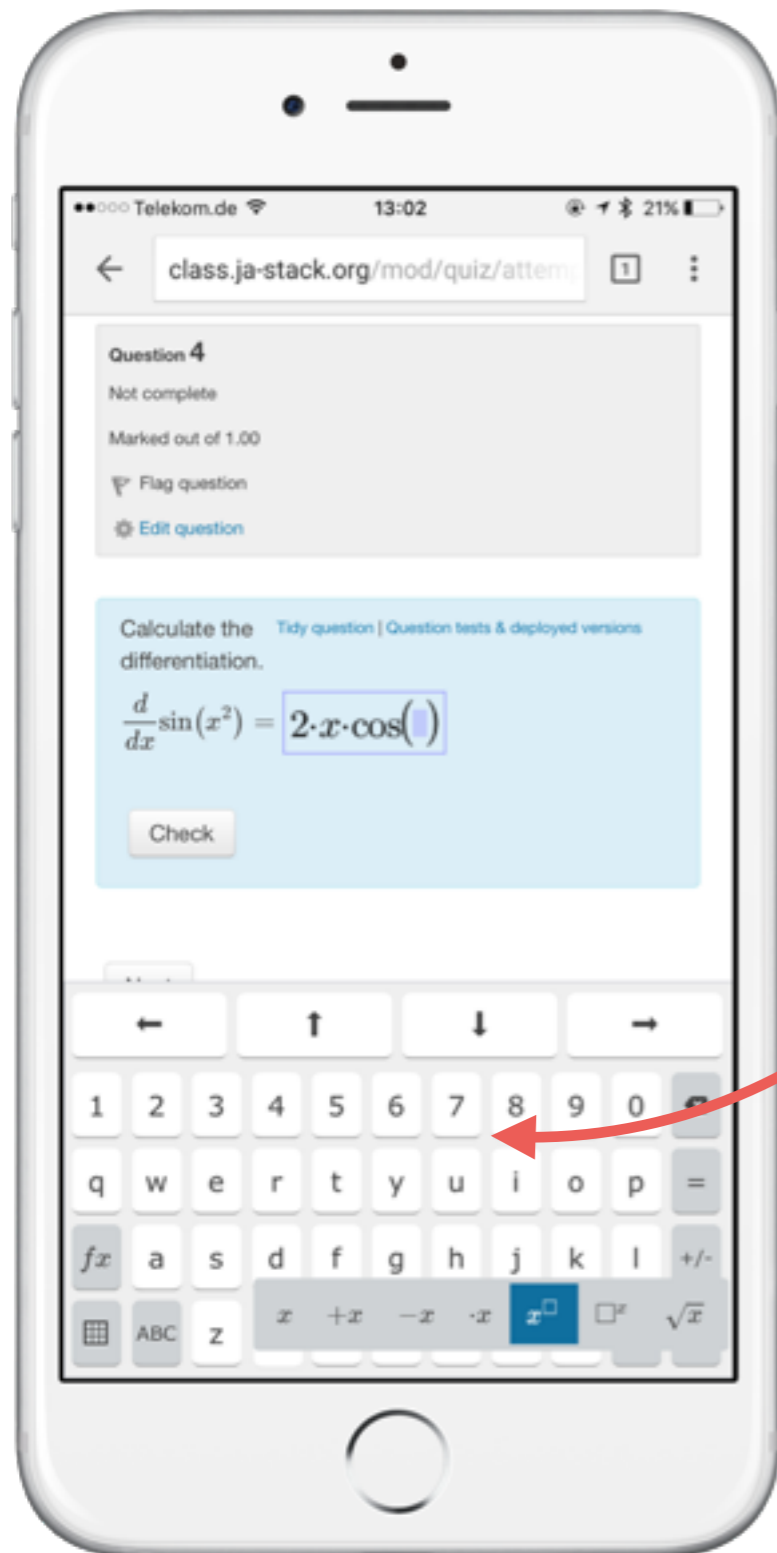


Function Enhancement of Math Input Environment with Flick Operation for Mobile Devices



Math Input with Flick Operation (ML2016)

+

Math Input with Flick Operation
for full keyboard

Yasuyuki Nakamura (Nagoya University, Japan)

Takahiro Nakahara (Sangensha LLC., Japan)

Math e-Learning System

Mathematical expressions are entered as answers and they are automatically assessed in an online test

- Maple T.A. (Maplesoft)
- MATH ON WEB (Osaka Pref. University)
- STACK (C. Sangwin, Edinburgh University)
- Numbas (C. Lawson-Perfect, Newcastle University)

Math e-Learning System

Ex. STACK

$$\frac{d}{dx} \cos(x^2) = -2*x*\sin(x^2)$$

[Tidy question](#) | [Question tests & deployed versions](#)

Check

press

Math e-Learning System

Ex. STACK

$$\frac{d}{dx} \cos(x^2) = -2*x*\sin(x^2)$$

[Tidy question](#) | [Question tests & deployed versions](#)

Your last answer was interpreted as follows:

$$-2 \cdot x \cdot \sin(x^2)$$

The variables found in your answer were: [x]

Check

Correct !

A correct answer is $-2 \cdot x \cdot \sin(x^2)$, which can be typed in as follows: `-2*x*sin(x^2)`

Math e-Learning System

Ex. STACK

$$\frac{d}{dx} \cos(x^2) = \text{sin}(x^2)$$

[Tidy question](#) | [Question tests & deployed versions](#)

Your last answer was interpreted as follows:

$$\sin(x^2)$$

The variables found in your answer were: [x]

Check

Incorrect !

A correct answer is $-2 \cdot x \cdot \sin(x^2)$, which can be typed in as follows: `-2*x*sin(x^2)`

Math e-Learning System

Ex. STACK

$$\frac{d}{dx} \cos(x^2) = \text{-sin(x^2)}$$

[Tidy question](#) | [Question tests & deployed versions](#)

Your last answer was interpreted as follows:

$$-\sin(x^2)$$

The variables found in your answer were: $[x]$

Check

Partially correct.

Remember to use the chain rule to differentiate it.

A correct answer is $-2 \cdot x \cdot \sin(x^2)$, which can be typed in as follows: $-2*x*\sin(x^2)$

Math e-Learning System

- Online test has the advantage of instant feedback by automatic assessment
- Quizzes can be automatically generated with random variables and students can repeatedly practice different quizzes, which is suitable for drill practice.

Math e-Learning System

- Online test has the advantage of instant feedback by automatic assessment
- Quizzes can be automatically generated with random variables and students can repeatedly practice different quizzes, which is suitable for drill practice.
- Problems in math input

$$-2x \sin(x^2)$$

$$-2*x*\sin(x^2)$$

Solutions for the problems in math input

MathDox formular editor

<http://mathdox.org/formulaeditor/>

Question 4

Not complete

Marked out of 1.00

Flag question

Edit question

次の微分を計算せよ。

Tidy question | Question tests & deployed versions

$$\frac{d}{dx} \sin(x^2) = 2 \cdot x \cdot \cos(x^2)$$

Check

+	-	·	∧	∨	cos(□)	√□	∫□dx	∫□dx	[□,□]	
<	≤	=	≥	>	sin(□)	√□	∏ _{n=□} (□)	∑ _{n=□} (□)	det(□)	[□,□]
π	e	i	∞		tan(□)	{□}	(□)	(□)	(□)	(□,□)
□	□	□	□!	e [□]	ln(□)	log(10,□)	(□)	(□)	(□)	(□,□)

Next

Solutions for the problems in math input

MathTOUCH <http://math.mukogawa-u.ac.jp/>

The screenshot shows the MathTOUCH interface. On the left, a sidebar for '問題 1' (Problem 1) indicates it is '未解答' (unsolved) with a maximum score of 1.00. It includes options to '問題にフラグ付けする' (flag the problem) and '問題を編集する' (edit the problem). The main area contains the problem statement: '次の計算をしてください。 *必ず簡単化してください (例: $\sqrt{8} \rightarrow 2\sqrt{2}$)'. The problem is $\sqrt{2} \times \sqrt{10}$. A hint section, '★ ヒント ★', provides the formula $\sqrt{a} \times \sqrt{b} = \sqrt{ab}$. Below the hint is a toolbar with buttons for 'space', '記号 選択' (symbol selection), '配置要素 分離' (separate configuration elements), 'Tab : 対象切替' (object switching), 'Enter : 確定' (confirm), 'delete : 取消' (cancel), and 'esc : やり直し' (redo). The input field shows the expression $2\sqrt{5}$ with a red arrow pointing to the radical part. A dropdown menu is open, showing several variations of the expression: $2\sqrt{5}$, $2^{\sqrt{5}}$, $2_{\sqrt{5}}$, $^2\sqrt{5}$, and $2^{\sqrt{5}}$. A '次へ' (next) button is located at the bottom left.

Math e-Learning System

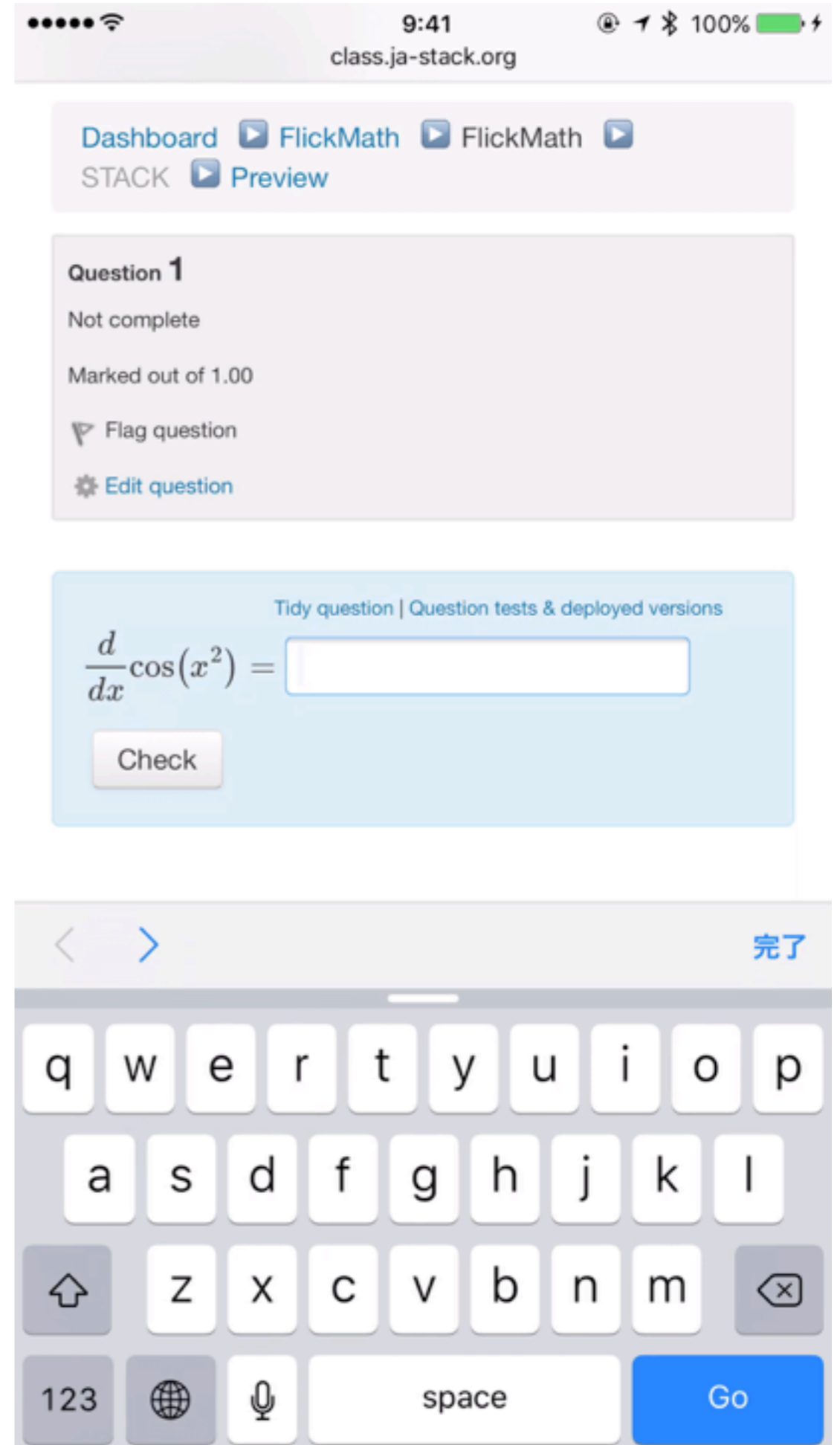
- Online test has the advantage of instant feedback by automatic assessment
- Quizzes can be automatically generated with random variables and students can repeatedly practice different quizzes, which is suitable for drill practice.



Using mobile devices

$$-2x \sin(x^2) \longrightarrow$$
$$-2*x*\sin(x^2)$$

It is necessary to switch the smartphone keyboard screen many times, requiring **24 key touches**.



Possibility of math input with flick operation

- **Motivation:** Providing a useful environment for mobile devices to be used in math online test
- **Method:** Math input with **flick operation**
- **Background:** Most young Japanese adopt flick operation to input characters on smartphones
- **Idea:** Select operations (times, power, etc.) using flick



Flick keyboard for math input

Display math

- MathDox formular editor (jQuery)

answer area: Canvas

Flick keyboard

- HTML + CSS + jQuery
- touchstart: display child elements based on the place tapped
- touchout: call functions to display math based on the place where a finger is released



Input example: $x^2 + 5x + 6$

Expand the following expression

$$(x + 2) \cdot (x + 3) = \text{[]}$$

Check

←	↑	↓	→	
123	<i>a</i>	<i>b</i>	<i>c</i>	⌫
<i>xy</i>	<i>x</i>	<i>y</i>	<i>z</i>	+/-
<i>fx</i>	μ	α	θ	\times/\div
⌨	()	<i>ABC</i>	=	↵

Input example: $x^2 + 5x + 6$

Expand the following expression

$$(x + 2) \cdot (x + 3) = \square$$

Check

←	↑	↓	→	
123	x^{\square}	b	c	⌫
$\cdot x$	x	\sqrt{x}	z	+/-
fx	\square^x	α	θ	\times/\div
⌨	()	ABC	=	↵

Input example: $x^2 + 5x + 6$

Expand the following expression

$$(x + 2) \cdot (x + 3) = x$$

Check

←	↑	↓	→	
123	<i>a</i>	<i>b</i>	<i>c</i>	⌫
<i>xy</i>	<i>x</i>	<i>y</i>	<i>z</i>	+/-
<i>fx</i>	μ	α	θ	\times/\div
⌨	()	<i>ABC</i>	=	↵

Input example: $x^2 + 5x + 6$

Expand the following expression

$$(x + 2) \cdot (x + 3) = x$$

Check

←	↑	2^{\square}	↓	→
123	$2x$	2	$2y$	⌫
xy	4	\square^2	6	+/-
fx	7	8	9	\times/\div
⌨	()	0	=	↵

Operating Environment

- Indispensable conditions
 - HTML5, JavaScript, CSS3
- Hardware
 - Most smartphones with 4inch or larger display.

Input efficiency

Number of touches

Direct Input

Flick Input

$$x^2 + 5x + 6$$

19

8

$$3x^2 - \frac{2x}{(x^2 + 1)^2}$$

36

13

$$2x \cos(x^2)$$

23

7

Weak Points and Next Goal

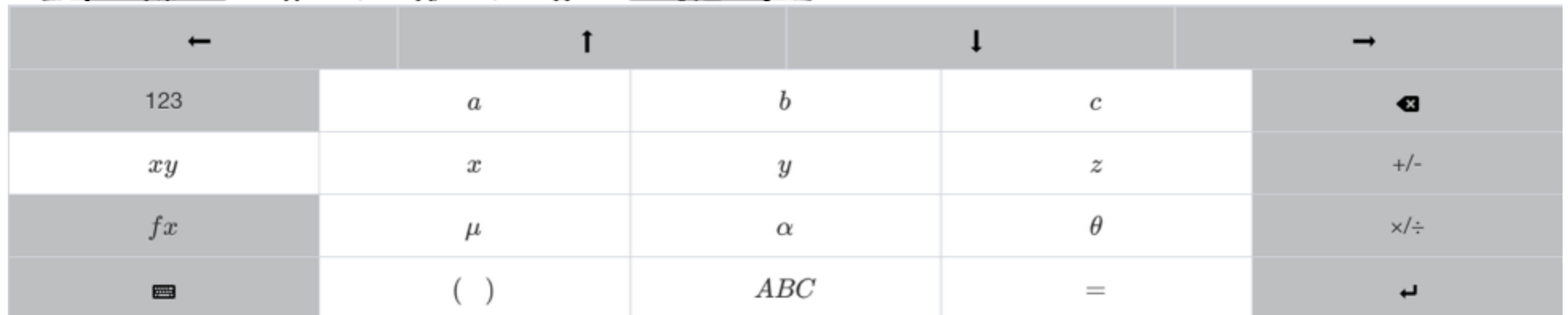
- Possible letters are limited: $x, y, z, a, b, c, \alpha, \beta, \gamma$
- Keyboard is not optimized for a tablet.


Weak Points and Next Goal

- Possible letters are limited: $x, y, z, a, b, c, \alpha, \beta, \gamma$
- Keyboard is not optimized for a tablet.



←	↑	↓	→	
123	a	b	c	⌫
xy	x	y	z	+/-
fx	μ	α	θ	\times/\div



←	↑	↓	→	
123	a	b	c	⌫
xy	x	y	z	+/-
fx	μ	α	θ	\times/\div
	()	ABC	=	↵

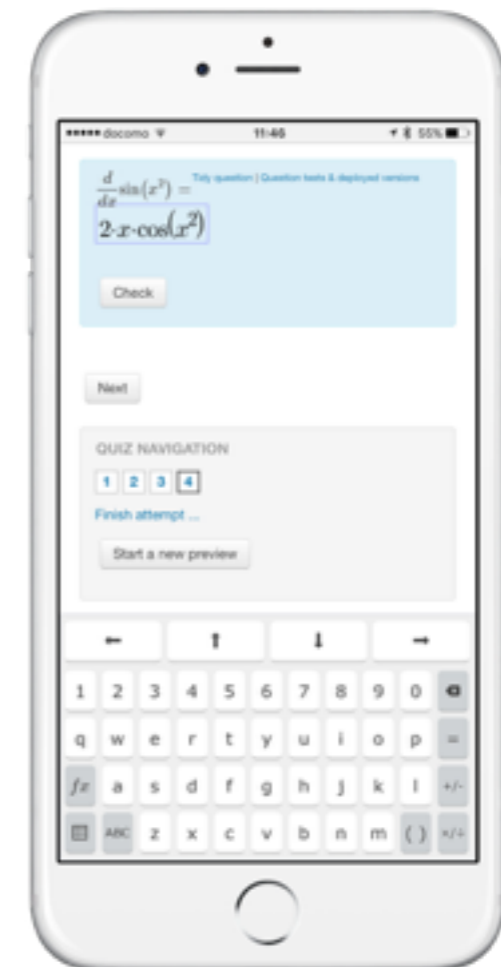
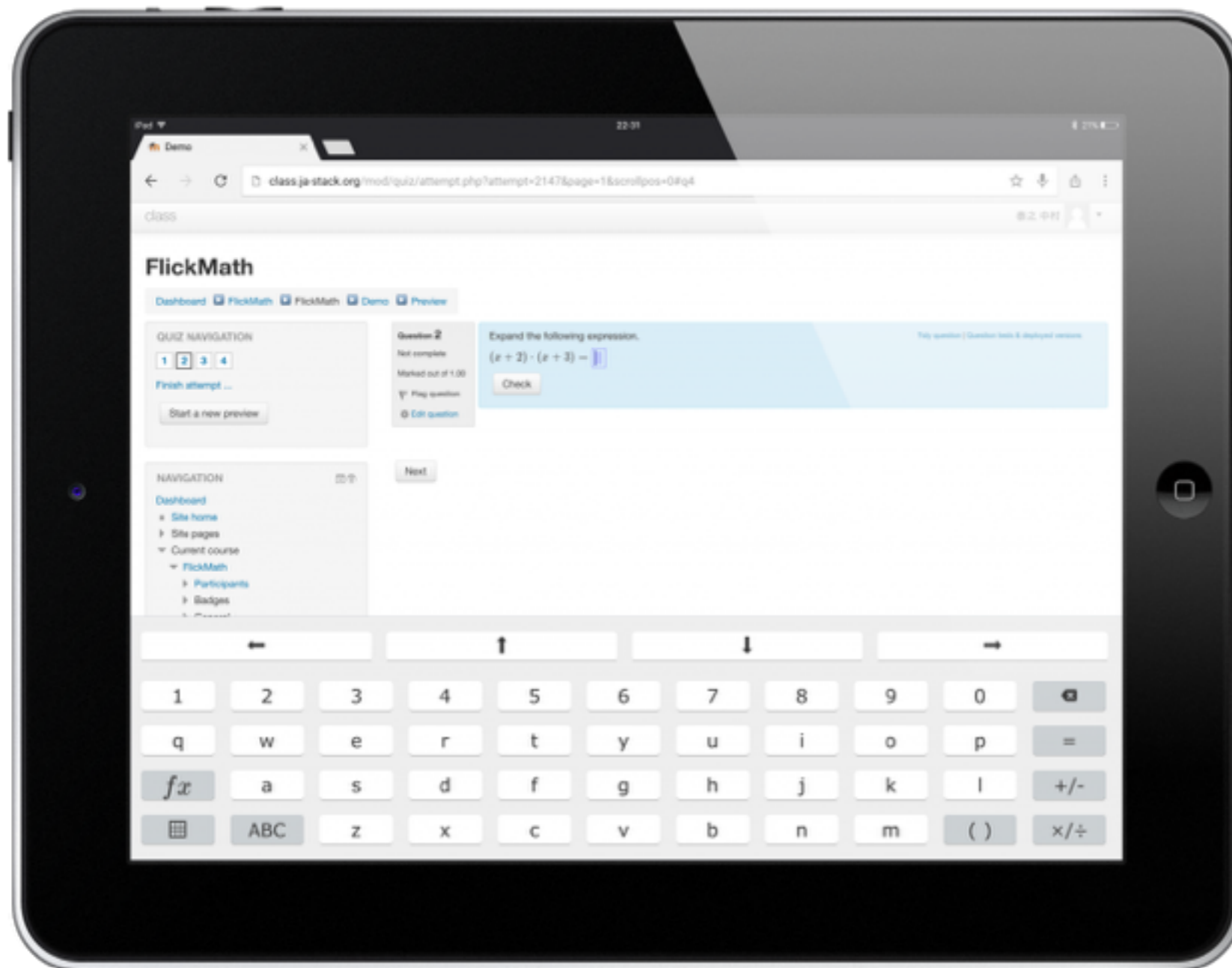
Weak Points and Next Goal

- Possible letters are limited: $x, y, z, a, b, c, \alpha, \beta, \gamma$
- Keyboard is not optimized for a tablet.



- Next Goal
 - to implement flick operation in full keyboard
 - to fully support tablets

Full keyboard for math input with flick operation



Input example: $2x \cos(x^2)$

Vodafone.de 15:01 55%

Question 4
Not complete
Marked out of 1.00
Flag question

$\frac{d}{dx} \sin(x^2) =$

Check

Tidy question | Question tests & deployed versions

← ↑ ↓ →

1 2 3 4 5 6 7 8 9 0 ×

q w e r t y u i o p =

fx a s d f g h j k l +/-

ABC z x c v b n m () ×/÷

Input example: $2x \cos(x^2)$

Vodafone.de

15:04

54%

Question 4

Not complete

Marked out of 1.00

Flag question

$$\frac{d}{dx} \sin(x^2) = 2$$

[Tidy question](#) | [Question tests & deployed versions](#)

Check



1

2

3

4

5

6

7

8

9

0

\times

q

w

e

r

t

y

u

i

o

p

=

fx

a

s

d

f

g

h

j

k

l

+/-



ABC

z

x

c

v

b

n

m

()

\times/\div

Input example: $2x \cos(x^2)$

Vodafone.de 15:04 54%

Question 4
Not complete
Marked out of 1.00
Flag question

$\frac{d}{dx} \sin(x^2) = 2$ [Tidy question](#) | [Question tests & deployed versions](#)

Check

← ↑ ↓ →

1 2 3 4 5 6 7 8 9 0 ×

q w e r t y u i o p =

fx a s d f g h j k l +/-

ABC z x $+x$ $-x$ $\cdot x$ x^\square \square^x \sqrt{x} $()$ \times/\div

Input example: $2x \cos(x^2)$

Vodafone.de 15:04 54%

Question 4
Not complete
Marked out of 1.00
Flag question

$\frac{d}{dx} \sin(x^2) = 2 \cdot x$

Tidy question | Question tests & deployed versions

Check

← ↑ ↓ →

1 2 3 4 5 6 7 8 9 0 ×

q w e r t y u i o p =

fx a s d f g h j k l +/-

⌘ ABC z x c v b n m () ×/÷

Input example: $2x \cos(x^2)$

Vodafone.de

15:04

54%

Question 4

Not complete

Marked out of 1.00

Flag question

$$\frac{d}{dx} \sin(x^2) = 2 \cdot x$$

Tidy question | Question tests & deployed versions

Check



1

2

3

4

5

6

7

8

9

0



q

w

e

r

t

y

u

i

o

p



fx

a

s

d

f

g

h

j

k

l

+/-



ABC

z

x

c

v

b

n

m



Input example: $2x \cos(x^2)$

Vodafone.de 15:19 51%

Question 4
Not complete
Marked out of 1.00
Flag question

$\frac{d}{dx} \sin(x^2) = 2 \cdot x \cdot$

[Tidy question](#) | [Question tests & deployed versions](#)

Check

← ↑ ↓ →

1 2 3 4 5 6 7 8 9 0 ×

q w e r t y u i o p =

fx a s d f g h j k l +/-

⌘ ABC z x c v b n m () ×/÷

Input example: $2x \cos(x^2)$

Vodafone.de 15:05 54%

Question 4
Not complete
Marked out of 1.00
Flag question

$\frac{d}{dx} \sin(x^2) = 2 \cdot x \cdot$

Check

Tidy question | Question tests & deployed versions

← ↑ ↓ →

1 2 3 4 5 6 7 8 9 0 ×

i ∞ e \log \ln y u i o p $=$

π \sin **\cos** \tan $\sqrt{\quad}$ g h j k l $+/-$

\times ABC z x c v b n m $()$ \times/\div

Input example: $2x \cos(x^2)$

Vodafone.de 15:05 54%

Question 4
Not complete
Marked out of 1.00
Flag question

$\frac{d}{dx} \sin(x^2) = 2 \cdot x \cdot \cos(\quad)$

[Tidy question](#) | [Question tests & deployed versions](#)

Check

← ↑ ↓ →

1 2 3 4 5 6 7 8 9 0 ×

q w e r t y u i o p =

fx a s d f g h j k l +/-

ABC z x $+x$ $-x$ $\cdot x$ x^{\square} \square^x \sqrt{x} () \times/\div

Input example: $2x \cos(x^2)$

Vodafone.de 15:25 50%

Question 4
Not complete
Marked out of 1.00
Flag question

$\frac{d}{dx} \sin(x^2) = 2 \cdot x \cdot \cos(x^2)$

Tidy question | Question tests & deployed versions

Check

← ↑ ↓ →

1 2 3 4 5 6 7 8 9 0 ×

q w e r t y u i o p =

fx a s d f g h j k l +/-

ABC z x c v b n m () ×/÷

Input example: $2x \cos(x^2)$

Vodafone.de 15:05 54%

Question 4
Not complete
Marked out of 1.00
Flag question

$\frac{d}{dx} \sin(x^2) = 2 \cdot x \cdot \cos(x^2)$

Check

Tidy question | Question tests & deployed versions

← ↑ ↓ →

1 2 3 4 5 6 7 8 9 0 ×

q w e r t y u i o p =

fx a s d f g h j k l +/-

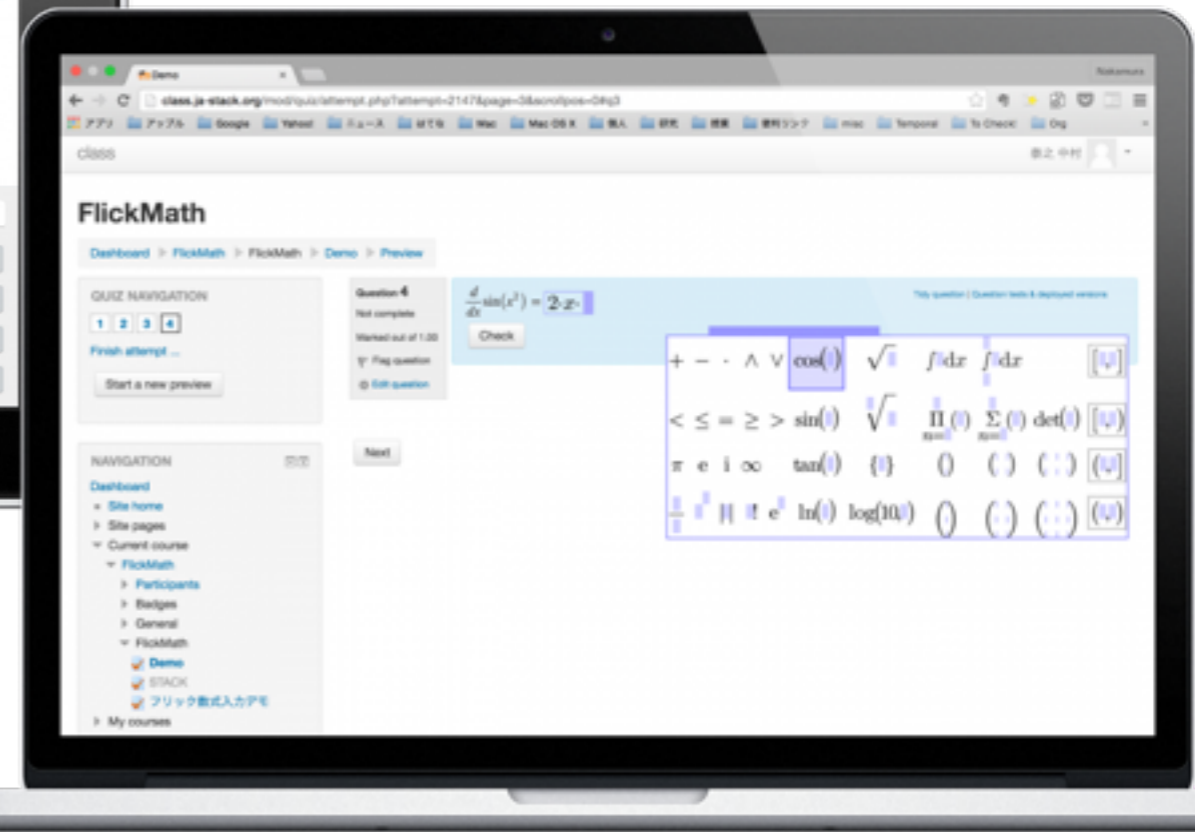
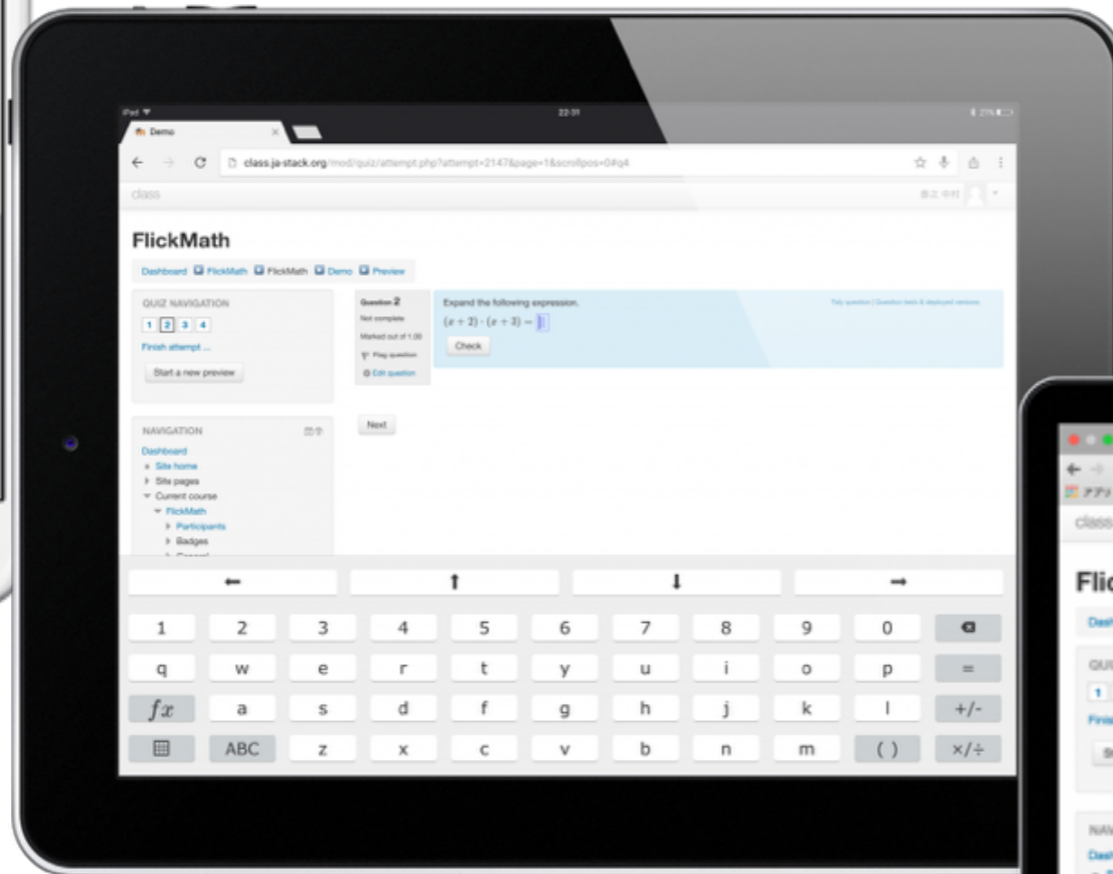
ABC z x c v b n m () ×/÷

Automatic Keyboard Selection in Response to Device

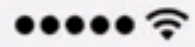
Numeric-type key
for smartphone

fullkeyboard for
tablet

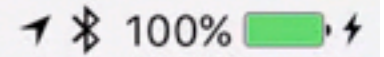
MathDox input type
for PC



Demo




9:41



Question 4

Not complete

Marked out of 1.00

 Flag question

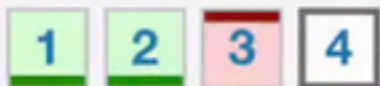
$$\frac{d}{dx} \sin(x^2) = \text{[input box]}$$

[Tidy question](#) | [Question tests & deployed versions](#)

Check

Next

QUIZ NAVIGATION



[Finish attempt ...](#)

Conclusion and Future Plan

- We developed a math input interface with flick operation assuming the use of STACK for online mathematics testing
- The keyboard is automatically selected in response to the kind of devices
- Future plan
 - Usability test for further improvements of our interface should be conducted
 - Best keyboard operation should be investigated after usability test
 - Our math-input environment is developed for the use in STACK, but the environment is developed by Javascript and not restricted to be used only in STACK. Implementation to other system could be done.
 - Native keyboard