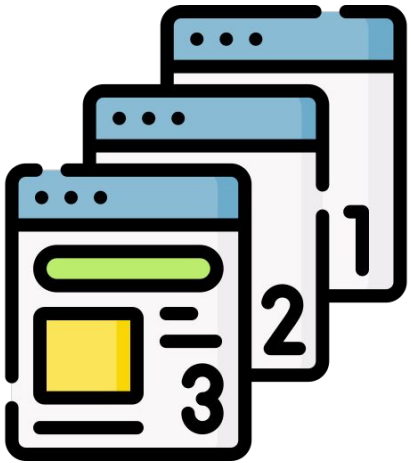


AUTO-GENERATION OF MULTIPLE QUESTION VARIATIONS IN E-LEARNING

Theresia Veronika Rampisela

Disclaimer: opinions expressed are solely my own and do not express the views or opinions of my (ex-)employer

Multiple question variations?

-Problem 1-	-Problem 2-	-Problem 3-	...	-Problem *n*-
Find the inverse of **f(x) = 7x - 3**	Find the inverse of **f(x) = 7x + 3**	Find the inverse of **f(x) = 4x - 3**		Find the inverse of **f(x) = 7x - 5**
Variation 1	**Variation 2**	**Variation 3**	...	**Variation *n***

- Start with **a problem/question**
- Vary the problem by changing **mathematical operator**, **numbers**, or **variable**
- … but **keep the (perceived) difficulty** and the **general solution** the **same**
  - I did not change **x to x^3** because it is harder to solve!
  - I did not change **7 to 17372** because it *may look* harder! (Even if it's not actually harder)
  - I did not change **subtraction to division** because the procedure is slightly different

This talk is about…

1. **Reasons** to create multiple question variations

   → find out if this is applicable to your course

2. **How to** automatically generate multiple variations

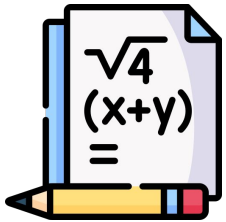
   → with a Moodle plugin

3. **The benefits** of having multiple question variations

   → for both teachers/TAs, and students

Background

This talk is based on **my personal experience, in teaching:**

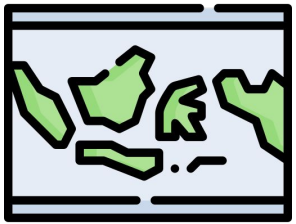


Maths-related & data science courses

- Logical sequence
- Questions can be varied by replacing numbers

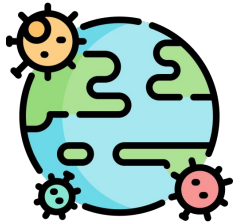
Computer science bachelor students

Prior math knowledge (course requirement)



In Indonesia

Final course grade may be calculated differently from in Denmark



During the pandemic

E-learning settings

Math, Code, Indonesia, and Pandemic icons created by Freepik - Flaticon

Setting: the course structure

A typical week:

Slides and **pre-recorded lectures** uploaded on e-learning platform

↓

Students do **graded, take-home pre-class quiz**

↓

Go through quizzes in class (+ other things)

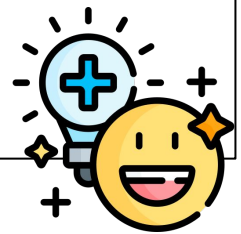
Students are still allowed to join the class even if they didn't do the quiz

Pre-class quiz (how much work this is)

- A total of **9** quizzes (16 weeks of lessons)
- **4-5 short questions**
- **10%** of final grade
- Individual work; **discussion** with peers/TAs is allowed

Q: How should we **encourage students** to discuss **how to solve the problem,** instead of solely focusing on the final answers?

A: Multiple question variations!
Each student only gets 1 variation



Positive thinking icons created by Freepik - Flaticon

Our wishlist 🌠

With ~400 students, 5 lecturers and 20 TAs (mostly undergrad students), we want:

- Fast feedback cycle so that students can learn from the exercises

  → Quizzes should be **autograded** (fill-in-the-blank, dropdown)

- Harder to find two students with exactly the same questions

  → **>20 variations** to be assigned randomly to students

- These variations should be **easily maintained**

  → If there is a mistake, we can **fix the main template** instead of individual variation

- Can be **regraded** automatically/manually

  → Just in case the initial answer key is wrong

Group icons created by Freepik - Flaticon

Different ways of creating question variations

Manual creation of different sets

❌ Not enough time for creating many variations (having 2–3 at most)

❌ Each variation needs to be updated manually if there's a typo or wrong answer

Use student ID number for variation

Find the inverse of f(x) = **a**x + **b**

"Use the **second last digit** of your student ID as **a** and the last digit as **b**"

❌ Students have to follow extra instructions – often the wrong digit was used

❌ Graders need to be extra careful too – auto-grading not possible

Auto-generation with Moodle plugin

✅ Easily create dozens to hundreds of variations

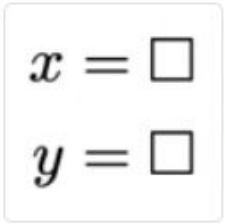
✅ Auto-grading

✅ Automatic or manual re-grading

✅ Only need to create one question item instead of multiple → easy maintenance

- **Open source** Learning Management System
  → free to download, modify, and share
- **Freemium** – some premium features
- Similar function as **Canvas**
- Allows customization with 2000+ plugins

Plugins / Quiz / Question types / Formulas question type / Description



Formulas question type

Question types ::: qtype_formulas

https://moodle.org/plugins/qtype_formulas

Simple example of variations of question

Student 1 view

		Actual	
		-	+
Predicted	-	15	3
	+	10	72

Recall =

Precision =

Accuracy =

Specificity =

Student 2 view

		Actual	
		-	+
Predicted	-	14	3
	+	11	72

Recall =

Precision =

Accuracy =

Specificity =

Student 3 view

		Actual	
		-	+
Predicted	-	13	3
	+	10	74

Recall =

Precision =

Accuracy =

Specificity =

Simple example of variations of question

Student view

		Actual	
		-	+
Predicted	-	15	3
	+	10	72

Recall =

Precision =

Accuracy =

Specificity =

Teacher view – choose what to vary and how

		Actual	
		-	+
Predicted	-	{TN}	{FN}
	+	{FP}	{TP}

Random variables

```
TP = {70:75};
FP = {10:14};
FN = {3:5};
```

Global variables

```
TN = 100-TP-FP-FN;

rec = round(TP/(TP+FN), 2);
prec = round(TP/(TP+FP), 2);
acc = round((TP+TN)/100, 2);
spec = round(TN/(TN+FP), 2);
```

Answer* [rec, prec, acc, spec]

```
Recall = {_0}

Precision = {_1}

Accuracy = {_2}

Specificity = {_3}
```

Other question forms

Dropdown

The numbers 11, 23, and 19 are [ ]. Hence, the system of linear congruence [ ]

- pairwise relatively prime
- not pairwise relatively prime

Guided exercise
(steps provided)

First, we rewrite $x \equiv 4 \pmod{11}$ into the form $x = b + km$ for $k \in \mathbb{Z}$:

$x =$ [ ] + $k \cdot$ [ ]

Next, we substitute that equation into the second linear congruence, $x \equiv 13 \pmod{17}$. Thus, we obtain:

[ ] + $k \cdot$ [ ] $\equiv 13 \pmod{17}$

We move the constant on the left to the right of the equation:

$k \cdot$ [ ] $\equiv 13 -$ [ ] $\pmod{17}$

Simplifying:

$k \cdot$ [ ] $\equiv$ [ ] $\pmod{17}$

Plenty of tutorials!

YouTube
https://www.youtube.com › watch · Oversæt denne side

Moodle Formula Question - Answer Types

Learn how to author questions using the **Moodle Formula** Question type. This video outlines how to use various Answer Types.

YouTube · Mark Schneider · 29. apr. 2022

10 vigtige øjeblikke i denne video

YouTube
https://www.youtube.com › watch · Oversæt denne side

Formula Questions for Moodle (Introduction)

This video gives a short introduction to **formula** questions and shows how to write a very simple question with random variables.

YouTube · Cormac Quigley · 15. apr. 2020

What is the advantage of doing this?

The question itself

- **Deterministic**: correct answer if formula is correct
- Even if the formula is wrong, it can be changed and **regraded** automatically or manually

Students

- They find it **fun** and **facilitate their learning**
- Ungraded exercises can be used as **self-review exercises** before exam
  - One student can try the same question with different numbers/variables & **learn from the automated feedback**
  - Reduce lucky guesses – sometimes doing a question wrong produces the right answer

Teachers

- **Easy maintenance** of multiple variations
- **Reduced prep time** in creating multiple variations

Test, students, teacher icons created by Freepik - Flaticon

🔥 *Q: Can ChatGPT/LLM be used to do this?*

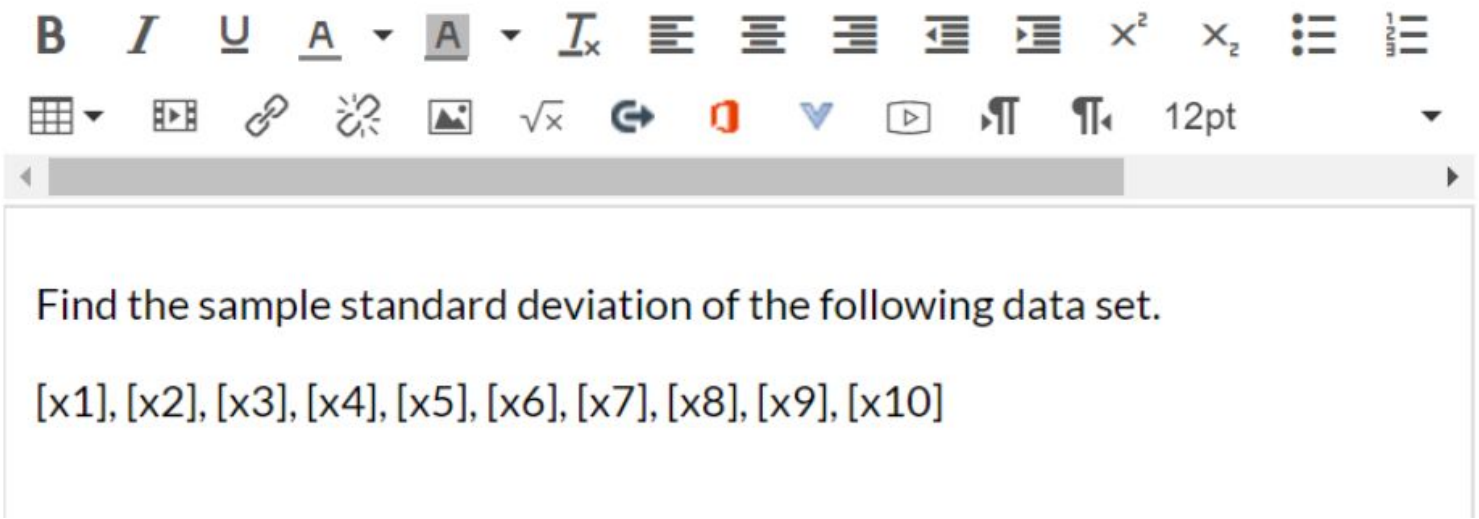
A: Yes, but:

- Need to **verify manually**; sometimes they may not give correct answers
- Each question variation still needs to be inputted/registered as an **individual question** as opposed to a single question
- Solutions and questions are “hardcoded” → **not easily maintained**

Or… it may be used to help with the syntax or question design

Q: Can we do this in Canvas?

A: Yes, with “Formula Question Type” – similar procedure



Recap:

1. Question variations have been used in **low-stake graded** exercises & **ungraded** exercises
2. **Automatically** create many question variations and answers with **Moodle Formulas**
3. Auto-generation of question variations encourages **fun discussion** among students and **reduces the time to create question variations** for teachers.

Icon created by khulqi Rosyid - Flaticon