NTNU

Kunnskap for en bedre verden

Precalculus assessed with STACK

Find the learning outcome of a STACK course with **N** quizzes, teacher engagement **TA**, preparation time **PT**, and **B** bugs.

`N/B`

Your last answer was interpreted as follows:

$$\frac{number\ of\ quizzes}{number\ of\ bugs}$$

Your answer is partially correct.

A correct answer is $\frac{(teacher\ engagement)\cdot(preparation\ time)}{number\ of\ bugs}$, which can be typed in as follows: `(TA*PT)/B`

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NTNU Trondheim

Digital math quizzes – do they work?

Valdez, 2021:

Will students use it voluntarily??

~~Factors affecting student perception~~

- Ease of use
- Personal preference
- Technical considerations
- Compatibility with other methods

"Students tend to become more accepting of a new strategy or technology if they feel that it helps them achieve their learning goals."

Valdez, M., & Maderal, L. D. (2021). An Analysis of Students' Perception of Online Assessments and Its Relation to Motivation towards Mathematics Learning.

STACK

Find the zeros of the expression $x^2 - 10 \cdot x + 9$. Enter your answer as a set. Tidy

{1,8}

Your last answer was interpreted as follows:

$\{1, 8\}$

Your answer is partially correct.

These entries should not be elements of your set.

$\{8\}$

The following are missing from your set.

$\{9\}$

Yes, $x = 1$ is one of the zeros. Can you find the other one?

A correct answer is $\{1, 9\}$, which can be typed in as follows: `{1,9}`

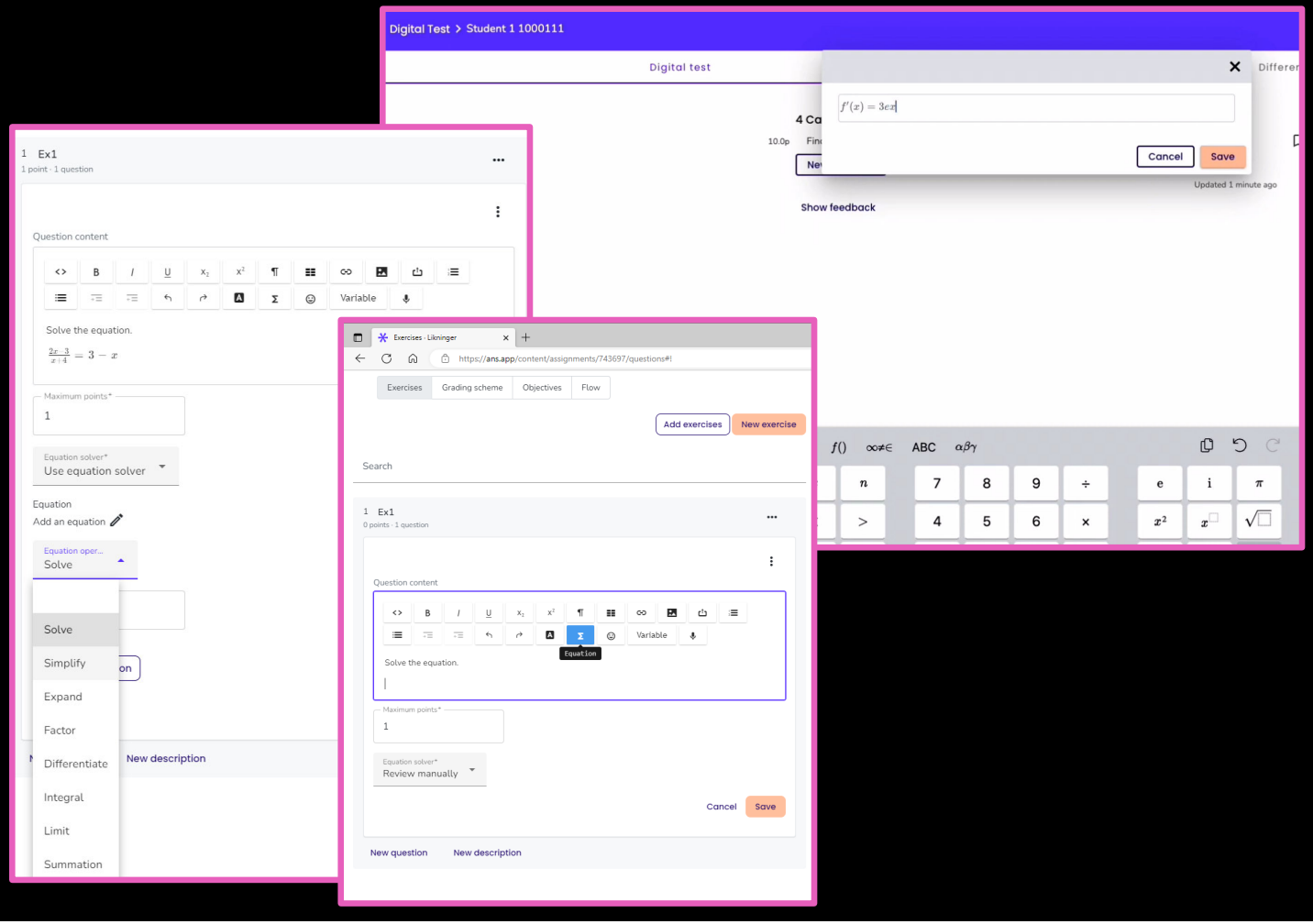
- The leading open-source online assessment system in STEM courses
- CAS-based
- 14 input types, 38 answer tests
- Easy randomization of question variables
- Costumizable and dynamic feedback

E-assessment: Popular choices

ans*

The satisfying assessment platform

With Ans, you can comment on test answers, essays and even other graders for a transparent and constructive experience.

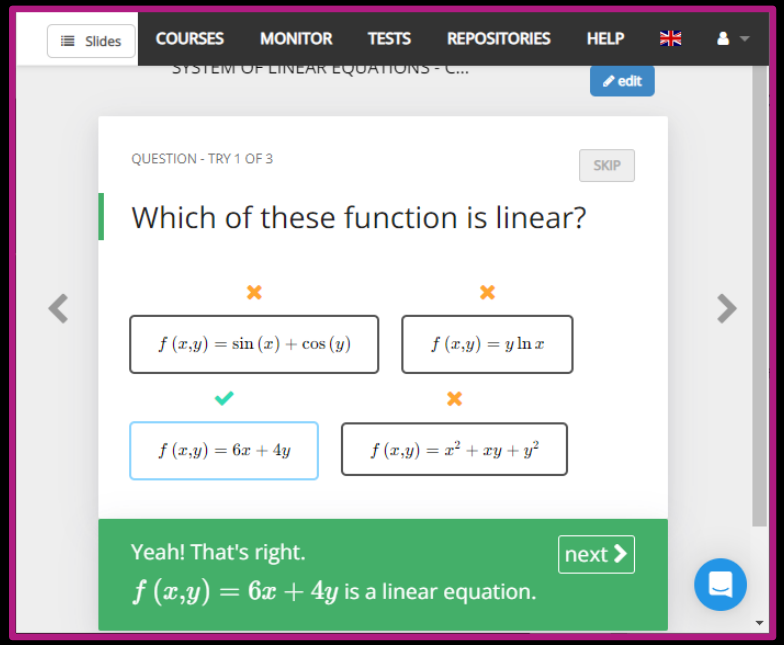


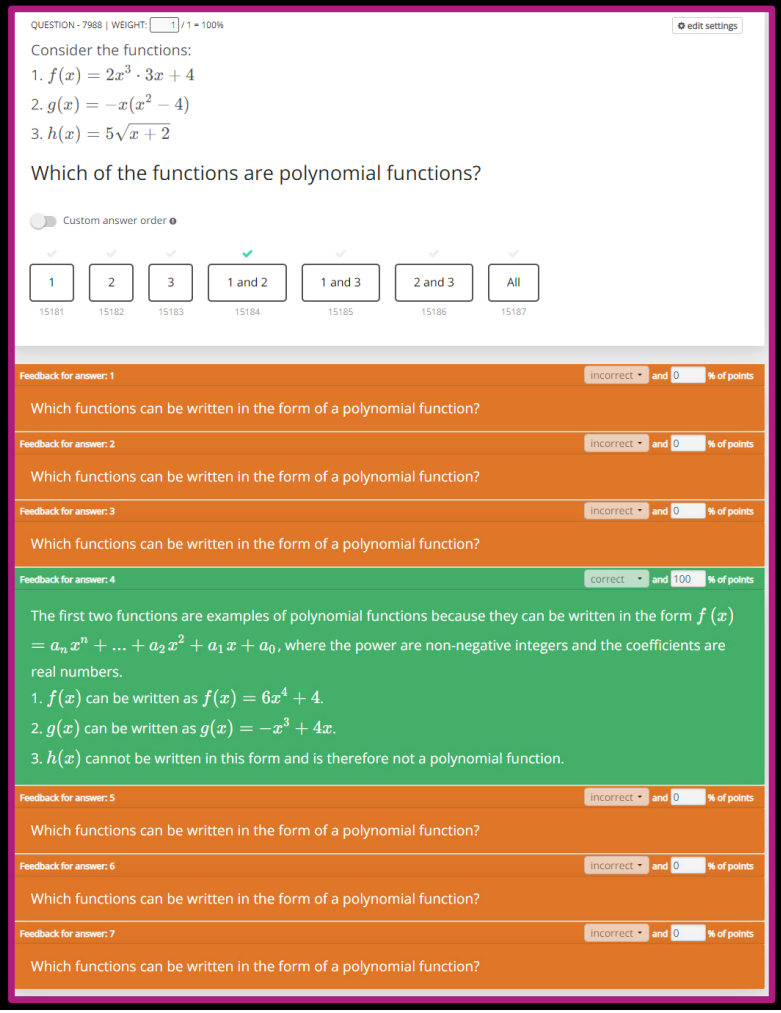
E-assessment: Popular choices

Grasple

open exercises
for math & stats

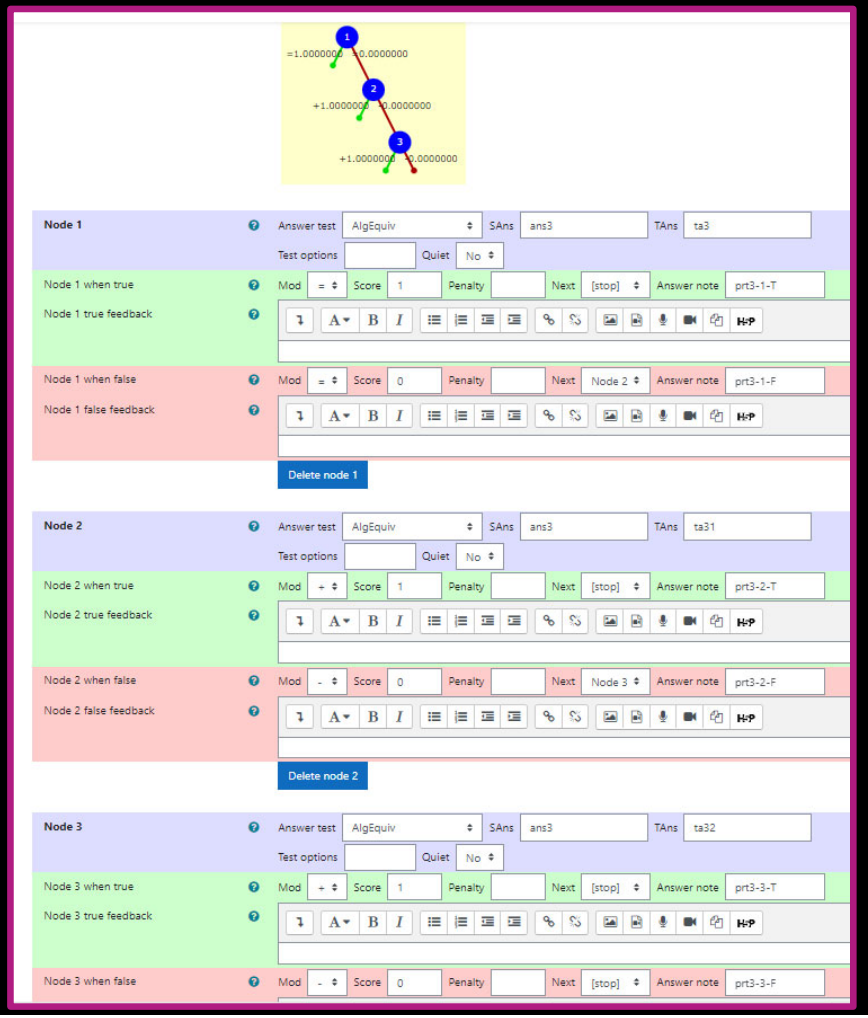
Grasple is a practice and assessment tool optimised for mathematics and statistics, with a focus on open education.





E-assessment: Popular choices

STACK is the world-leading open-source (GPL) automatic assessment system for mathematics, science and related disciplines.



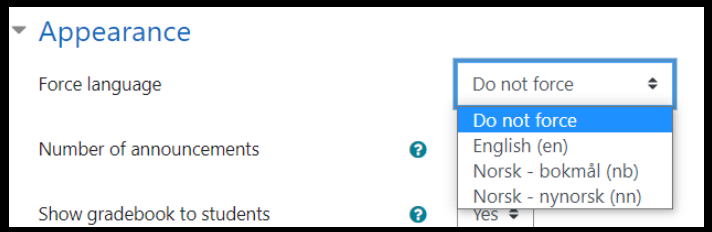
Translation of quizzes: HELM

HELM

‘Helping Engineers Learn Mathematics’, Uni consortium project in UK 2002-2005

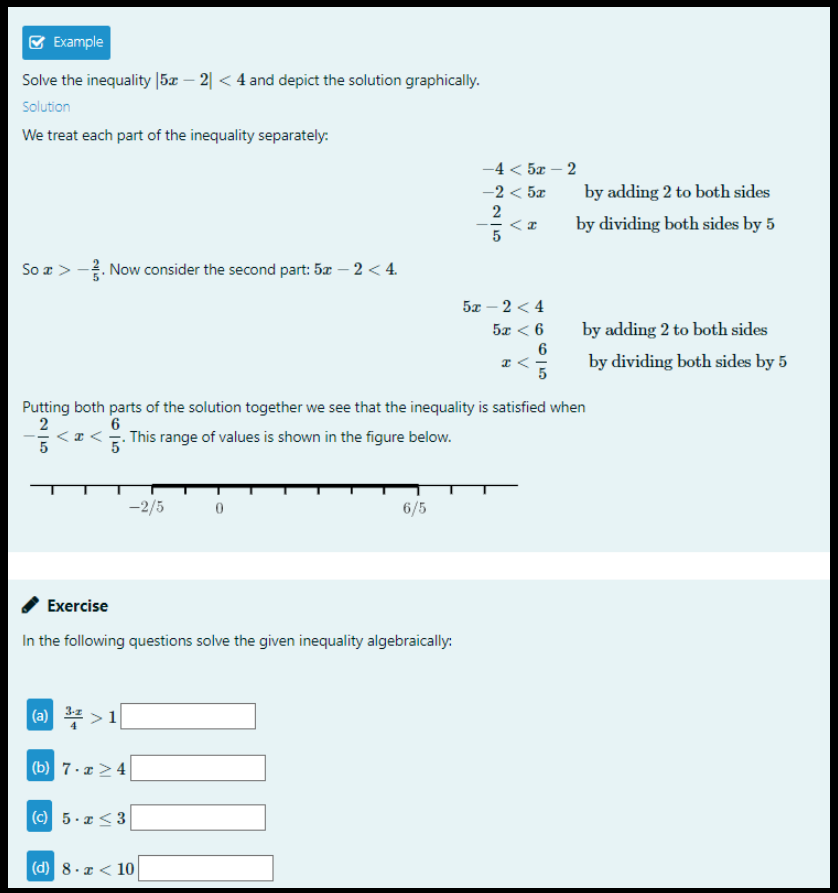
50 open-source workbooks (chapters) for engineering undergraduates

Translation work as part of Erasmus+ project «




```
<p class="HELM_exercise"><span class="multilang" lang="en">Exercise</span>
    <span class="multilang" lang="no">Øving</span>
</p>
<p><span class="multilang" lang="en">Solve the quadratic equation \({@exp@}=0\). If there is a repeated root, enter this twice.</span>
    <span class="multilang" lang="no">Løs andregradsligningen \({@exp@}=0\). Hvis det er et dobbelt nullpunkt, skriv inn denne to ganger.</span>
</p>
<p>
    <nowrap>\(x = \) [[input:ans1]] [[validation:ans1]] or \(x = \) [[input:ans2]][[validation:ans2]]
    </nowrap>
</p>
```

Start-Ing STACK



Example

Solve the inequality $|5x - 2| < 4$ and depict the solution graphically.

Solution

We treat each part of the inequality separately:

$$\begin{aligned} -4 &< 5x - 2 \\ -2 &< 5x && \text{by adding 2 to both sides} \\ -\frac{2}{5} &< x && \text{by dividing both sides by 5} \end{aligned}$$

So $x > -\frac{2}{5}$. Now consider the second part: $5x - 2 < 4$.

$$\begin{aligned} 5x - 2 &< 4 \\ 5x &< 6 && \text{by adding 2 to both sides} \\ x &< \frac{6}{5} && \text{by dividing both sides by 5} \end{aligned}$$

Putting both parts of the solution together we see that the inequality is satisfied when $-\frac{2}{5} < x < \frac{6}{5}$. This range of values is shown in the figure below.

Exercise

In the following questions solve the given inequality algebraically:

(a) $\frac{3 \cdot x}{4} > 1$

(b) $7 \cdot x \geq 4$

(c) $5 \cdot x \leq 3$

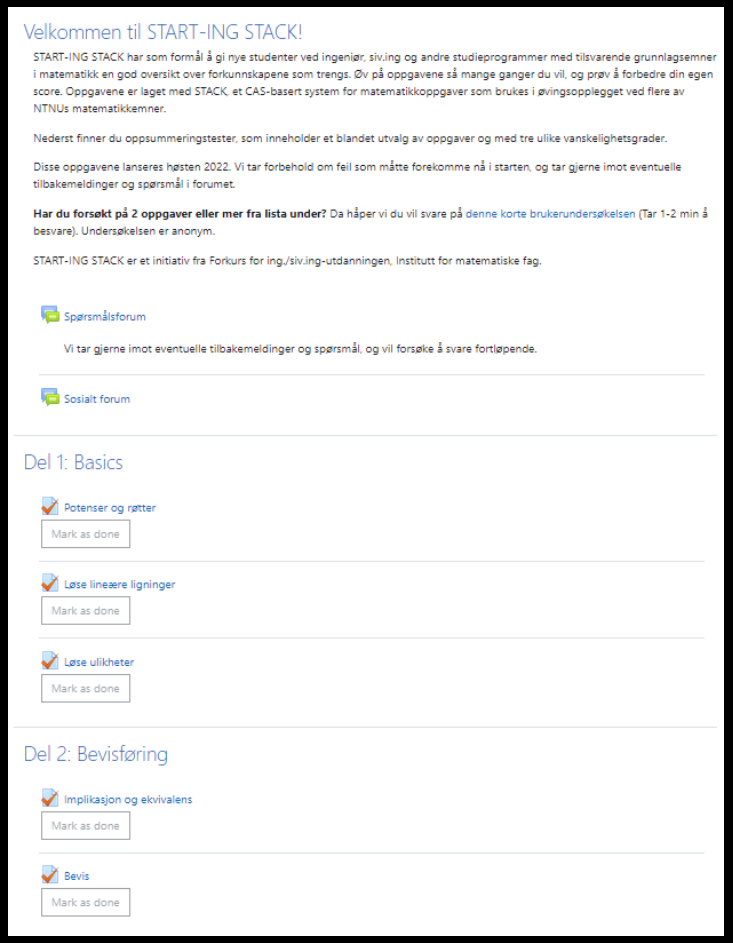
(d) $8 \cdot x < 10$

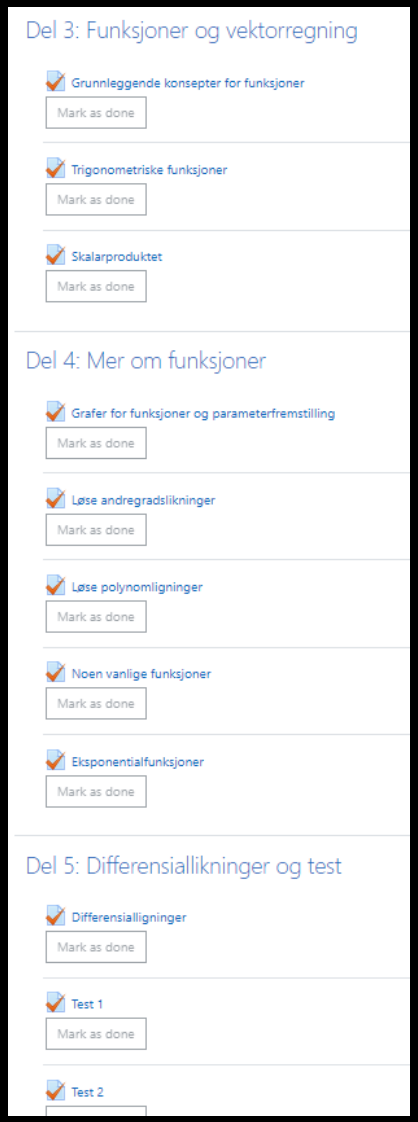
- Started at NTNU August 2022
- ~ 4000 students ~~enrolled~~ invited
- At beginning of first year
- Most quizzes from HELM

Should enable students to…

- check whether they have sufficient prior knowledge in place early in the first term
- repeat concepts that they may be unsecure about
- get to know the use and functionality of STACK from a student perspective, so that you are ready to use the system for compulsory exercises

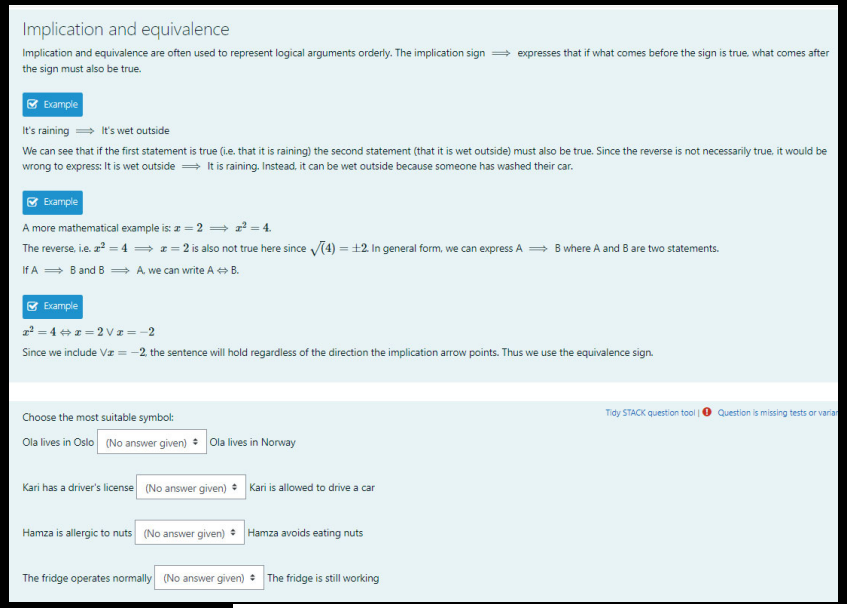
Start-Ing STACK





Start-Ing STACK

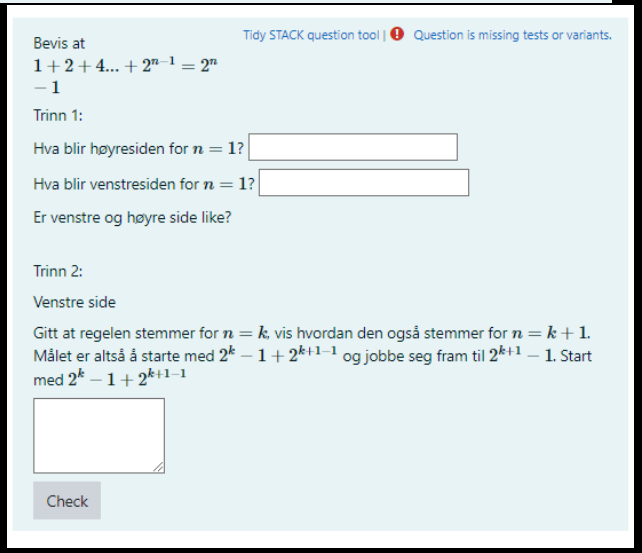
- Basics
- Proofs
- Functions and vectors
- More about functions
- Differential equations



- 611 students tried one or more quizzes
- Most did the first quiz only (powers and roots)

Survey results:

- “May be useful for checking my prior skills”: 75 % *
- “May be useful for repeating/improving”: 75 % *



* Only 4 respondents.To engage students when the quizzes are voluntary is a challenge!

Start-Ing STACK: Interview at end of 1st year

(Sciences bachelor student)

“There were many holes in the basic math knowledge when I started in August, for example concerning integrals. I can see the utility value [of this knowledge] much better now, in retrospect.”

“I experienced high school mathematics as a multitude of different parts where it was difficult to see what to use it for. Nice to see how things fit together [in Uni math], it makes it more fun to keep going.”

“You often may have to go back to old concepts because you didn't learn them properly when you were supposed to. The tools are often more powerful than we think when we learn the subject as a foundation.”

Start-Ing STACK: Interview at end of 1st year

“What did you gain from ‘Start-ing STACK’?”

“There were many years since I had mathematics in school, and I wanted to test and see what I could do. It was nice to go over everything fundamentally. Had the foundation checked. I found out several things, for example that I had forgotten a lot about vectors.”

Start-Ing STACK: Interview at end of 1st year

“Would it be helpful to a student starting studies straight from high school to carry out these STACK quizzes?”

“I don't see why it shouldn't be useful. If you are unsure about something, you can test it. If you feel sure, you can double check. There are probably about 50% of the students in my class who ought to do these excercises.”

“For most students, probably the main reason for trying it was to find out what STACK is.”

Start-Ing STACK: Changes 2023

- Place proof quiz first
- Ranking list?
- Provide feedback / hints

NTNU

References

- Zerva, K., Sangwin, C., Jones, I., & Quinn, D. (2022). Rejuvenating the HELM workbooks as online STACK quizzes in 2020.
- Sangwin, C. J. (2007). Assessing elementary algebra with STACK. *International journal of mathematical education in science and technology*, *38*(8), 987-1002.
- Drijvers, P. (2015). Digital technology in mathematics education: Why it works (or doesn't). In *Selected regular lectures from the 12th international congress on mathematical education* (pp. 135-151). Springer International Publishing.
- Barana, A., & Marchisio, M. (2021). Analyzing interactions in automatic formative assessment activities for mathematics in digital learning environments.
- Valdez, M., & Maderal, L. D. (2021). An Analysis of Students' Perception of Online Assessments and Its Relation to Motivation towards Mathematics Learning. *Electronic Journal of e-Learning*, *19*(5), 416-431.

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