

Precalculus assessed with STACK

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

Your last answer was interpreted as follows:

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



Your answer is partially correct.

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

Digital math quizzes – do they work?

Valdez, 2021:

Will students use it voluntarily??

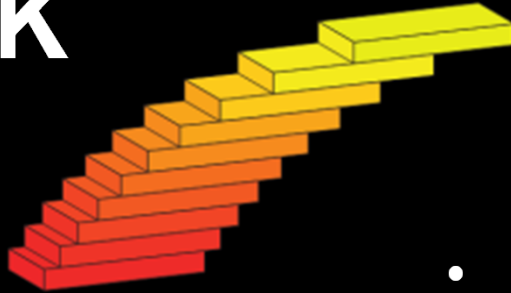
~~Factors affecting student perception~~

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

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

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

STACK



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

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?

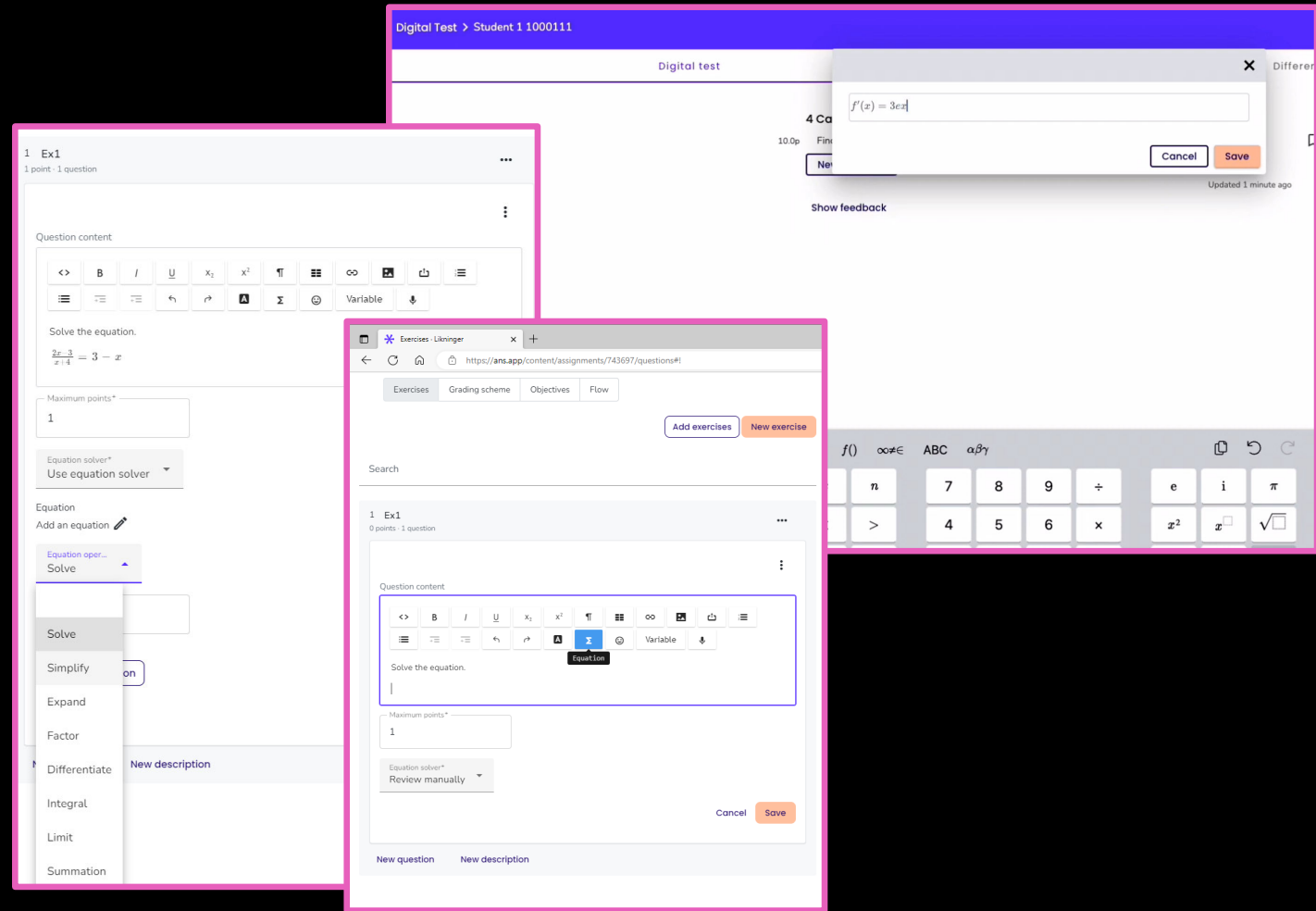
A correct answer is $\{1, 9\}$, which can be typed in as follows: $\{1, 9\}$

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

E-assessment: Popular choices



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



The collage displays several screenshots of the Ans platform interface:

- Top Left:** A question editor for "1 Ex1" (1 point, 1 question). It shows the question content, a rich text editor with mathematical symbols, and a list of actions: Solve, Simplify, Expand, Factor, Differentiate, Integral, Limit, and Summation.
- Top Right:** A "Digital Test" interface for "Student 1 1000111". It shows a question with a text input field containing $f(x) = 3ex$ and a "Save" button.
- Bottom Center:** A browser window showing the "Exercises: Likninger" page. It features a search bar and a list of exercises, including "1 Ex1" (0 points, 1 question). A "Solve" button is highlighted in the interface.
- Bottom Right:** A mathematical keypad with various symbols and functions like $f()$, ∞ , ϵ , ABC , $\alpha\beta\gamma$, n , 7 , 8 , 9 , \div , e , i , π , $>$, 4 , 5 , 6 , \times , x^2 , x^{\square} , and $\sqrt{\square}$.

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.

QUESTION - TRY 1 OF 3

Which of these function is linear?

$f(x,y) = \sin(x) + \cos(y)$
 $f(x,y) = y \ln x$

$f(x,y) = 6x + 4y$
 $f(x,y) = x^2 + xy + y^2$

Yeah! That's right.
 $f(x,y) = 6x + 4y$ is a linear equation.

next

QUESTION - 7988 | WEIGHT: 1 | 1 = 100%

Consider the functions:

- $f(x) = 2x^3 - 3x + 4$
- $g(x) = -x(x^2 - 4)$
- $h(x) = 5\sqrt{x + 2}$

Which of the functions are polynomial functions?

Custom answer order

1
 2
 3
 1 and 2
 1 and 3
 2 and 3
 All

Feedback for answer: 1
Which functions can be written in the form of a polynomial function? incorrect and 0 % of points

Feedback for answer: 2
Which functions can be written in the form of a polynomial function? incorrect and 0 % of points

Feedback for answer: 3
Which functions can be written in the form of a polynomial function? incorrect and 0 % of points

Feedback for answer: 4
correct and 100 % of points

The first two functions are examples of polynomial functions because they can be written in the form $f(x) = a_n x^n + \dots + a_2 x^2 + a_1 x + a_0$, where the power are non-negative integers and the coefficients are real numbers.

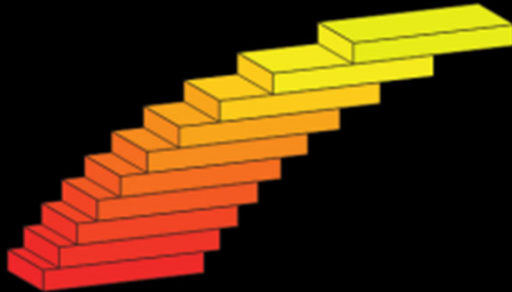
- $f(x)$ can be written as $f(x) = 6x^4 + 4$.
- $g(x)$ can be written as $g(x) = -x^3 + 4x$.
- $h(x)$ cannot be written in this form and is therefore not a polynomial function.

Feedback for answer: 5
Which functions can be written in the form of a polynomial function? incorrect and 0 % of points

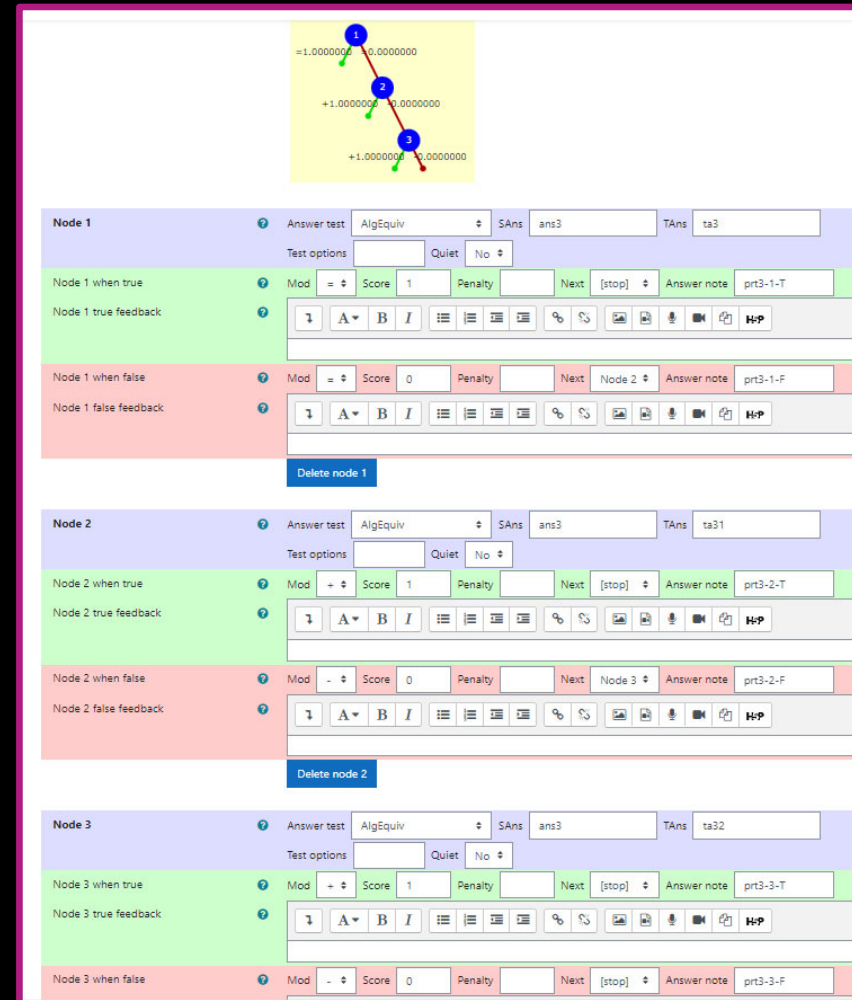
Feedback for answer: 6
Which functions can be written in the form of a polynomial function? incorrect and 0 % of points

Feedback for answer: 7
Which functions can be written in the form of a polynomial function? incorrect and 0 % of points

E-assessment: Popular choices



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

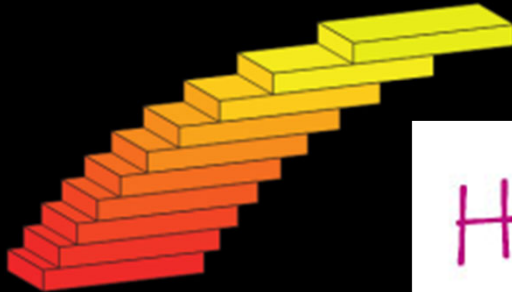


The screenshot displays the STACK assessment system interface. At the top, a math problem is shown with three nodes (1, 2, 3) and arrows indicating a sequence of steps. Below the problem, the configuration for three nodes is visible:

- Node 1:** Answer test: AlgEquiv; SAns: ans3; TAns: ta3; Mod: =; Score: 1; Penalty: ; Next: [stop]; Answer note: prt3-1-T.
- Node 2:** Answer test: AlgEquiv; SAns: ans3; TAns: ta31; Mod: +; Score: 1; Penalty: ; Next: [stop]; Answer note: prt3-2-T.
- Node 3:** Answer test: AlgEquiv; SAns: ans3; TAns: ta32; Mod: -; Score: 1; Penalty: ; Next: [stop]; Answer note: prt3-3-T.

Each node configuration includes fields for 'Test options' (Quiet, No), 'Mod' (operator), 'Score', 'Penalty', 'Next' (action), and 'Answer note'. A 'Delete node' button is present for each node configuration.

Translation of quizzes: 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 «

Appearance

Force language

Number of announcements

Show gradebook to students

- Do not force
- Do not force
- English (en)
- Norsk - bokmål (nb)
- Norsk - nynorsk (nn)
- Yes

```

1 <p class="HELM_exercise"><span class="multilang" lang="en">Exercise</span>
2   <span class="multilang" lang="no">Øving</span>
3 </p>
4 <p><span class="multilang" lang="en">Solve the quadratic equation  $\{x^2 - 4x + 4 = 0\}$ . If there is a repeated root, enter this twice.</span>
5   <span class="multilang" lang="no">Løs andregradsligningen  $\{x^2 - 4x + 4 = 0\}$ . Hvis det er et dobbelt nullpunkt, skriv inn denne to ganger.</span>
6 </p>
7 <p>
8   <nowrap>\(x = \) [[input:ans1]] [[validation:ans1]] or \((x = \) [[input:ans2]] [[validation:ans2]]
9   </nowrap>
10 </p>

```

Start-Ing STACK

Example

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

Solution

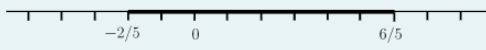
We treat each part of the inequality separately:

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

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) $\frac{3x}{4} > 1$

(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

Velkommen til START-ING STACK!

START-ING STACK har som formål å gi nye studenter ved ingeniør, siviling og andre studieprogrammer med tilsvarende grunnlagsemner i matematikk en god oversikt over forkunnskapene som trengs. Øv på oppgavene så mange ganger du vil, og prøv å forbedre din egen score. Oppgavene er laget med STACK, et CAS-basert system for matematikkoppgaver som brukes i øvingsopplegget ved flere av NTNUs matematikkemner.

Nederst finner du oppsummeringstester, som inneholder et blandet utvalg av oppgaver og med tre ulike vanskelighetsgrader.

Disse oppgavene lanseres høsten 2022. Vi tar forbehold om feil som måtte forekomme nå i starten, og tar gjerne imot eventuelle tilbakemeldinger og spørsmål i forumet.

Har du forsøkt på 2 oppgaver eller mer fra lista under? Da håper vi du vil svare på [denne korte brukerundersøkelsen](#) (Tar 1-2 min å besvare). Undersøkelsen er anonym.

START-ING STACK er et initiativ fra Forkurs for Ing./siv.ing-utdanningen, Institutt for matematiske fag.

Spørsmålforum

Vi tar gjerne imot eventuelle tilbakemeldinger og spørsmål, og vil forsøke å svare fortløpende.

Sosialt forum

Del 1: Basics

Potenser og røtter

Mark as done

Løse lineære ligninger

Mark as done

Løse ulikheter

Mark as done

Del 2: Bevisføring

Implikasjon og ekvivalens

Mark as done

Bevis

Mark as done

Del 3: Funksjoner og vektorregning

Grunnleggende konsepter for funksjoner

Mark as done

Trigonometriske funksjoner

Mark as done

Skalarproduktet

Mark as done

Del 4: Mer om funksjoner

Grafer for funksjoner og parameterfremstilling

Mark as done

Løse andregradsligninger

Mark as done

Løse polynomligninger

Mark as done

Noen vanlige funksjoner

Mark as done

Eksponentialfunksjoner

Mark as done

Del 5: Differensialligninger og test

Differensialligninger

Mark as done

Test 1

Mark as done

Test 2

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!

Implication and equivalence

Implication and equivalence are often used to represent logical arguments orderly. The implication sign \implies expresses that if what comes before the sign is true, what comes after the sign must also be true.

Example

It's raining \implies It's wet outside

We can see that if the first statement is true (i.e. that it is raining) the second statement (that it is wet outside) must also be true. Since the reverse is not necessarily true, it would be wrong to express: It is wet outside \implies It is raining. Instead, it can be wet outside because someone has washed their car.

Example

A more mathematical example is: $x = 2 \implies x^2 = 4$.

The reverse, i.e. $x^2 = 4 \implies x = 2$ is also not true here since $\sqrt{4} = \pm 2$. In general form, we can express $A \implies B$ where A and B are two statements.

If $A \implies B$ and $B \implies A$, we can write $A \iff B$.

Example

$x^2 = 4 \iff x = 2 \vee x = -2$

Since we include $\forall x = -2$, the sentence will hold regardless of the direction the implication arrow points. Thus we use the equivalence sign.

Choose the most suitable symbol:

Ola lives in Oslo Ola lives in Norway

Kari has a driver's license Kari is allowed to drive a car

Hamza is allergic to nuts Hamza avoids eating nuts

The fridge operates normally The fridge is still working

Tidy STACK question tool | Question is missing tests or variants.

Bevis at

$$1 + 2 + 4 + \dots + 2^{n-1} = 2^n - 1$$

Trinn 1:

Hva blir høyresiden for $n = 1$?

Hva blir venstresiden for $n = 1$?

Er venstre og høyre side like?

Trinn 2:

Venstre side

Gitt at regelen stemmer for $n = k$, vis hvordan den også stemmer for $n = k + 1$. Målet er altså å starte med $2^k - 1 + 2^{k+1-1}$ og jobbe seg fram til $2^{k+1} - 1$. Start med $2^k - 1 + 2^{k+1-1}$

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

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.

Thank you for your attention!

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