# Steps to Improving e-Assignment Performance with STACK

E. Safiulina[1], O. Labanova[1], A. Šeletski[2]

## Introduction


In the last year, the principles of creating multi-step test tasks for solving applied technical problems were presented in [1].

Test tasks were created with a step-by-step solution using the STACK question type. The students checked their answers and got feedback at the end of each task.

To demonstrate these exercises, those were offered to first-year graduate students at Tallinn University. These students are current or future mathematics teachers. After the students completed the tasks, they were asked to fill out a questionnaire posted on the Internet.

After analyzing the feedback of experts, it was decided to make some changes to those tasks.

[1] Labanova, Oksana; Safiulina, Elena; Šeletski, Anna; Babenko, Kristina (2021). Step-by-step Solution of Applied Engineering Problems in Mathematics Courses Using STACK. International Meeting of the STACK Community 2021. Zenodo.

## Problems

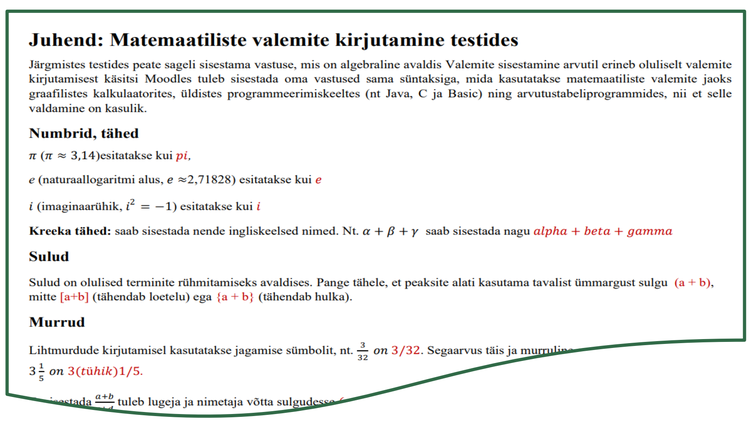
Analysing the questionnaire answers the core problems were obtained:

- long scrolling, experts wanted to see tasks all the time;
- difficulty entering math text;
- unclear division of task parts;
- absence of "helpful hints“;
- absence of integrated online calculator and sketchpad.

The authors decided:

- to create short instructions about the STACK questions inputs syntax and training test;
- to create more answers with math input;
- to develop a clearer design of questions according to the possibilities of STACK with feadback on each step of task.

## Solutions



**Juhend: Matemaatiliste valemite kirjutamine testides**

Järgmistes testides peate sageli sisestama vastuse, mis on algebraline avaldis Valemite sisestamine arvutil erineb oluliselt valemite kirjutamisest käsitsi Moodles tuleb sisestada oma vastused sama süntaksiga, mida kasutatakse matemaatiliste valemite jaoks graafilistes kalkulaatorites, üldistes programmeerimiskeeltes (nt Java, C ja Basic) ning arvutustabeliprogrammides, nii et selle valdamine on kasulik.

**Numbrid, tähed**

$\pi$ ($\pi \approx 3{,}14$)esitatakse kui *pi*,

*e* (naturaallogaritmi alus, $e \approx 2{,}71828$) esitatakse kui *e*

*i* (imaginaarühik, $i^2 = -1$) esitatakse kui *i*

**Kreeka tähed:** saab sisestada nende ingliskeelsed nimed. Nt. $\alpha + \beta + \gamma$ saab sisestada nagu *alpha + beta + gamma*

**Sulud**

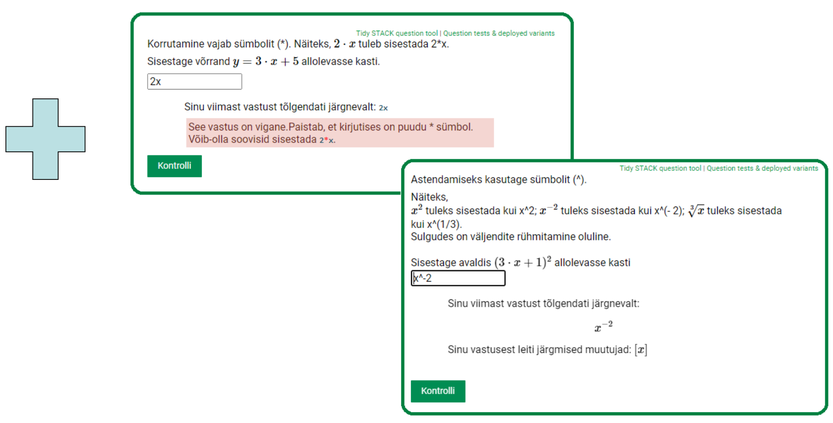
Sulud on olulised terminite rühmitamiseks avaldises. Pange tähele, et peaksite alati kasutama tavalist ümmargust sulgu (a + b), mitte [a+b] (tähendab loetelu) ega {a + b} (tähendab hulka).

**Murrud**

Lihtmurdude kirjutamisel kasutatakse jagamise sümbolit, nt. $\frac{3}{32}$ *on* 3/32. Segaarvus täis ja murruline

$3\frac{1}{5}$ *on* 3(*tühik*)1/5.

sisestada $\frac{a+b}{c}$ tuleb lugeja ja nimetaja võtta sulgudesse



Tidy STACK question tool | Question tests & deployed variants

Korrutamine vajab sümbolit (*). Näiteks, $2 \cdot x$ tuleb sisestada 2*x.

Sisestage võrrand $y = 3 \cdot x + 5$ allolevasse kasti.

2x

Sinu viimast vastust tõlgendati järgnevalt: 2x

See vastus on vigane.Paistab, et kirjutises on puudu * sümbol.
Võib-olla soovisid sisestada 2*x.

Kontrolli

Tidy STACK question tool | Question tests & deployed variants

Astendamiseks kasutage sümbolit (^).

Näiteks,
$x^2$ tuleks sisestada kui x^2; $x^{-2}$ tuleks sisestada kui x^(- 2); $\sqrt[3]{x}$ tuleks sisestada kui x^(1/3).
Sulgudes on väljendite rühmitamine oluline.

Sisestage avaldis $(3 \cdot x + 1)^2$ allolevasse kasti

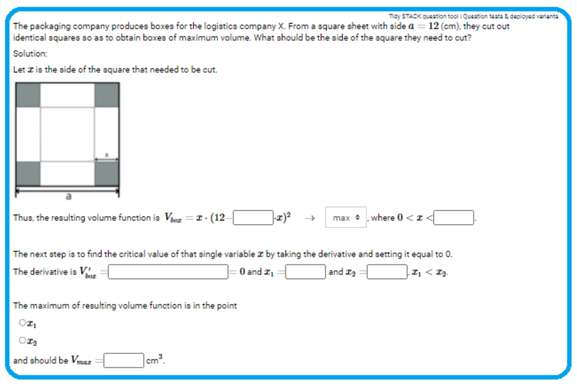
x^-2

Sinu viimast vastust tõlgendati järgnevalt:

$x^{-2}$

Sinu vastusest leiti järgmised muutujad: [x]

Kontrolli



Tidy STACK question tool | Question tests & deployed variants

The packaging company produces boxes for the logistics company X. From a square sheet with side $a = 12$ (cm), they cut out identical squares so as to obtain boxes of maximum volume. What should be the side of the square they need to cut?

Solution:

Let $x$ is the side of the square that needed to be cut.




Thus, the resulting volume function is $V_{box} = x \cdot (12 - \square \cdot x)^2 \rightarrow$ max, where $0 < x <$ .

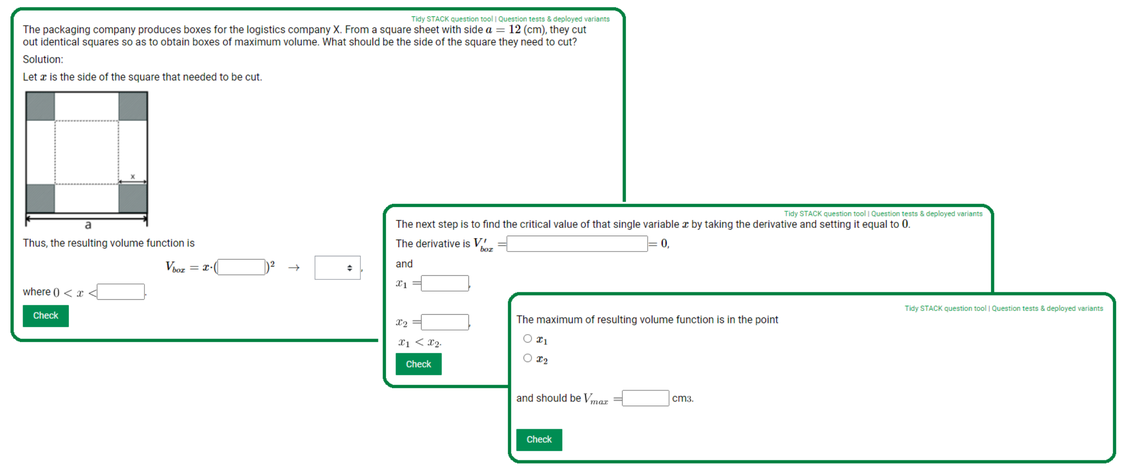
The next step is to find the critical value of that single variable $x$ by taking the derivative and setting it equal to 0.

The derivative is $V'_{box} = \square = 0$ and $x_1 = \square$ and $x_2 = \square$ $x_1 < x_2$.

The maximum of resulting volume function is in the point

- $x_1$
- $x_2$

and should be $V_{max} = \square$ $cm^3$.



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Solution:

Let $x$ is the side of the square that needed to be cut.




Thus, the resulting volume function is

$V_{box} = x \cdot (\square)^2 \rightarrow$ ,

where $0 < x <$ .

Check

Tidy STACK question tool | Question tests & deployed variants

The next step is to find the critical value of that single variable $x$ by taking the derivative and setting it equal to 0.

The derivative is $V'_{box} = \square = 0$,

and

$x_1 =$ ,

$x_2 =$ ,

$x_1 < x_2$.

Check

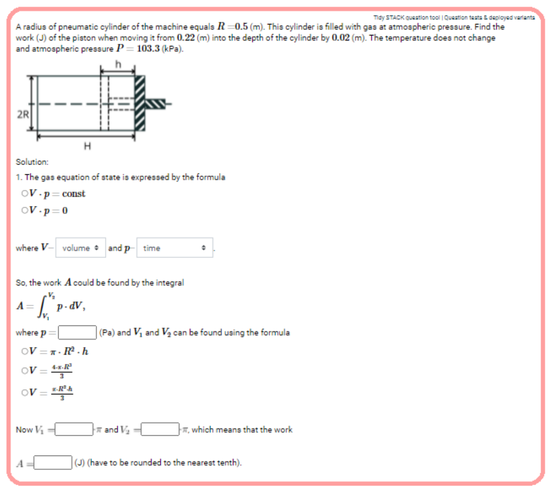
Tidy STACK question tool | Question tests & deployed variants

The maximum of resulting volume function is in the point

- $x_1$
- $x_2$

and should be $V_{max} = \square$ cms.

Check



Tidy STACK question tool | Question tests & deployed variants

A radius of pneumatic cylinder of the machine equals $R = 0.5$ (m). This cylinder is filled with gas at atmospheric pressure. Find the work (J) of the piston when moving it from $0.22$ (m) into the depth of the cylinder by $0.02$ (m). The temperature does not change and atmospheric pressure $P = 103.3$ (kPa).




Solution:

1. The gas equation of state is expressed by the formula

- $V \cdot p = \text{const}$
- $V \cdot p = 0$

where $V$– volume and $p$– time .

So, the work $A$ could be found by the integral

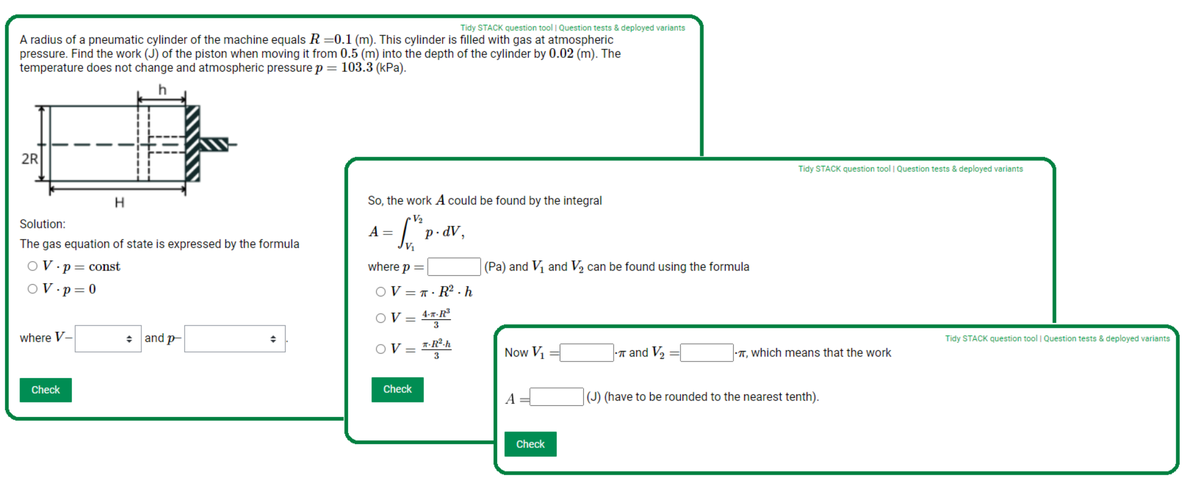
$A = \int_{V_1}^{V_2} p \cdot dV$,

where $p =$ (Pa) and $V_1$ and $V_2$ can be found using the formula

- $V = \pi \cdot R^2 \cdot h$
- $V = \frac{4 \cdot \pi \cdot R^3}{3}$
- $V = \frac{\pi \cdot R^2 \cdot h}{3}$

Now $V_1 = \square \cdot \pi$ and $V_2 = \square \cdot \pi$, which means that the work

$A = \square$ (J) (have to be rounded to the nearest tenth).



Tidy STACK question tool | Question tests & deployed variants

A radius of a pneumatic cylinder of the machine equals $R = 0.1$ (m). This cylinder is filled with gas at atmospheric pressure. Find the work (J) of the piston when moving it from $0.5$ (m) into the depth of the cylinder by $0.02$ (m). The temperature does not change and atmospheric pressure $p = 103.3$ (kPa).




Solution:

The gas equation of state is expressed by the formula

- $V \cdot p = \text{const}$
- $V \cdot p = 0$

where $V$– and $p$– .

Check

Tidy STACK question tool | Question tests & deployed variants

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Check

Tidy STACK question tool | Question tests & deployed variants

Now $V_1 = \square \cdot \pi$ and $V_2 = \square \cdot \pi$, which means that the work

$A = \square$ (J) (have to be rounded to the nearest tenth).

Check

## Conclusions

1) According to positive feedback, the outlined approach will be extended to the other mathematics courses.
2) The practice has shown mutual benefit from the active involvement of students (future teachers of mathematics) in the logical and didactic analysis of educational materials of mathematical subjects

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