DPG Didaktik der Physik Bochum

Erfahrung mit online Hausübungen in einführenden Physikvorlesungen

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Szenario

- Einführende Physikvoranstaltungen für Nebenfächler
- 200 bis 800 Studierende pro Kurs
- Keine Finanzmittel für Hausübungskorrektur
- In einigen der betrachteten Veranstaltungen auch keine Übungsgruppen
- Typischerweise 10-20 Aufgaben/Woche

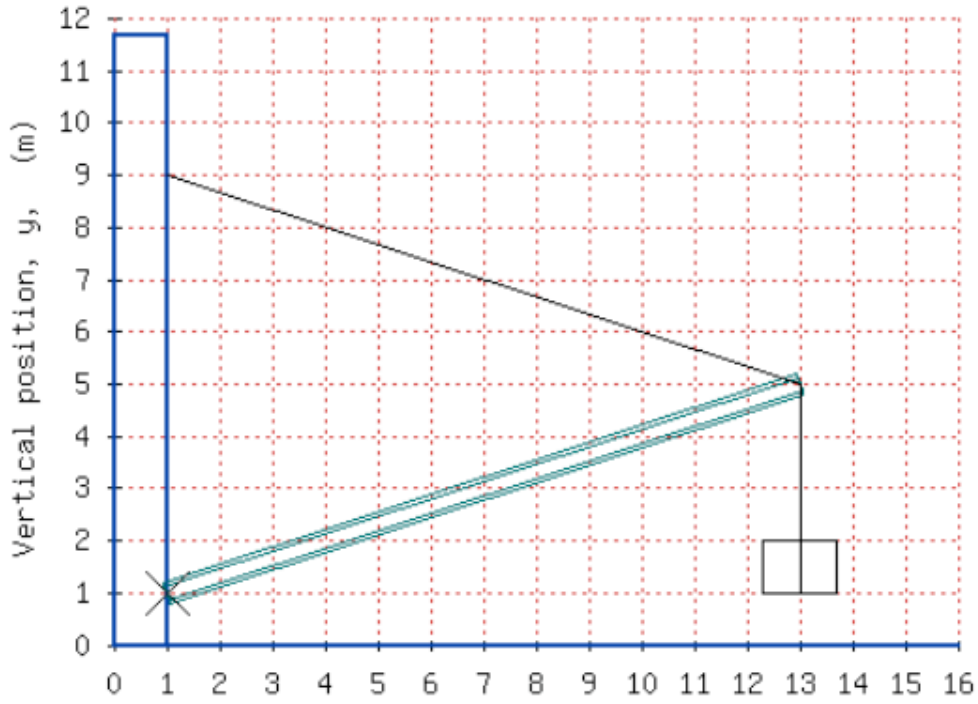
Online Übungsaufgaben

- Verwendetes System: LON-CAPA
- Open-Source Freeware
- Aufgabensammlung, die allen Lehrenden zur Verfügung steht
- Natürlich das Übliche:
  - Mehrfachauswahlen
  - Klicke-auf-Bild
  - Zuordnungsaufgaben
  - Rangordnungsaufgaben

Verschiedene Versionen

- Hausübungs- und Testprobleme
- Verschiedene Optionen, Bilder, Nummern, Graphen, etc
- Gleiches Problem, zwei Studierende

A crate with a mass of 155.5 kg is suspended from the end of a uniform boom with mass of 89.5 kg. The upper end of the boom is supported by a cable attached to the wall and the lower end by a pivot (marked X) on the same wall. Calculate the tension in the cable.



One Source, Multiple Target

A capacitor is completely charged with 650 nC by a voltage source that had 350 V.

1 pt What is its capacitance? *(in* F*)*

7. **A**◯ 1.49×10^{-9} **B**◯ 1.86×10^{-9} **C**◯ 2.32×10^{-9}
   D◯ 2.90×10^{-9} **E**◯ 3.63×10^{-9} **F**◯ 4.53×10^{-9}
   G◯ 5.67×10^{-9} **H**◯ 7.08×10^{-9}

1 pt Now the plates of the charged capacitor are pushed together with the voltage source already disconnected.

8. **A**◯ The charge on the plates increases.
   B◯ The energy stored in the capacitor remains the same.
   C◯ The capacitance increases.
   D◯ The voltage drop between the plates increases.
   E◯ The energy stored in the capacitor increases.

1 pt The initial air gap was 8 mm. What is the stored energy if the air gap is now 6 mm? *(in* J*)*

9. **A**◯ 0.00 **B**◯ 8.53×10^{-5} **C**◯ 1.14×10^{-4}
   D◯ 1.30×10^{-4} **E**◯ 1.52×10^{-4} **F**◯ 3.41×10^{-4}
   G◯ 3.44×10^{-4} **H**◯ 4.87×10^{-4}

A capacitor is completely charged with 670 nC by a voltage source that had 350 V.

1 pt What is its capacitance? *(in* F*)*

7. **A**◯ 1.91×10^{-9} **B**◯ 2.39×10^{-9} **C**◯ 2.99×10^{-9}
   D◯ 3.74×10^{-9} **E**◯ 4.67×10^{-9} **F**◯ 5.84×10^{-9}
   G◯ 7.30×10^{-9} **H**◯ 9.13×10^{-9}

1 pt Now the plates of the charged capacitor are pulled apart with the voltage source already disconnected.

8.

1 pt
if th
9.

Problem 6 Due on Tuesday, Feb 22 at 10:00 am

A capacitor is completely charged with 640 nC by a voltage source that has 375 V.

What is its capacitance? [ ]

Submit Answer Tries 0/3

Now the plates of the charged capacitor are pulled apart with the voltage source still connected.

- ◯ The capacitance increases.
- ◯ The voltage drop between the plates increases.
- ◯ The energy stored in the capacitor increases.
- ◯ The energy stored in the capacitor remains the same.
- ◯ None of the above.

Submit Answer Tries 0/2

The initial air gap was 5 mm. What is the stored energy if the air gap is now 10 mm?

[ ]

Submit Answer Tries 0/3

Druck versus Online
Freie Eingabe versus MC

Symbolische Aufgaben

Example:

$$\frac{d}{dt}\begin{pmatrix} 3at \\ 2t^2 \\ 5 \end{pmatrix} = \begin{pmatrix} 3a \\ 4t \\ 0 \end{pmatrix}$$

Exercise: What is the derivative of the vector

$$\begin{pmatrix} c\sin(at) \\ c\exp(kt) \\ bt^3 \end{pmatrix}$$

with respect to t? Enter the components separated by commas, with exponents denoted by `^` and explicit multiplication using `*`, e.g., `7*b*t^2+a,5a,a+b*t`.

a*c*cos(a*t), c*k*exp(k*t), 3*b*t^2

Submit Answer Tries 0/99

Symbolische Aufgaben

Berechnen Sie die Ableitung der folgenden Funktion:

$f(x)=(x-3)\cos(x)$

$f'(x)=$

Antwort einreichen Versuche 0/99

Gezielte Hinweise

Verschiedene Formeln

Berechnen Sie die Ableitung der folgenden Funktion:

$f(x)=(x^2-x+3)\cos(x)$

$f'(x)=$ -(2 x -1) sin(x)

Die Produktregel lautet nicht $f'(x)=u'(x)v'(x)$.

Antwort einreichen Inkorrekt. Versuche 2/99 Bisherige Antworten

What is the derivative of

$$\begin{pmatrix} 4t^3 \\ 8t^8 \end{pmatrix}$$

with respect to t? 4t^2,8t^7

You need to multiply with the original exponent.

Give an example of a function

1. which is orthogonal to $6\cdot\cos(7\cdot x)-2\cdot\sin(2\cdot x)$ with respect to the scalar product

$$< g \mid h > = \frac{1}{\pi} \int_{-\pi}^{\pi} dx\, g(x) \cdot h(x)$$

2. whose norm is 1.

Unendlich viele Antworten

cos(2x)+sin(7x)

The function you have provided does not have a norm of one.

Submit Answer Incorrect. Tries 1

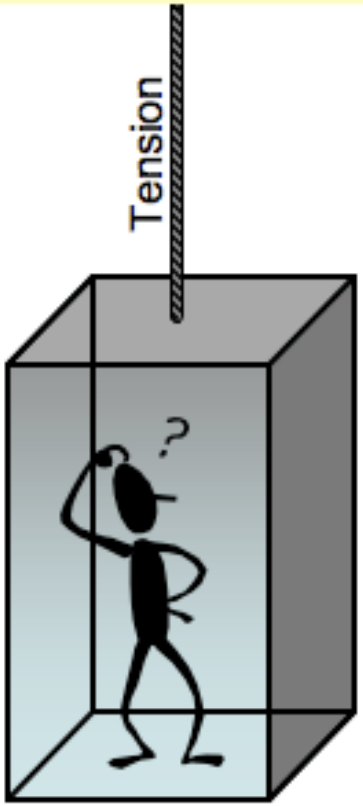
Physikalische Einheiten

Elevator Problem

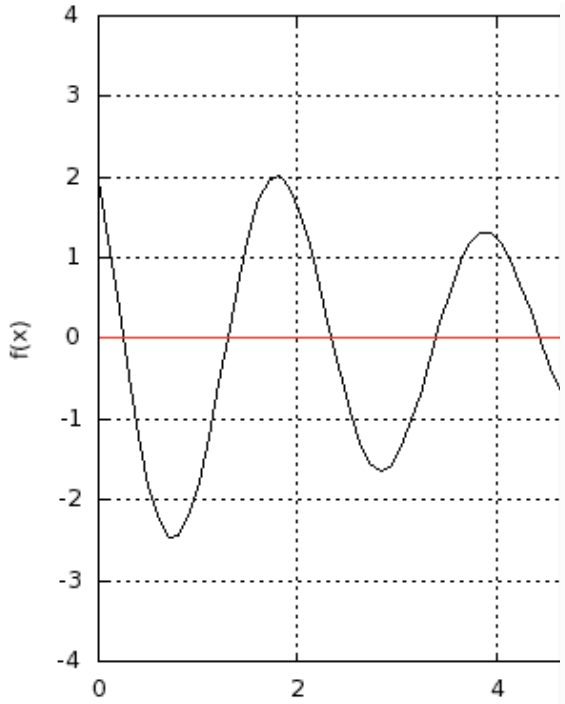
Due never

An elevator (cabin mass 500 kg) is designed for a maximum load of 2600 kg, and to reach a velocity of 3 m/s in 5 s. For this scenario, what is the tension the elevator rope has to withstand? 32270 kg*m/s^2

Submit Answer Tries 0/99



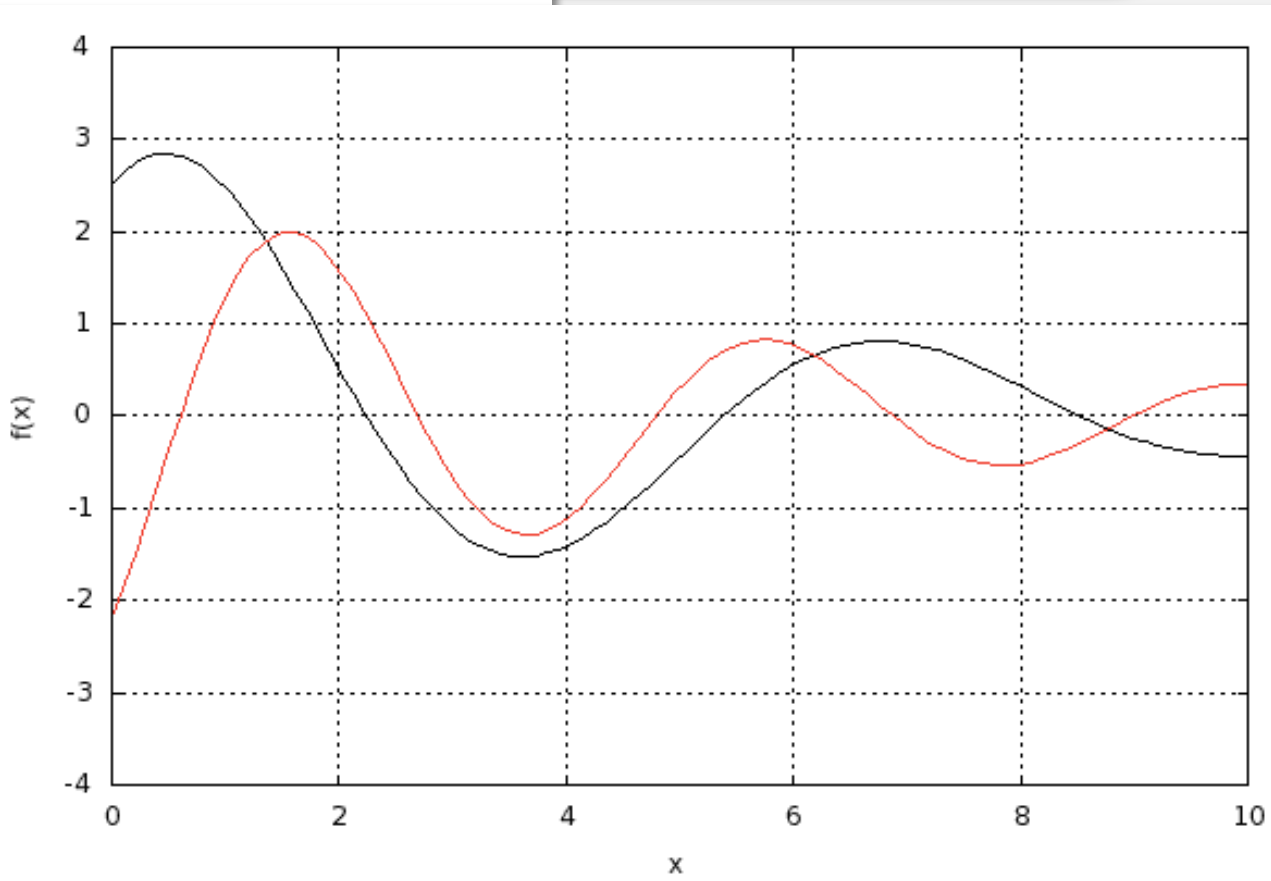
Graphen



Match the function indicated in black.

f(x)=

Submit Answer Tries 0/99



Match the function indicated in black. The function you entered is indicated in red.

f(x)= 2.8*exp(-0.21*x)*sin(1.5*x-0.9)

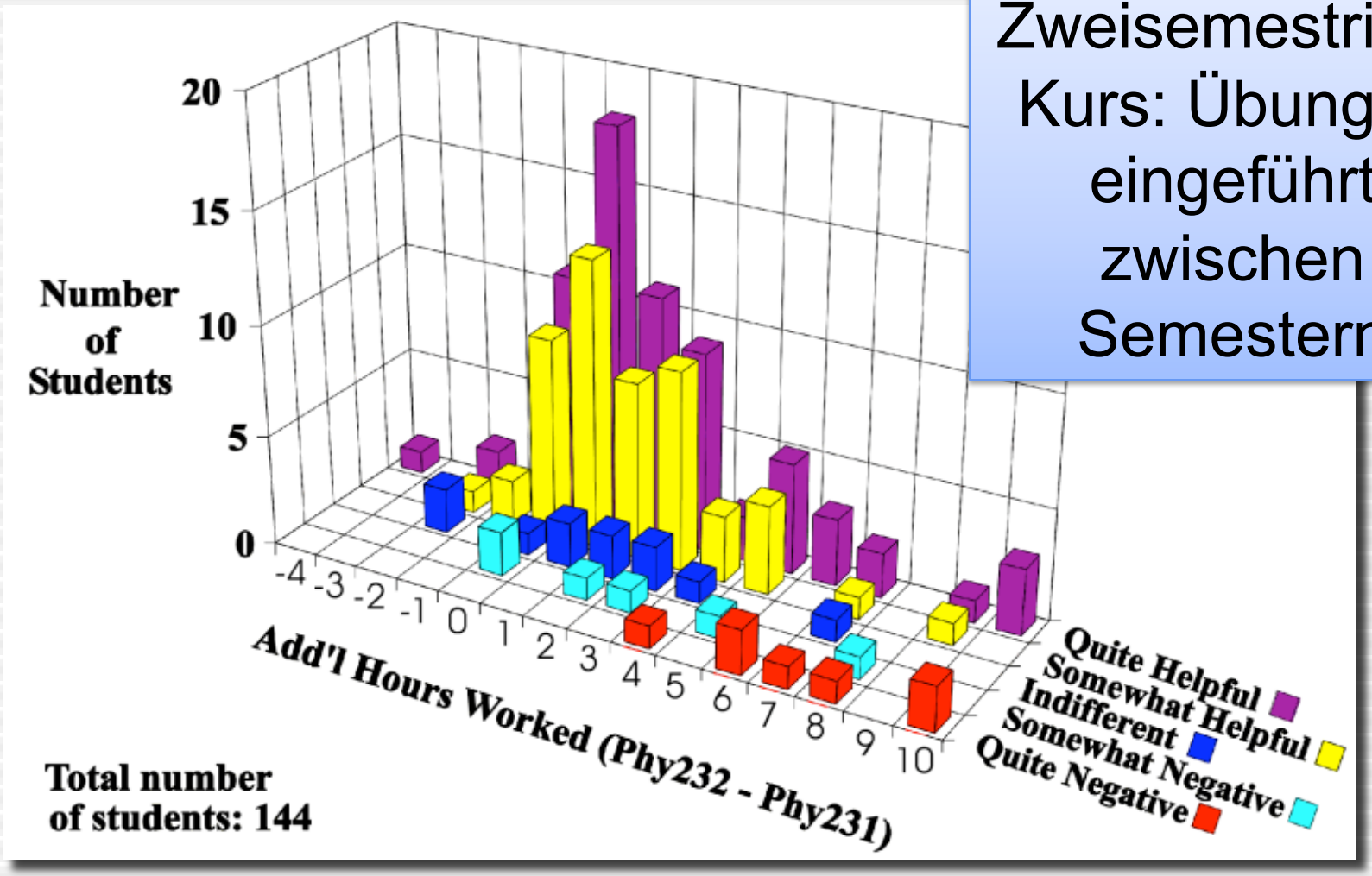
Submit Answer Incorrect. Tries 4/99 Previous Tries

Fragen

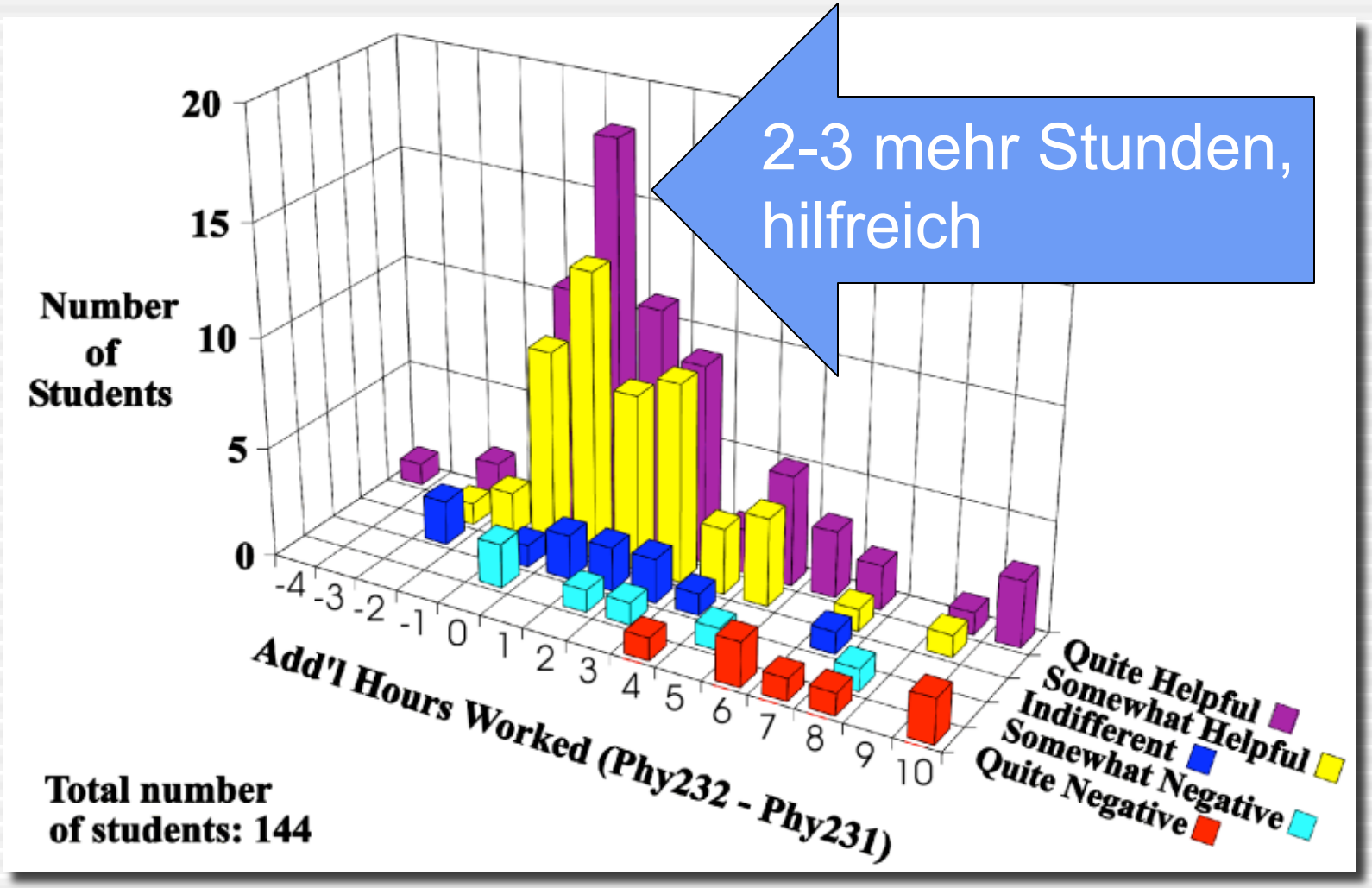
- Wird das von den Studierenden angenommen?
- Welchen Einfluß haben die Übungen auf den Lernerfolg?
- Wer profitiert am meisten von den Übungen?

Subjektiv, Studierende

Zweisemestriger Kurs: Übungen eingeführt zwischen Semestern



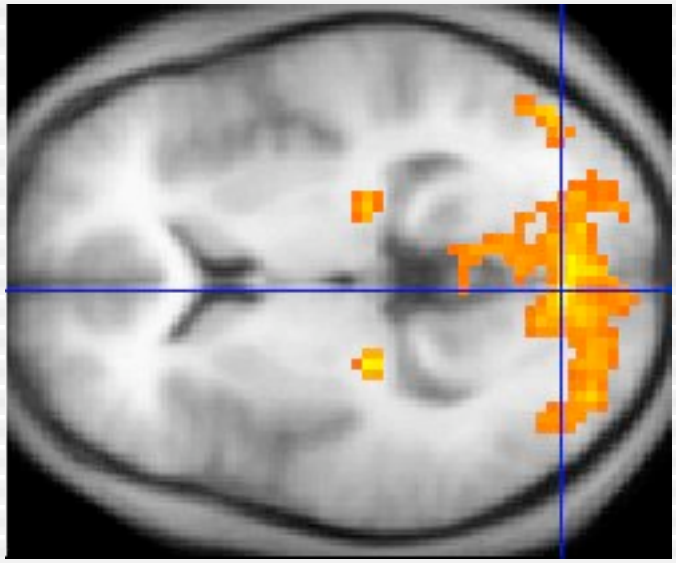
Subjektiv, Studierende



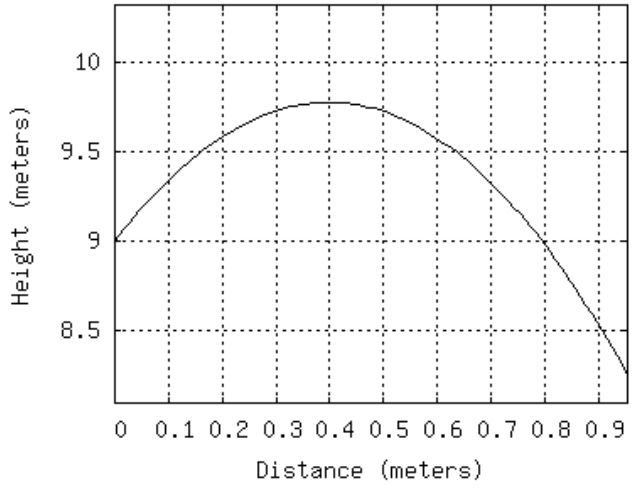
Was machen die da?

- Gute Frage: was genau machen die Studierenden in dieser Zeit?
- Nachteil von online Aufgaben: keine schriftlichen Ausarbeitungen
- Dafür: online Diskussionen

Das sehe ich ein!



Online Diskussionen



Diskussionen
Erlaubt, weil jeder Studierende eine andere Version hat. Peer-Teaching.

The plot shows the trajectory (height versus distance) of an object launched at an angle of 75.6 degrees. What was the initial speed of the object? **4.0 m/s**
Computer's answer now shown above. Tries 0/12

Threaded View Chronological View Sorting/Filtering options Export?

Anonymous 1 (Fri Sep 22 01:26:29 2006 (EDT))

any hints to start?

Re: *Anonymous 2* (Fri Sep 22 01:56:48 2006 (EDT))

You need to find the Y component of velocity... you can do this by finding the height traveled (notice it does not start on the ground) and combining that with acceleration in a kinematics equation. From there use trig to get the original velocity.

Re: Re: *Anonymous 1* (Fri Sep 22 12:10:37 2006 (EDT))

how can we find the height traveled and how can we get the acceleration if we don't have the time?

Anonymous 3 (Fri Sep 22 16:41:27 2006 (EDT))

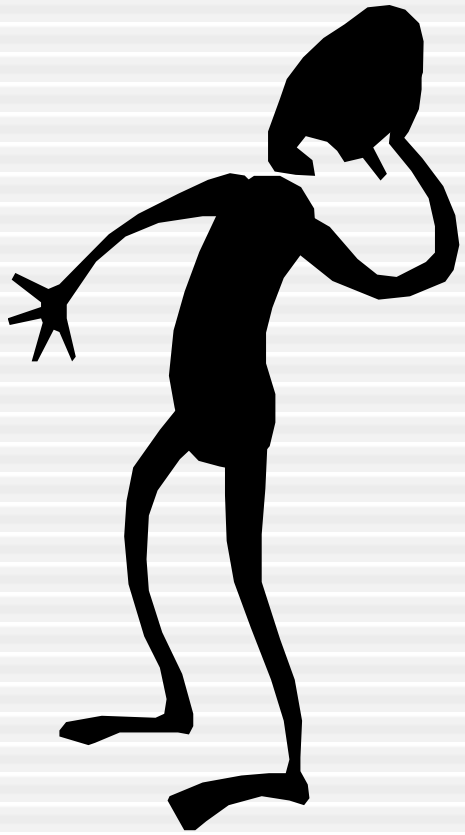
i'm lost on this one... can anyone help?

Re: *Anonymous 4* (Fri Sep 22 20:02:45 2006 (EDT))

Use the squared kinematics equation - so Vf^2 = Vi^2 + 2a (Xf-Xi).

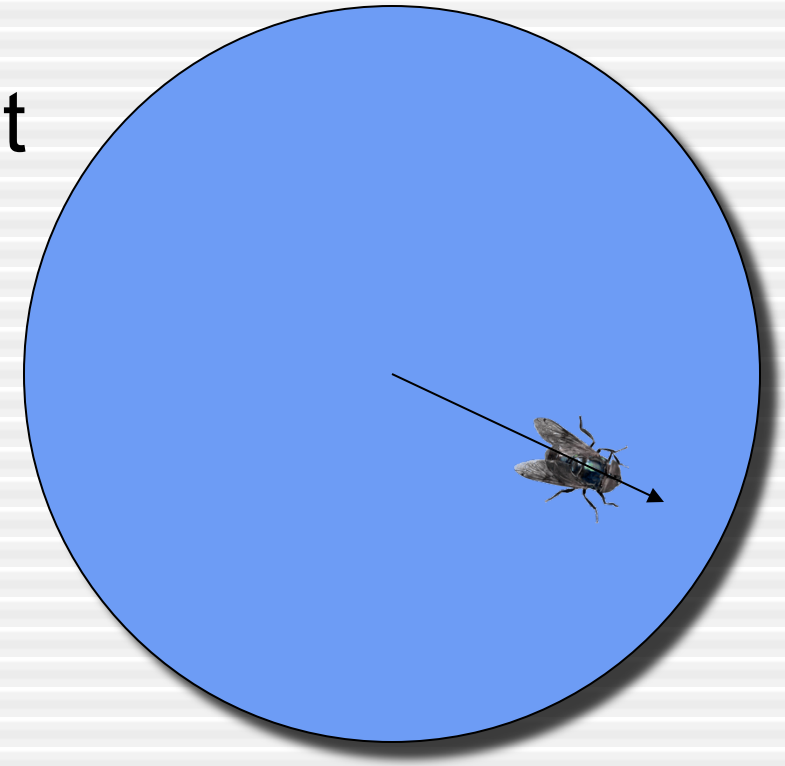
Diskussionsanalyse

- Häufig könnte man fast hoffen, nicht geguckt zu haben …



Beispielproblem

- A bug that has a mass m_b=4g walks from the center to the edge of a disk that is freely turning at 32rpm. The disk has a mass of m_d=11g. If the radius of the disk is R=29cm, what is the new rate of spinning in rpm?



Lösung

- Kein externes Drehmoment
  ➔Drehimpuls erhalten
- Käfer ist klein im Vergleich zur Scheibe, kann als Punktmasse angenommen werden

$$\left(\frac{1}{2}m_d R^2 + m_b 0^2\right)\omega_0 = \left(\frac{1}{2}m_d R^2 + m_b R^2\right)\omega$$

$$\Rightarrow \omega = \frac{m_d}{m_d + 2m_b}\omega_0$$

Zweizeiler!

Student Discussion

- *Student A:* What is that bug doing on a disk? Boo to physics.
- *Student B:* OHH YEAH

  ok this should work it worked for me

  Moments of inertia that are important....

  OK first the Inertia of the particle is mr^2

  and of a disk is .5mr^2

  OK and angular momentum is conserved

  IW=IWo W=2pi/T

  then do this

  .5(mass of disk)(radius)^2(2*pi/T original)+ (mass of bug)

  (radius of bug=0)^2= (.5(mass of disk)(radius)^2(2pi/T))+

  (mass of bug)(radius of bug)^2(2*pi/T)

  and solve for T

Student Discussion (cont.)

- *Student C:* What is T exactly? And do I have to do anything to it to get the final RPM?
- *Student B:* ok so T is the period... and apparently it works for some and not others.... try to cancel out some of the things that are found on both sides of the equation to get a better equation that has less numbers in it
- *Student D: what did I do wrong?*

  This is what I did. initial inertia x initial angular velocity = final inertia x final angular velocity. I=mr^2, angular velocity = w... so my I initial was (10g)(24 cm^2) and w=28 rpm. The number calculated was 161280 g *cm^2. Then I divided by final inertia to solve for the final angular speed. I found final Inertia by (10g +2g)(24 cm^2)=6912. I then found the new angular speed to be 23.3 rpm. This was wrong...what did I do incorrectly?

Student Discussion (cont.)

[…]

- *Student H: :sigh:* Wow. So, many, little things, can go wrong in calculating this. Be careful.

[…]

- Keiner der Studierenden stellte fest
  - Käfer als Punktmasse gerechtfertigte und magels Angaben nötige Näherung
  - Ergebnis unabhängig vom Radius der Scheibe
  - Keine Einheitenumrechnung nötig
  - Verwechslung von Radius *R* im Trägheitsmoment eines ausgedehnten symmetrischen Objektes und dem Radius *R* der Kreisbahn einer Punktmasse

Student Discussion (cont.)

- Viele Studierende setzen fast sofort Zahlenwerte ein
- Viel unnötiger Aufwand

Klassifizierung

- Quantitative Aussagen: Klassifizierung
- Diskussionen von drei Kursen
- Zirka 3400 Diskussionsbeträge

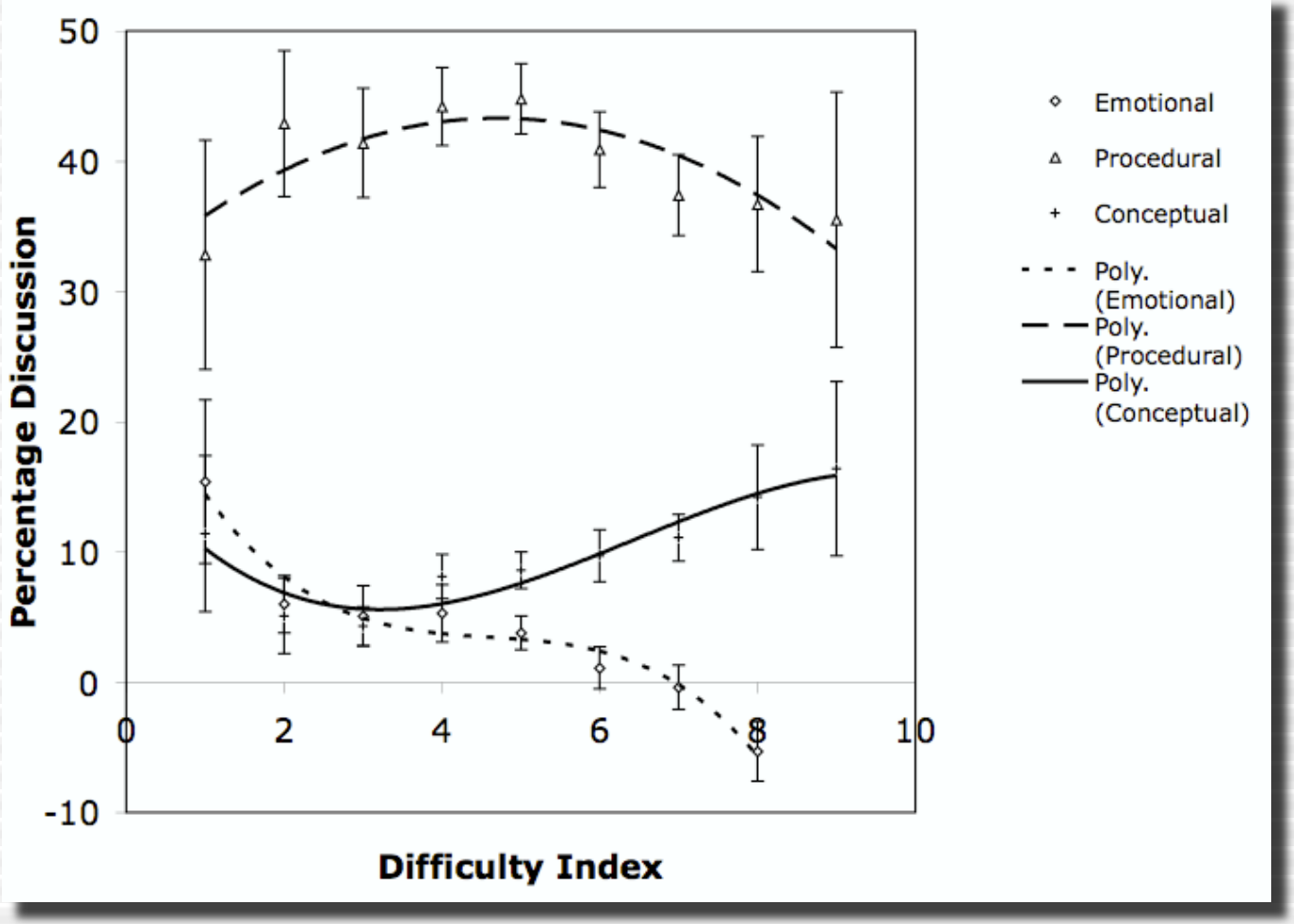
Klassifizierung

- Emotional: “So ein Mist, ich gebe auf!”
- Surface: “Ist Theta hier der Winkel mit der Horizontalen?”
- Procedural: “Nimm den Abstand zum Quadrat, multipliziere ihn mit der doppelten Beschleunigung, …”
- Conceptual: “Je schwerer der Ball, desto mehr sollte unter der Oberfläche sein.”
- Unrelated: “Obendrein muss es heute auch noch den ganzen Tag regnen!”
- Solution: “Du darfst hier nicht runden, sonst klappt’s nicht.”
- Math: “Der Sinus von 90 Grad ist Eins.”
- Physics: “Was ist die Definition von ‘Leistung’?”

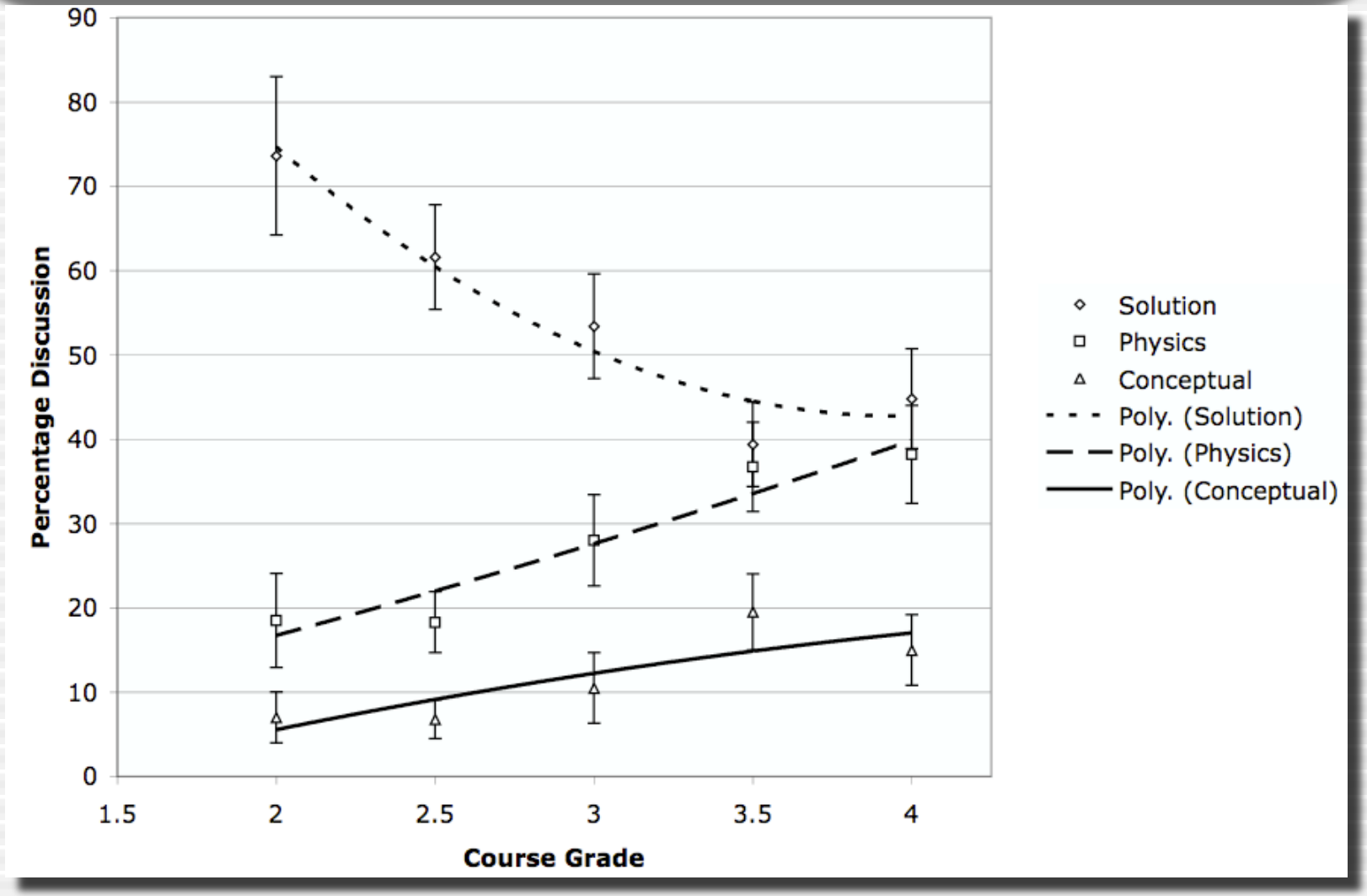
	Emotional		Surface		Procedural		Conceptual		
	Pos	Neg	Q	A	Q	A	Q	A	
Unrelated	71	54	10	1			1		137
Solution	279	185	601	341	353	456	12	3	2230
Math	1	6	49	36	73	87	3	6	261
Physics		14	85	81	170	190	100	126	766
	351	259	745	459	596	733	116	135	3394

Einfluss der Aufgabenschwierigkeit

- Schwieriger als 0,6: “more pain, no gain”

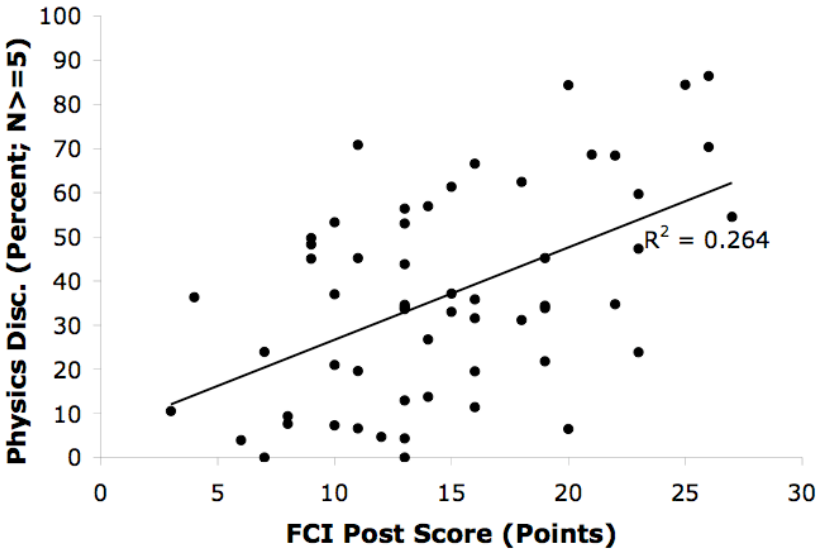


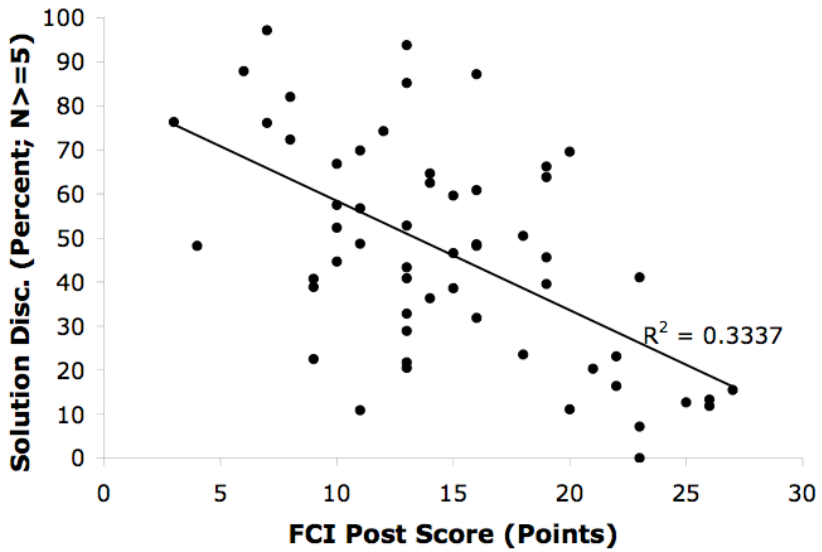
Diskutieren bessere Studiernde besser?



Korrelationen

- Force Concept Inventory (FCI)



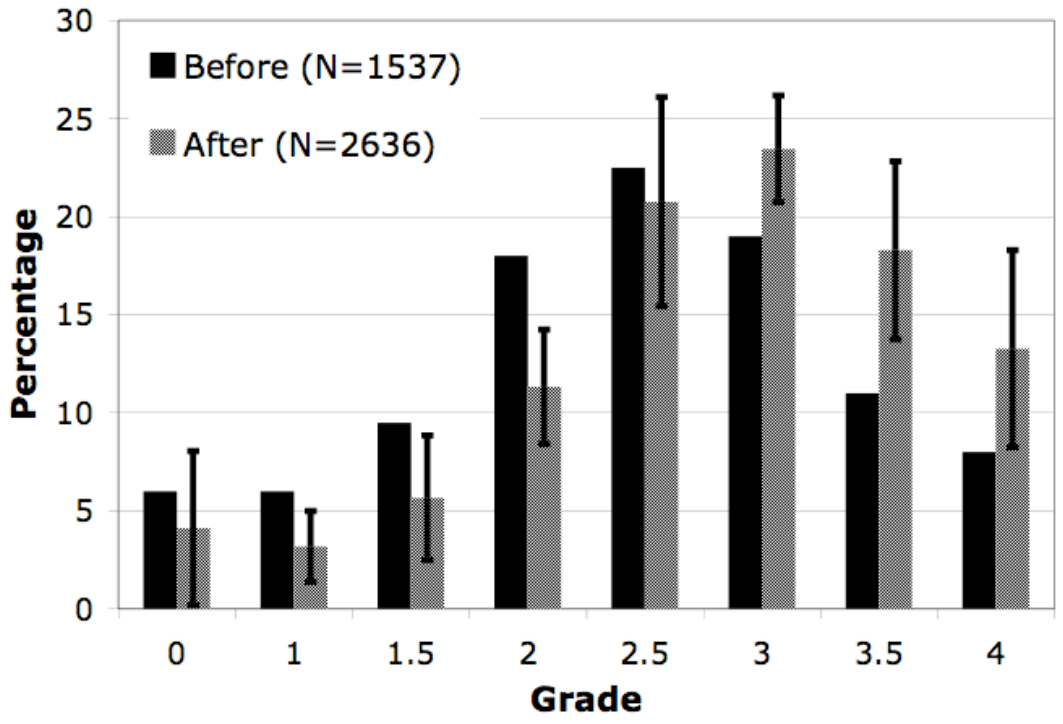


Regression

- PostFCI=5,486+0,922•PreFCI+0,24 •ProzentPhysics
- PostFCI=7,606+0,857•PreFCI-0.042 •ProzentSolution
- Wie zu verstehen?
- Wenn jemand 100% solution-oriented Diskussionen macht, hat er - nachdem Pre-Punkte schon eingerechnet sind - im Durchschnitt 4.2 Punkte weniger Post-Punkte

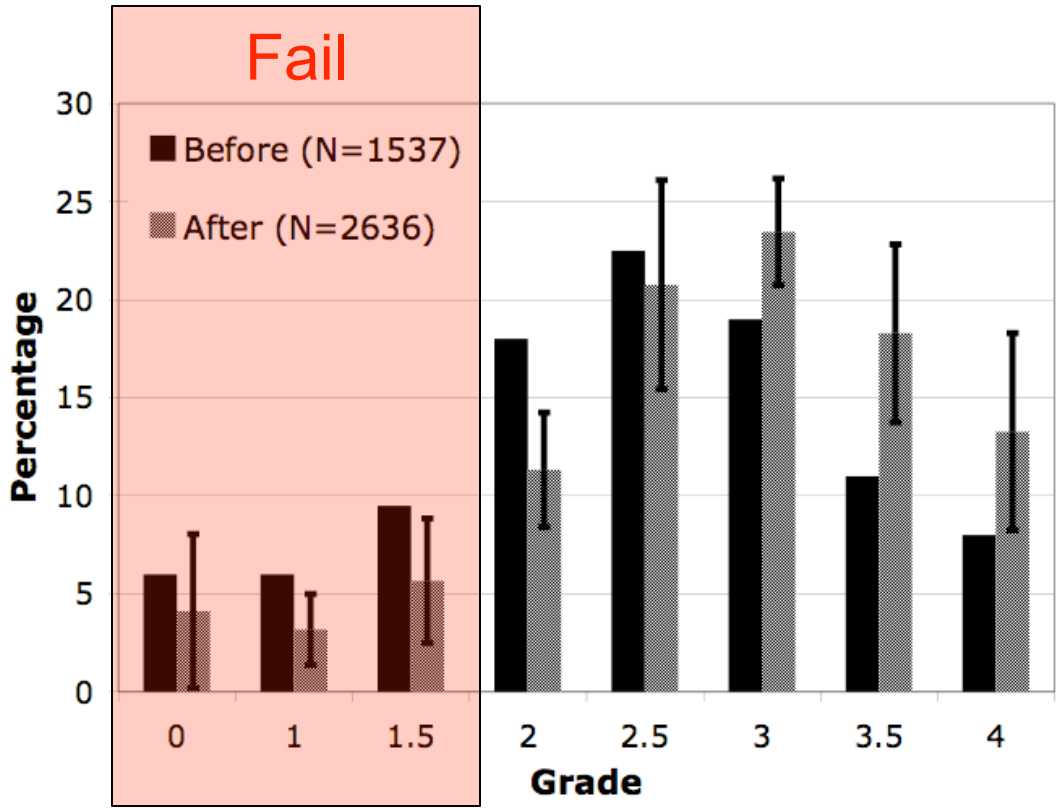
Lernerfolgskontrolle

Die gleiche Veranstaltung, in Jahren vor und nach Einführung zusätzlicher vorlesungs-begleitender online Hausübungen



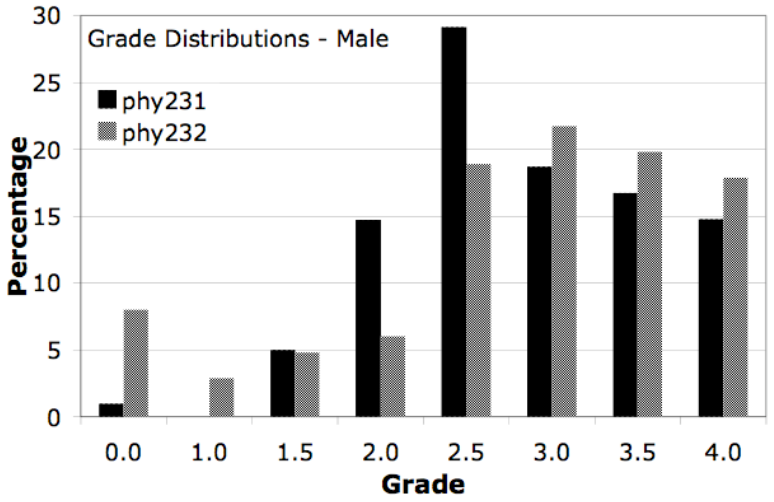
Lernerfolgskontrolle

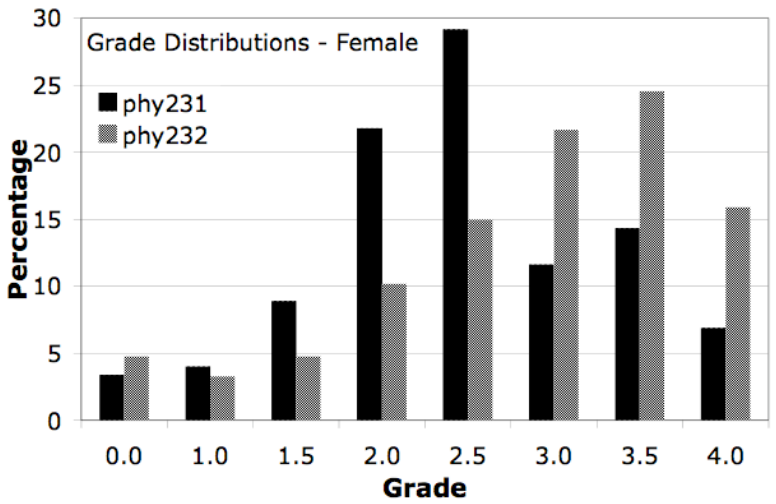
Hilft hauptsächlich Studierenden, die vom Durchfallen bedroht sind.



Geschlechts-unterschiede

- phy231:
  ohne CAPA
- phy232:
  mit CAPA
- Geschlechts-unterschied
- Aber wie?



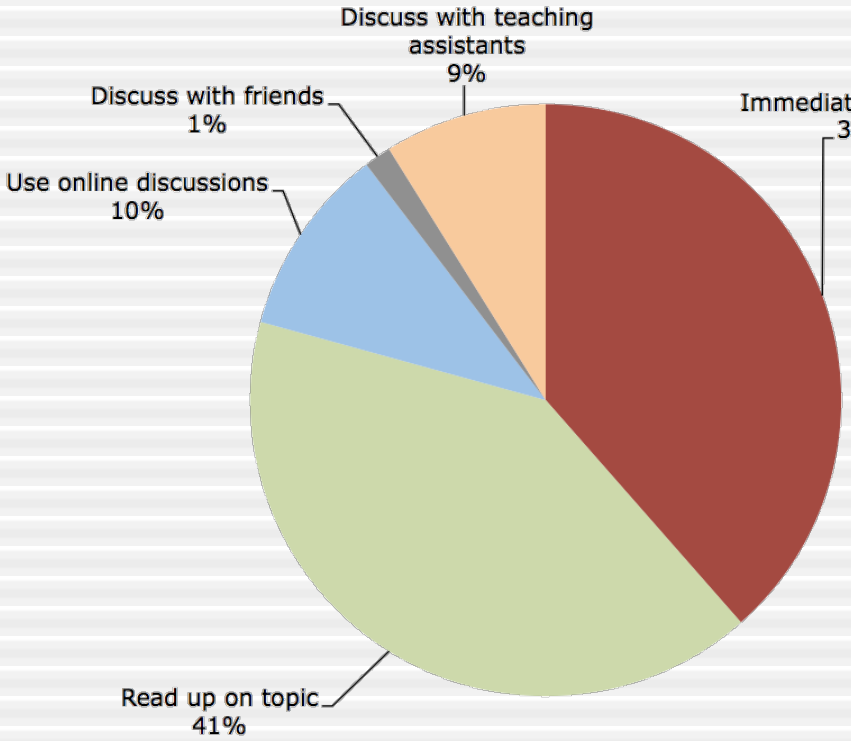


Geschlechterunterschiede

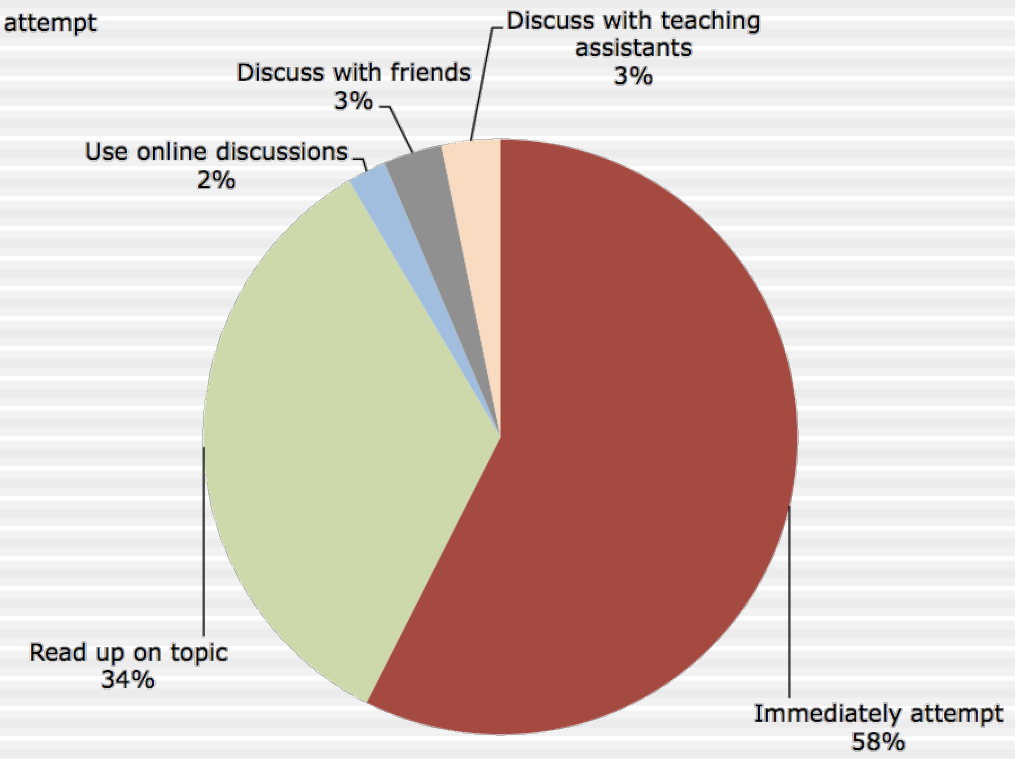
- Geschlechterunterschiede in der Nutzung des Systemes
- Könnten zum Teil den Unterschied im Lernerfolg erklären

Allererster Ansatz

Initial Action on Homework: Female



Initial Action on Homework: Male

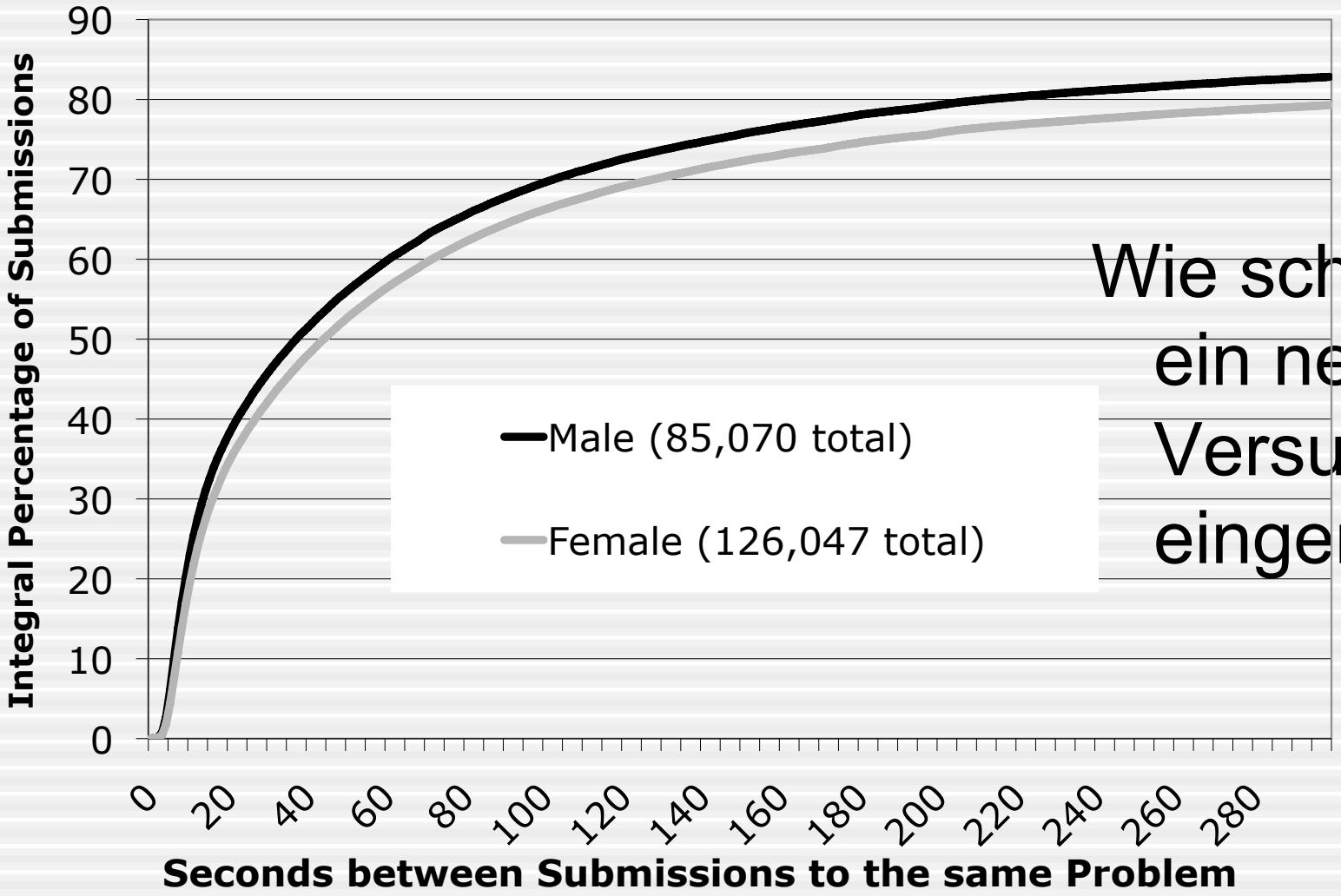


Mehrere erlaubte Anläufe

Open-ended: How do you make use of the multiple allowed attempts?

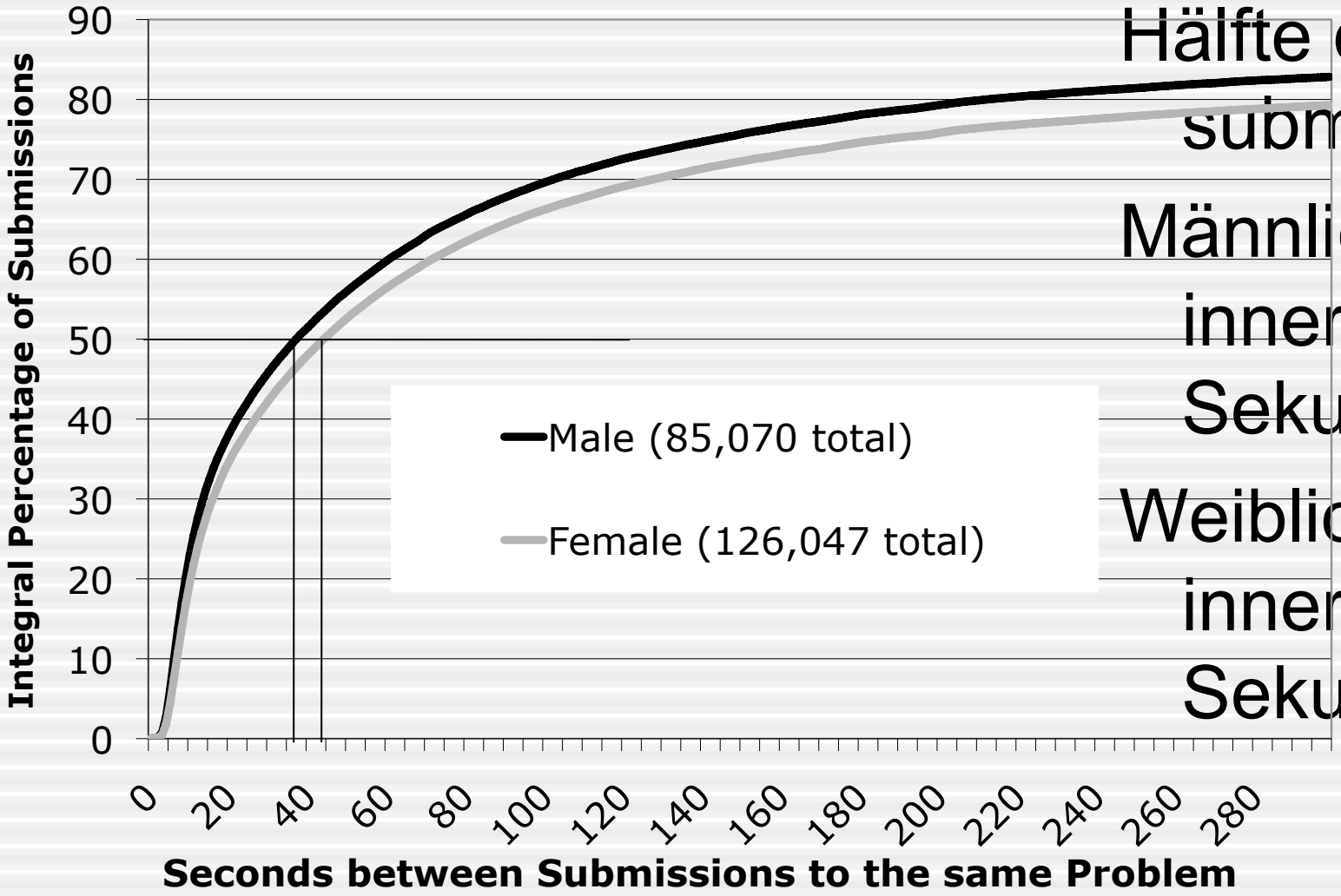
Statement	Male	Female	Δ
I submit random stuff or guess	14%	8%	-6%
If I get it wrong, I backtrack my calculations	5%	0%	-5%
Having many tries allows me to try different approaches and learn from my mistakes	22%	18%	-4%
I use tries for a process of elimination, often coordinated with friends	5%	3%	-2%
Having many tries does not allow me to just give up or quit	2%	0%	-2%
Tries are useful to get answer formatting correct	3%	2%	-1%
I don't use many tries	3%	3%	0
I take every try seriously	5%	5%	0
I vary the equations till they work	9%	10%	+1%
Having many tries allows me to start working on the problem myself without waiting for help from others	2%	3%	+1%
Tries are useful if I make errors in unit conversions	7%	8%	+1%
Tries are useful if I make calculation errors	5%	7%	+2%
Tries are useful if I make order of magnitude errors	1%	3%	+2%
Tries are useful if I plug in the wrong numbers	0%	2%	+2%
I use many tries	8%	11%	+3%
Having many tries allows me to try out my own approach without the stress or worry about grades	6%	10%	+4%
Other	3%	7%	+4%

Nach einem Fehlschlag



Wie schnell wird ein neuer Versuch eingereicht?

Nach einem Fehlschlag



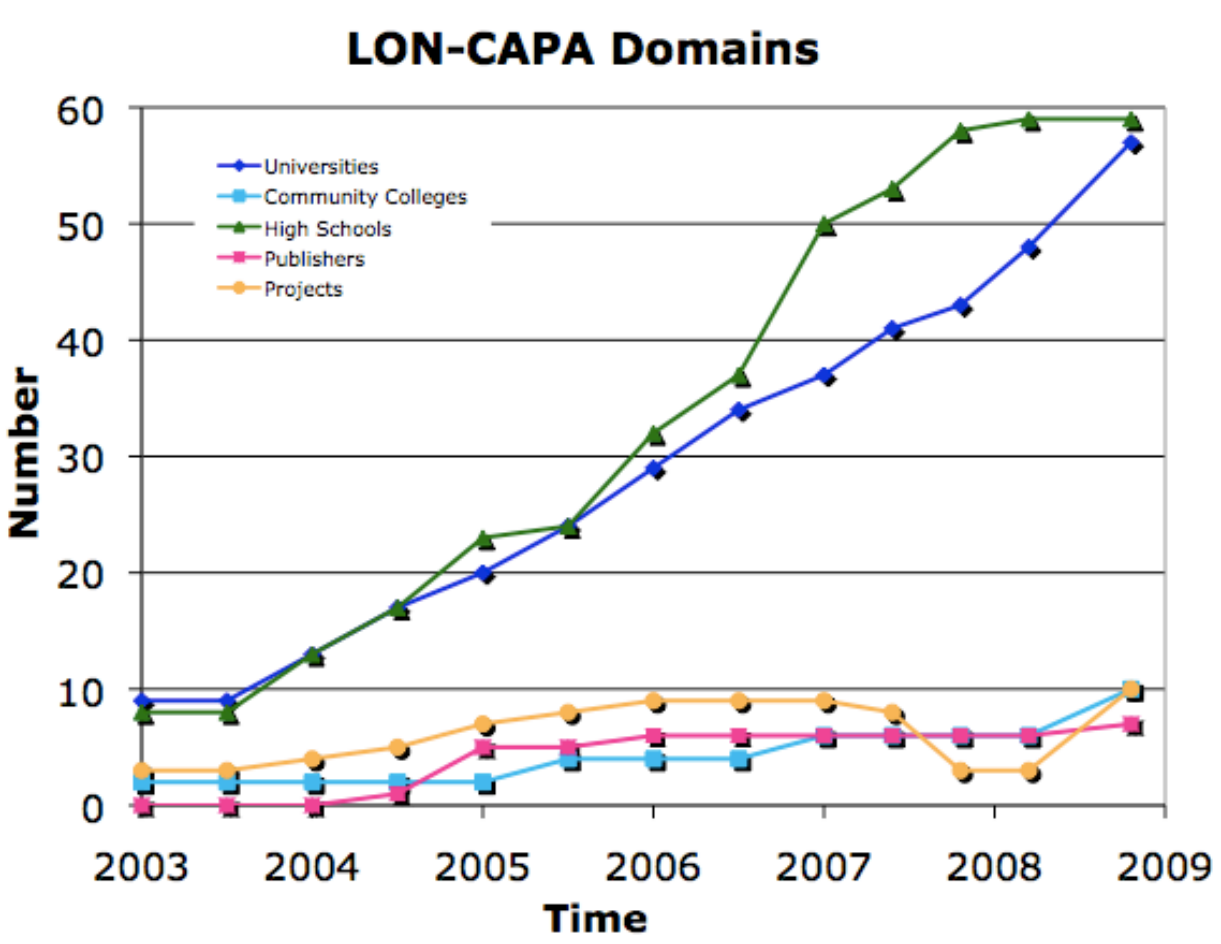
Hälfte der Re-submissions:

Männlich: innerhalb 38 Sekunden

Weiblich: innerhalb 45 Sekunden

Lehrende

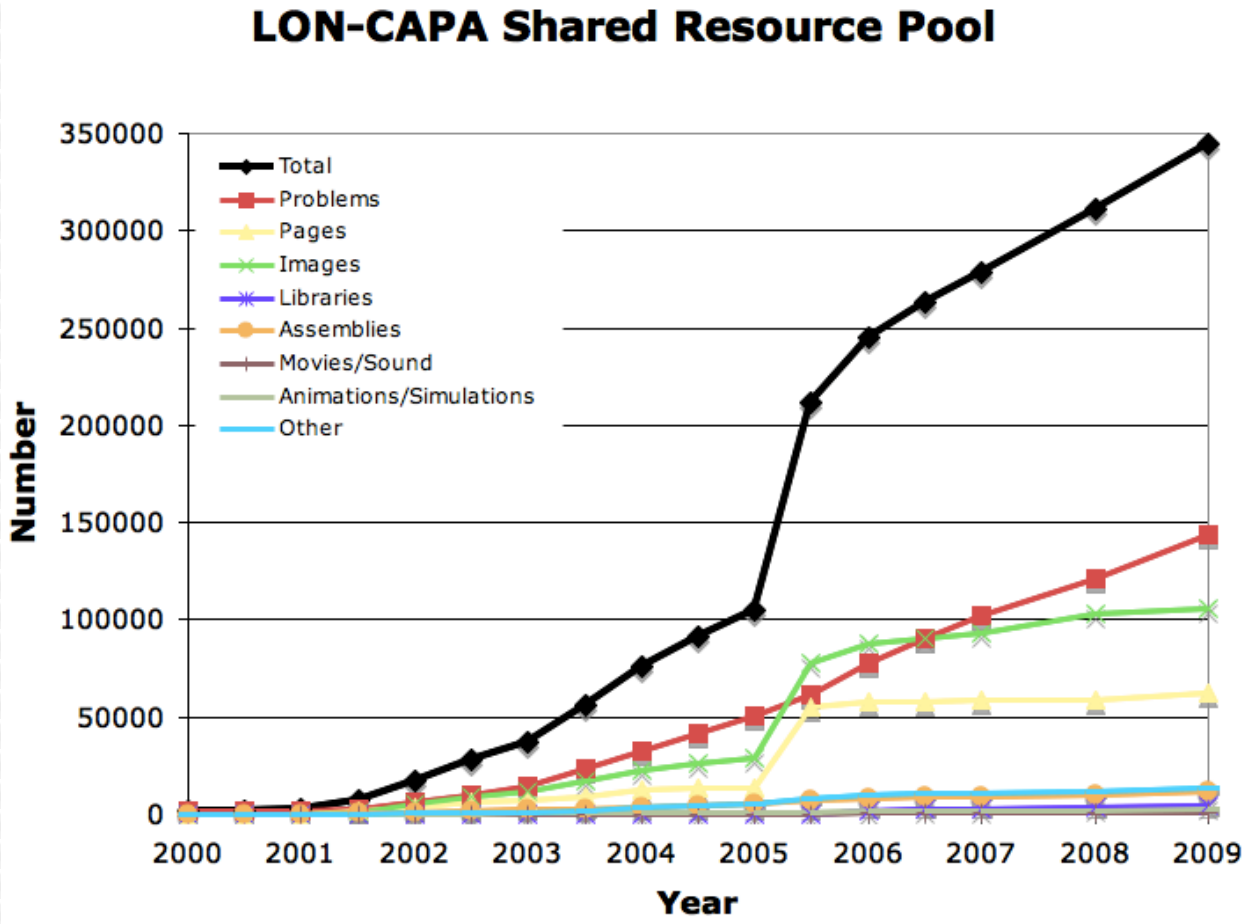
Wird das System von Lehrenden angenommen?



59 High Schools
57 Colleges
and Universities

Lehrende

Wird das System von Lehrenden angenommen?



350.000
Resources

140.000
Übungsaufgaben

Projekt VITA

- Geht das auch in Deutschland?
- VITA Projekt, gefördert vom Land Niedersachsen
- Verbund von Fachhochschulen und niedersächsischen Schulen
- Erstellung von Übungsmaterialien für Mathematik und Physik

Projekt VITA

- Einsatz in 43 Kursen
- Befragung zur Halbzeit:
  - 130 Studierenden der Fachhochschulen Braunschweig/Wolfenbüttel und Oldenburg/ Ostfriesland/Wilhelmshaven
  - 60% der Studierenden befürworten online Übungen,
    10% lehnen sie ab,
    30% „egal“

Vielen Dank

- http://www.lon-capa.org/
- kortemey@msu.edu
- http://www.lite.msu.edu/kortemeyer/