Atomic, reusable feedback: a technology-mediated solution for assessing handwritten math tasks?

Poster presented at the International Congress on Mathematical Education, ICME 14, 11 to 18 July 2021, Shangai

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Motivation

- Half of the teachers in the European Union complain they have too many correcting tasks.
- Fully automated assessment is not ready to solve this problem: teacher-led corrections on handwritten tasks are still important as fully automated assessment can not assess all mathematical skills (e.g., problem-solving).
- Need for an efficient solution to assess handwritten tasks.

Research goal

Tackle the problem semi-automatically:

- …if a teacher must give feedback on handwritten tasks, how can a computer help and work together with the teacher to make the process efficient?
- …with reusable feedback: when a teacher writes feedback for a student, the computer saves it, so it can be reused when following students make the same or similar mistakes.

Atomic feedback

How to write reusable feedback? No one knows; that is why we introduce atomic feedback. To write it, a teacher must:

(1) identify the independent error occurring and,

(2) write separate feedback sentences for each error, independent of each other.

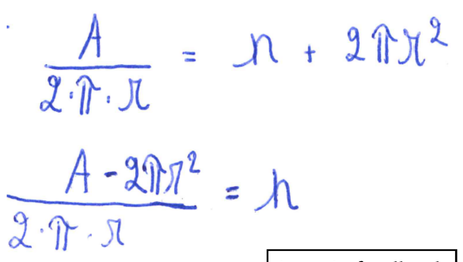
As such, the atomic feedback items form a hierarchical list of bullet points with feedback.

Example of classic vs atomic feedback

Student's solution

Manipulate the formula:

$$A = 2\pi rh + 2\pi r^2 \quad \text{to } h$$



Classic feedback

Mind the fact that the dominant operation in the right-hand side of the equation is an addition! It is impossible to divide the left-hand side by $2\pi r$ because, in the first step, it is not handled as the common factor of the right-hand side. Your final answer is right, but written this way, it seems as coincidence. Going from the first to the second step, normally you would substract $2\pi r^2$ from both sides, meaning that it shouldn't be placed in the nominator. It is unclear of this is an additional mistake or a compensation of the previous mistake.

Atomic feedback

- First step
  - Right-hand side
    - Mind the fact that the dominant operation is an addition!
  - It is impossible to divide the left-hand side by $2\pi r$ because, in the first step, it is not handled as the common factor of the right-hand side.
- Second-step
  - Your final answer is right, but
    - Going from the first to the second step, you should substract $2\pi r^2$ from both sides.
    - $2\pi r^2$ shouldn't be placed in the nominator.
    - It is unclear of this is an additional mistake or a compensation of the previous mistake.

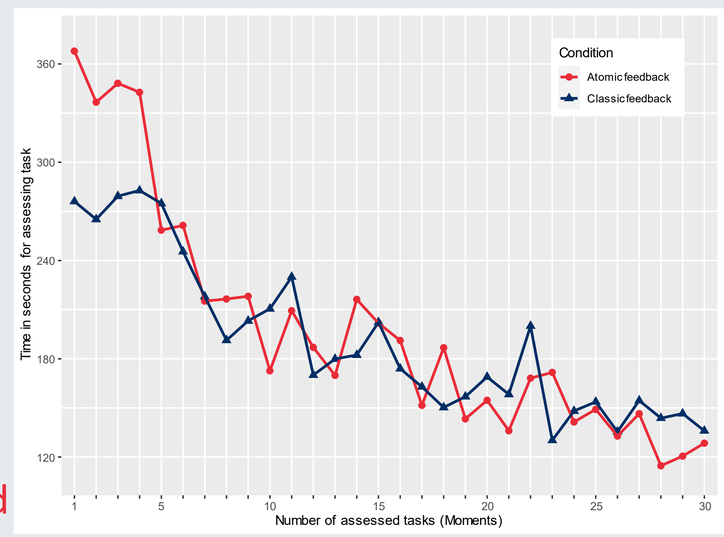
Experimental design

We developed a Moodle-plugin to assess semi-automatically with atomic feedback that could be reused (suggestion of items based on used words)

We did a crossover study with 45 math teachers where they had to correct 60 tasks on linear equations in two different conditions: the traditional, classic feedback condition and the atomic feedback condition, using the developed plugin.

Results

- No significant time differences between classic and atomic feedback-conditions.
- Effect on amount of feedback, teachers provided significantly more feedback under atomic feedback-condition (d=0.41)
- Items classified as atomic were significantly more reused than the non-atomic items (odds ratio = 2.6).



Need explanation? Try a demo?

Go to www.vvwl.be/icme or scan the QR-code to get a short presentation or a demo.

Conclusion & Further research

- Atomic feedback is reusable feedback, so we found formal requirements to write feedback that can be reused.
- Teachers in this sample tend to give more feedback with the semi-automated system instead of saving time.
- In the future, we will link a marking system with atomic feedback and make the suggestions system smarter.

1 This research project is funded as PhD fellowship of Filip Moons by FWO, the Research Foundation of Flanders, Belgium (1S95920N).

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