

# Developing a network for digital content and assessment

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# What may happen, if I like to use a 3D-Math-Tool

The screenshot shows a web-based 3D mathematical tool interface. On the left, there's a sidebar with a yellow book icon labeled "Wilhelm W. Peter Knauf Mathe und" and a list of topics:

- Ergänzende Inhalte zur Vorlesung
- Optimierung
- Mehrdimensionale Integration
  - Links auf Beispiele im Netz
- Kurvenintegrale
- Oberflächenintegrale
  - Parametrisierung des Torus
  - Parametrisierung der Halbkugel
  - Rotationsfläche
  - Möbiusband
  - Ring
  - Animation Orientierung der Oberfläche
- Differentialgleichungen

The main area features a code editor with the following code:

```
vmax = breite
umin = 0
umax = 2*pi
vn = 25
un = 25
```

Below the code is a "Auswerten" button. To the right, there's a formula input field with the expression:

$$S(x, y) = ((u, v) \mapsto \frac{1}{2} (v \cos(\frac{1}{2} u) + 2) \cos(u), (u, v) \mapsto \frac{1}{2} (v \cos(\frac{1}{2} u) + 2) \sin(u), (u, v) \mapsto \frac{1}{2} v \sin(\frac{1}{2} u))$$

Sliders for  $u$  and  $v$  are shown, along with values  $\pi$  and  $0$ . A star icon is present. At the bottom, a 3D plot of a surface is displayed, showing a red and blue textured surface with a small coordinate system at the top.

# What may happen, if I like to use a LMS

The screenshot shows a LMS interface with a navigation bar at the top. The left sidebar contains a list of course topics. The main content area displays a question about a differential equation, with three multiple-choice options. A large question mark icon is overlaid on the right side of the question box.

FAU UnivIS IdM mein campus

Schreibtisch · Angebote · Hilfe ·

—STUDON— Zurück Weiter →

System 1. Ordnung (1)

Frage 11 von 12 (1 Punkt)  
Nicht beantwortet

Aktionen ▾

Gegeben sei folgende Differentialgleichung:  
 $\beta w''' - \alpha w = q(x)$ ,  $\alpha, \beta \in \mathbb{R}^+$ . Wie lautet das System erster Ordnung?

$w'(x) = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -\frac{\alpha}{\beta} & 0 & 0 & 1 \end{pmatrix} w(x) + \begin{pmatrix} 0 \\ 0 \\ 0 \\ \frac{q}{\beta} \end{pmatrix}$

$w'(x) = \begin{pmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -\frac{\alpha}{\beta} & 0 & 0 & 0 \end{pmatrix} w(x) + \begin{pmatrix} 0 \\ 0 \\ 0 \\ \frac{q}{\beta} \end{pmatrix}$

$w'(x) = \begin{pmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -\frac{\beta}{\alpha} & 0 & 0 & 0 \end{pmatrix} w(x) + \begin{pmatrix} 0 \\ 0 \\ 0 \\ \frac{q}{\beta} \end{pmatrix}$

Zurück Weiter →

# What can happen if I want to use an LMS

Using it as file manager as a beginning

- But: What would we like to have?  
An integrated learning environment:
  - Providing all necessary information
  - Handling the exercises
  - Interactive diagrams
  - Offering formative assessments
  - Using formulas in assessments
- Which LMS: ILIAS, Moodle, LON-CAPA etc.

# The (digital) Content

What is the difference between a pdf and a learning module?

Provide more interactivity in a learning module,  
e.g.

- Interactive diagrams
- Assessments with immediate feedback
- Example 1 (Graph of a function, Sage)
- Example 2 (Sequences in 2d, jsxGraph)
- Example 3 (integration techniques)

# Example 1 (Graph of a function, Sage)

The screenshot shows a web-based interface for a university system, likely FAU, featuring a sidebar menu and a main content area. The sidebar includes links for 'Ergänzungen zu den Vorlesungen' (such as 'Einleitung', 'Folgen', 'Funktionen', and 'Funktionen mehrerer Veränderlicher' with sub-links like 'Folgen im  $\mathbb{R}^2$ ', 'Graphen von Funktionen zweier Veränderlicher', 'Niveaulinien von Funktionen zweier Veränderlicher', 'Stetigkeit', 'Tangentialebene', 'Taylorpolynom', and 'Implizite Funktion'). The main content area displays a code snippet in a text editor, followed by a 'Auswerten' (Evaluate) button, and a 3D plot window. The 3D plot shows a surface defined by the equation  $G(x, y) = -x^2 - y^2 + 2$ . The axes are labeled  $x_0$  and  $y_0$ , with sliders set at  $-0.25$  and  $0.75$  respectively. The plot shows a blue paraboloid surface opening downwards from a peak at  $(0, 0, 2)$ .

```
10 * def _ (x0=(-0.25, (-1, 1)), y0=(0.75, (-1, 1))):  
11 *     order = 1  
12 *     F0 = float(G.subs(xx=x0).subs(yy=y0))  
13 *     P = (x0, y0, F0)  
14 *     dot = point3d(P, size=15, color='red')  
15 *     plot = dot + plotF  
16 *     approx = F0  
17 *     for n in range(1, order+1):  
18 *         for i in range(n+1):  
19 *             if i == 0:  
20 *                 deriv = G.diff(yy, n)  
21 *             elif i == n:  
22 *                 deriv = G.diff(xx, n)
```

Auswerten

$x_0$    $y_0$

$G(x, y) = -x^2 - y^2 + 2$   
 $\nabla G(x, y) = (-2x, -2y)^T$   
 $\nabla G(x_0, y_0) = (0.50, -1.5)^T$

2.38  
z=1.19  
0.00  
-1.00  
-1.00

# Example 2 (Sequences in 2d, jsxGraph)

The screenshot shows a university website interface with a sidebar on the left and a main content area on the right.

**Sidebar (Left):**

- FAU UnivIS IdM mein campus
- STUDION
- Schreibtisch ▾
- Angebote ▾
- Hilfe ▾
- Ergänzungen zu den Vorlesungen
  - Einleitung
  - Folgen
  - Funktionen
- Funktionen mehrerer Veränderlicher
  - Folgen im  $\mathbb{R}^2$  (selected)
  - Graphen von Funktionen zweier Veränderlicher
  - Niveaulinien von Funktionen zweier Veränderlicher
  - Stetigkeit
  - Tangentialebene
  - Taylorpolynom
  - Implizite Funktion

**Main Content Area (Right):**

## Folgen im $\mathbb{R}^2$

### Konvergenz von Folgen

nth-element of the sequence:  $2 / n * \cos(n)$ , start at n = 1

nth-element of the sequence:  $(-1)^n + 1 / n * \sin(n)$

start stop Spur zeigen Spur nicht zeigen

The graph displays two sequences in the  $\mathbb{R}^2$  plane. One sequence, represented by red dots, converges to a point labeled 'a' located at approximately (-0.4, 1.0). A green circle indicates the limit point. The other sequence, represented by red dots, appears to diverge or have multiple accumulation points near the origin (0,0).

# Example 3 (integration techniques)

The screenshot shows a digital assignment interface. At the top, there is a header bar with the text "Automatisches Speichern erfolgreich durchgeführt..." and icons for messaging, a briefcase (with a red notification dot), a search bar, and user profile.

The main navigation bar includes "STUD ON" (highlighted in blue), "Schreibtisch", "Angebote", and "Hilfe".

The title of the assignment is "Übungsaufgaben zur Substitution".

The left sidebar lists various topics under "Fragenliste":

- Substitution bei einer ganzrationalen Funktion
- Herleitung der Regel der Substitution
- Substitution bei einer gebrochen-rationalen Funktion
- Substitution mit Parametern (gebrochen-rationale Funktion)
- Substitutionsmöglichkeiten bei einer gebrochen-rationalen Funktion
- Substitution (echt gebrochen-rationale Funktion)
- Substitution (Exponentialfunktion)
- Substitution (lineare und Wurzelfunktion)
- Substitution (natürliche Exponentialfunktion)

The current question is titled "Substitution bei einer ganzrationalen Funktion". It is "Frage 1 von 9" and is marked as "Nicht beantwortet (in Bearbeitung)".

The question text asks: "Bestimmen Sie mithilfe der Substitution alle Stammfunktionen von  $f(x) = (4x + 5)^3$ !"

A student input field contains the answer:  $\int (4x + 5)^3 dx = \frac{1}{16}*(4*x+5)$ , followed by a checked checkbox and the text ",  $c \in \mathbb{R}$ ".

The system feedback states: "1/16\*(4\*x+5) wurde wie folgt interpretiert:  $\frac{1}{16} \cdot (4 \cdot x + 5)$ ".

Below the input field, it says: "Die folgenden Variablen wurden gefunden: [x]" and "Geben Sie das Ergebnis als Produkt an."

A button labeled "Rückmeldung anfordern" is visible.

At the bottom right of the question area is a green "Weiter" button.

# Example 3 (integration techniques)

The screenshot shows a digital assessment interface. At the top, there is a navigation bar with icons for email (2 notifications), briefcase, search, and user profile. The main menu includes "STUDON", "Schreibtisch", "Angebote", and "Hilfe". On the left, a sidebar lists various substitution methods for rational functions, such as "Substitution mit Parametern (gebrochen-rationale Funktion)", "Substitutionsmöglichkeiten bei einer gebrochen-rationalen Funktion", etc. The main content area contains a math problem: "Bestimmen Sie mithilfe der Substitution alle Stammfunktionen von  $f(x) = (4x + 5)^3$ !". A text input field contains the answer  $\frac{1}{16} \cdot (4 \cdot x + 5)^4$ , which is marked as correct. Below it, a note says: "1/16\*(4\*x+5)^4 wurde wie folgt interpretiert:  $\frac{1}{16} \cdot (4 \cdot x + 5)^4$ ". A button "Rückmeldung anfordern" is visible. A large yellow box at the bottom provides feedback: "Die Antwort ist falsch." It shows the correct derivation:  $4x + 5 = t$ ,  $\frac{dt}{dx} = 4 \Leftrightarrow dt = 4dx \Leftrightarrow dx = \frac{dt}{4}$ ,  $\int t^3 \cdot \frac{1}{4} dt =$ ,  $= \frac{1}{4} \cdot \frac{1}{4} \cdot t^4 + c =$ ,  $= \frac{1}{16} t^4 + c =$ ,  $= \frac{1}{16} (4x + 5)^4 + c, c \in \mathbb{R}$ . The last step,  $(4x + 5)^4$ , is circled in red.

# STACK

System for Teaching and Assessment using a Computer algebra Kernel

Initiated by Chris Sangwin (Edinburgh) on Moodle  
Ported to ILIAS (at FAU)

“This open-source system helps you build sophisticated assessments for STEM which challenge your students and provides feedback to help them improve their performance and understanding.”

<https://www.ed.ac.uk/maths/stack>

# Usage in Germany



Kallweit et al: STACK in Germany. 1. STACK Conference 2018

Albert-Ludwigs-Universität Freiburg  
DHfPG - Deutsche Hochschule für Prävention und Gesundheitsmanagement  
Duale Hochschule Baden-Württemberg Mannheim  
Fachhochschule Münster  
FAU Erlangen-Nürnberg  
FH Aachen  
FH Dortmund  
FH Potsdam  
HAW Hamburg  
Hochschule Bochum  
Hochschule Bremen  
Hochschule für Technik Stuttgart - HFT Stuttgart  
Hochschule für Technik und Wirtschaft Berlin  
Hochschule Karlsruhe - Technik und Wirtschaft  
Hochschule Ruhr West  
Julius-Maximilians-Universität Würzburg  
Karlsruher Institut für Technologie  
Leibniz Universität Hannover  
Ostbayerische Technische Hochschule Amberg-Weiden  
Pädagogische Hochschule Heidelberg  
Ruhr-Universität Bochum  
TH Köln  
TU Darmstadt  
Universität Göttingen  
Universität Hamburg  
Universität Kassel  
Universität Paderborn  
Universität Potsdam  
Universität zu Köln

# Groups in Germany (dates not up to date)



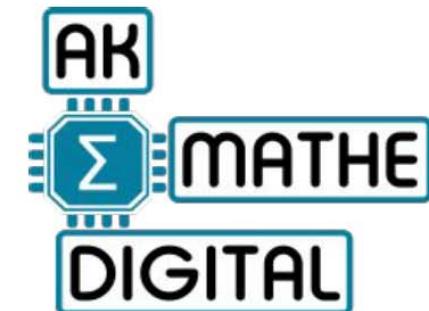
Minisymposium:  
Digitale-Aufgaben in der  
Hochschullehre  
Potsdam, 27.03.2017  
Paderborn, 06.03.2018

## STACK Workshops

Bochum, 21.03.2017  
Nürnberg, 04.04.2017  
Aachen, 31.05.2017  
Potsdam, 28.06.2017  
Stuttgart, 12.10.2017  
Bochum, 24.10.2017  
Potsdam, 05.12.2017  
Bochum, 06.02.2018  
Aachen, 13.04.2018  
Potsdam, 18.06.2018

## STACK Süd+

Karlsruhe, 02.02.2015, 27.03.2017  
Mannheim, 14.11.2017



Bochum, 26.07.2017  
Hamburg, 30.07.2018

## SIG Mathe+ILIAS

Special Interest Group for using ILIAS in math education



## Workshops in BW

Karlsruhe, 15.02.2017  
Stuttgart, 19.04.2018

Moodle Arbeitskreis  
HS Mannheim

14.07.2016



# Netzwerk Mathe Digital est. 2019

# How does a STACK question looks like?

The screenshot shows the StudOn interface for creating a Potential response tree. The top navigation bar includes links for FAU UnivIS, IdM, mein campus, and various icons for messaging, files, search, and user profile.

The main area displays a "New Potential response Tree" configuration:

- Graphical view:** Shows a tree structure with root node 0. Node 0 has two children: node 1 (labeled "+0") and node 0 (labeled "=0"). Node 1 has two children: node 0 (labeled "+0") and node 0.5 (labeled "+0.5").
- Potential response Tree Name \***: prt1
- First Node**: A dropdown menu showing "0".
- Copy Potential Response Tree**: A button labeled "Copy Potential Response Tree".
- Show**: A button to preview the tree.

Below this, there is a "New Node" configuration:

<b>Answer test</b>	<b>AlgEquiv</b>
<b>Student answer *</b>	An answer test is used to compare two expressions to establish whether they satisfy some mathematical criteria
<b>Teacher answer *</b>	<code>diff(ans1,x)</code> This is the first argument to the answer test function. In asymmetrical tests this is considered to be the "student's answer" although it may be any valid CAS expression, and may depend on the question variables or the feedback variables. Allowed elements: CAS Expression
<b>Test options</b>	<code>(4*x+5)^3</code> This is the second argument to the answer test function. In asymmetrical tests this is considered to be the "teacher's answer" although it may be any valid CAS expression, and may depend on the question variables or the feedback variables. Allowed elements: CAS Expression
<b>This field enables answer tests to accept an option, e.g. a variable or a numerical precision.</b>	
<b>Allowed elements: CAS Expression</b>	

# DOMAIN: A Database for digital mathematics tasks

The screenshot shows the DOMAIN database search interface. At the top, there is a navigation bar with the logo 'DOMAIN Database of Math Instructions', user information (Wigand Rathmann), and links for Importieren, Suchen, Status, and Ausloggen. Below the navigation bar, the search form is displayed with the following filters applied:

- Suchbegriff: partielle integration
- Aufgaben Typ: stack
- Zufällige Aufgabenstellung: ja
- Nach Gruppen filtern: (empty)
- Aufgaben Sprache: Deutsch (DE)
- Nur eigene Aufgaben suchen

On the right side of the search form, there is a green 'Suchen' button with a magnifying glass icon.

Below the search form, a green banner displays the message "68 Suchergebnisse, zeige 24.". To the right of the banner, there are buttons for "Ansicht:" (grid, list, card) and "Sortieren nach:" (Relevanz). A dropdown menu for "Sortieren nach:" is open, showing options like "Relevanz", "Erstellt am", "Titel", etc.

The main content area shows a list of search results. One result is expanded, showing detailed information:

**Partielle Integration - Monome**

ID: 35 UID: 4F10CFD (Klicken zum Bewerten)

**Autor:** Eva Glasmachers **Uploader:** Nadine Ende **Hochgeladen am:** 2018-05-12 14:39:09

**Beschreibung:** In dieser randomisierten Aufgabe sollen die Studierenden eine Stammfunktion eines Monoms mittels partieller Integration ermitteln.

**Allgemeine Informationen:**

Thema	Partielle Integration
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# Where we can get new ideas?

## Digital content

- Federal state Rhineland-Palatinate  
**Virtual Campus Rhineland-Palatinate with Netmath ([www.netmath.de/](http://www.netmath.de/))**
- LMS ILIAS (open source)  
SIG Mathe + ILIAS (Mathe Digital now)  
Important contribution to MathJax in ILIAS,  
Exchange of content  
Supports the development of STACK

# Where we can get new ideas?

## Discuss teaching

- One of the first series in Germany was the “Workshop in Engineering Math” est. by Prof. Dieter Schott (Wismar) in 2001 (16<sup>th</sup> workshop will be in Dortmund next year)
- Mathematics Working Group SEFI est. 1982 [sefi.htw-aalen.de](http://sefi.htw-aalen.de)
- [khdm](http://khdm.de) (Centre for Higher Mathematics Education)
- [HD MINT](http://www.hd-mint.de) (Aliance of the Universities of Applied Sciences in Bavaria)

## It's a mess with the formats

There are even more tools for developing digital exercises for mathematics:

IMathAS, JACK,LON-CAPA, MathCoach,  
MathWeb, Möbius Assessment, MyMathLab,  
Onyx, Questionmark, WIRIS

Ingo Dahn has more information  
[\(dahn-research.eu/Survey/\)](http://dahn-research.eu/Survey/)

## STACK used in ILIAS and Moodle LMS

## Further projects providing math content

- AK Mathe Digital ([ak-mathe-digital.de](http://ak-mathe-digital.de), 2017)
- VEMINT (Virtual Introductionary Tutorium)
- Optes (Optimisation of the self-study phase)
- JSXGraph (jsxgraph.org)  
[Google Group JSXGraph](https://groups.google.com/forum/#!forum/jsxgraph)  
stackoverflow:[jsxgraph](https://stackoverflow.com/questions/tagged/jsxgraph)

**1. Conference: 8./9.10.2020 Bayreuth**

## And now?

- Find a balance between making it for yourself and using provided content
- Start bilateral
- Start cooperation inside your institution
- Especially for STACK: Get inspirations from the tasks of others
- Be patient