sources/evidence</th>
<th>Content/Ideas</th>
<th>Closing</th>
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<tr>
<td></td>
<td></td>
<td>Contains incorrect, misstated, irrelevant, or unnecessary facts</td>
<td>Mostly predictable based on available material</td>
<td>Material appropriate and aimed at target audience AND mostly avoids scientific jargon, colloquialisms, or acronyms</td>
<td>Includes fact-checked expert and/or lay testimony (newspaper article only)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Does not back up facts with proper, convincing, or interesting sources or evidence</td>
<td></td>
<td>Material appropriate and aimed at target audience AND relates to practical/everyday concerns AND uses analogies or other techniques to relate unfamiliar content to familiar concepts; no jargon, colloquialisms, or acronyms</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Most, but not all, facts backed up with proper, convincing, or interesting sources or evidence</td>
<td></td>
<td>Some originality apparent</td>
<td>Some originality apparent</td>
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**Rubric for Calibrated Peer Review**

1 = needs improvement

- Does not meet expectations entirely
- Wordy, long, unimaginative, or inappropriate title
- Missing a "hook" or a lead in the first paragraphs AND does not orient reader to subject
- Many paragraphs are long (6 or more sentences)
- Lacks organization, no logical headings, no transitions between paragraphs
- Does not end compellingly or with an important idea AND does not tie back to opening

2 = satisfactory

- Meets expectations
- Hook or lead present OR first few paragraphs orient reader to subject
- Some paragraphs are long (6 or more sentences), most are short (1-5 sentences)
- A few headings OR most paragraphs linked by transitions
- Summary-like closing, but does not tie back to title or opening hook

3 = admirable

- Exceeds expectations (rarely selected)
- Catchy title drawing audience into article
- Compelling audience appropriate hook or lead present OR first few paragraphs orient lay reader to subject
- All paragraphs are short (1-5 sentences)
- Headings structure paper in organized, logical way AND paragraphs linked by transitions
- Ends compellingly with an important idea or though provoking question AND ties back to title and opening hook

**WRITING RUBRIC**

1 purposes
2 problems
3 improvements
Step 2: upload

Step 3: review

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1 purposes
2 problems
3 improvements
Spectacular Supernova Observed Worldwide

By John Glenn

January 20, 2009

New York, N.Y. – People around the world witnessed the brightest exploding star, or supernova, in recorded history this morn

ing. The supernova, named SN2009Z, first lit up the sky at 4:14 AM Eastern Time, appearing as bright as the full moon. At first light, it was 20 billion times brighter than our sun. It continued to shine for several hours. As of press time, the supernova had disappeared over the horizon. By now everyone has noticed the new addition to our night sky.

昨夜の新たなる明るい天体

The New York Times

Galileo
20 January 2008

Yesterday at about 4 p.m., I observed a peculiar appearance in the sky. A glowing flash emitted for a few seconds, accompanied its appearance. The object first appeared as a small flash of light, which then grew larger and larger. It was so bright that it was visible even in broad daylight. How did this unexpected event and its consequences for Earth? In order to understand it and not be alarmed, we have to understand the life cycle of stars and how they form.

Supernovae are the result of a massive star merging with another star, causing a violent explosion. This explosion releases huge amounts of energy, causing the star to expand and brighten. Supernovae are very rare events, occurring only once in every 100 million years. However, when one occurs, it is visible from Earth for several months, making it one of the most spectacular events in the universe.

By now everyone has noticed the new addition to our sky, which outshines the brightest star at night and is an unmistakable new addition to our night sky. None of us have seen such a sight in the course of our lives and for many it has served as a jarring reminder of the violent and powerful cosmic events that occur in space.

Bright new addition to night sky

Spires fear and awe – Mona Lisa

Bright new addition to night sky

Supernovae are so energetic that to put them in perspective one may consider the amount of energy released by a supernova. This energy is equal to three million times the mass of our sun. However, this energy is not distributed evenly. It is released in a series of pulses, each lasting for a few seconds. Each pulse is brighter than the previous one, causing the supernova to appear as a series of flashes.

It is precisely the brightening of the star, as its outer layers are blasted outward, that we see when we look skyward. Supernovae are classified into two main types: Type I and Type II. Type I supernovae are caused by the explosion of a white dwarf star, while Type II supernovae are caused by the explosion of a red giant star. SN2009Z is a Type Ic supernova, meaning that it is caused by the explosion of a red giant star.

New York, N.Y. – People around the world witnessed the brightest exploding star, or supernova, in recorded history this morning. The supernova, named SN2009Z, first lit up the sky at 4:14 AM Eastern Time, appearing as bright as the full moon. As of press time, the supernova had disappeared over the horizon.

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It is precisely the brightening of the star, as its outer layers are blasted outward, that we see when we look skyward. Supernovae are classified into two main types: Type I and Type II. Type I supernovae are caused by the explosion of a white dwarf star, while Type II supernovae are caused by the explosion of a red giant star. SN2009Z is a Type Ic supernova, meaning that it is caused by the explosion of a red giant star.

New York, N.Y. – People around the world witnessed the brightest exploding star, or supernova, in recorded history this morning. The supernova, named SN2009Z, first lit up the sky at 4:14 AM Eastern Time, appearing as bright as the full moon. As of press time, the supernova had disappeared over the horizon.
1 purposes
2 problems
3 improvements
1. purposes
2. problems
3. improvements
1. purposes
2. problems
3. improvements

Diagram:

- UPLOAD
- CALIBRATION
- PEER ASSESSMENT
- SELF EVAL
- SCORING BY PEERS
- CALIBRATION SCORE
- SCORE FOR PEERS

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