PhysikClub

Students Research Centre

Understanding Science
by doing
self-reliant and independent research

Part 1

Inquiry based learning IBL
and
the constructivist learning theory

Learning is like exploring an undiscovered country…

Follow the teacher

Inquiry based learning

Removing the blocks…

What teachers must not do!

What teachers should do!

Constructivist teaching and learning theory

- Knowledge can‘t be absorbed or transfered, but must be constructed individually
- Learning is an active process with individual and collective aspects
- „Education is a self-organizing system, where learning is an emergent phenomenon“; (Sugata Mitra, 2010)

Examples

LOL: Learning without teacher

- Step 1: Learn how to learn

  Studying techniques, informations about neurocognition, practical experience in learning and comprehension
- Step 2: Discuss homework without teacher
- Step 3: Give homework to themselves
- Step 4: LOL

  Work on own subjects, teacher as an adviser, groups gather the learning objectives during several months by themselves

Linear motion with constant velocity

Answering these three questions will lead to inquiry based learning:

- What is the meaning of 50 km/h? Convert in m/s and give reasons for your approach
- Explain the distinction between instantaneous velocity and average speed.
- Inquire motions with constant velocity and the relation between the covered distance and the required time

Research program: Vibrations

Students develop questions and make their own inquiries with the help of experiments and texts:

- How does a pendulum oscillate? (path-time-diagram and equation)
- Why does a pendulum oscillate? (restoring force, inertia)
- When is it necessary to support an oscillation and how can we do this? (damping, feedback)
- When does a pendulum start oscillations? (natural oscillation, forced oscillation, resonance)
- How can you describe an oscillation? (harmonic oscillations, circular motions)

How can we implement IBL?

Characterization of inquiry based learning

- Working out a complex issue with own concepts and approach
- Students pursue their own objectives
- IBL is not exploratory learning, observations need theoretical background
- Students acquire the necessary knowledge by their own
- IBL demands permanent alternation between instruction by teachers and constructions made by students themselves
- IBL changes the role of teachers from instructors to coaches

Building blocks for IBL

- *Work out linguistic competences*: write down their own notes, generating texts produce accuracy and comprehend key issues
- *Literacy:* searching the answers of one´s own questions
- *Teacher as advisors*: hold back instructions
- *Induce self-confidence*: don´t dictate theorems and abstracts, students control their homework
- *Mistakes* are a chance of learning
- *Cooperate in a team*: learning by teaching, talking about problems

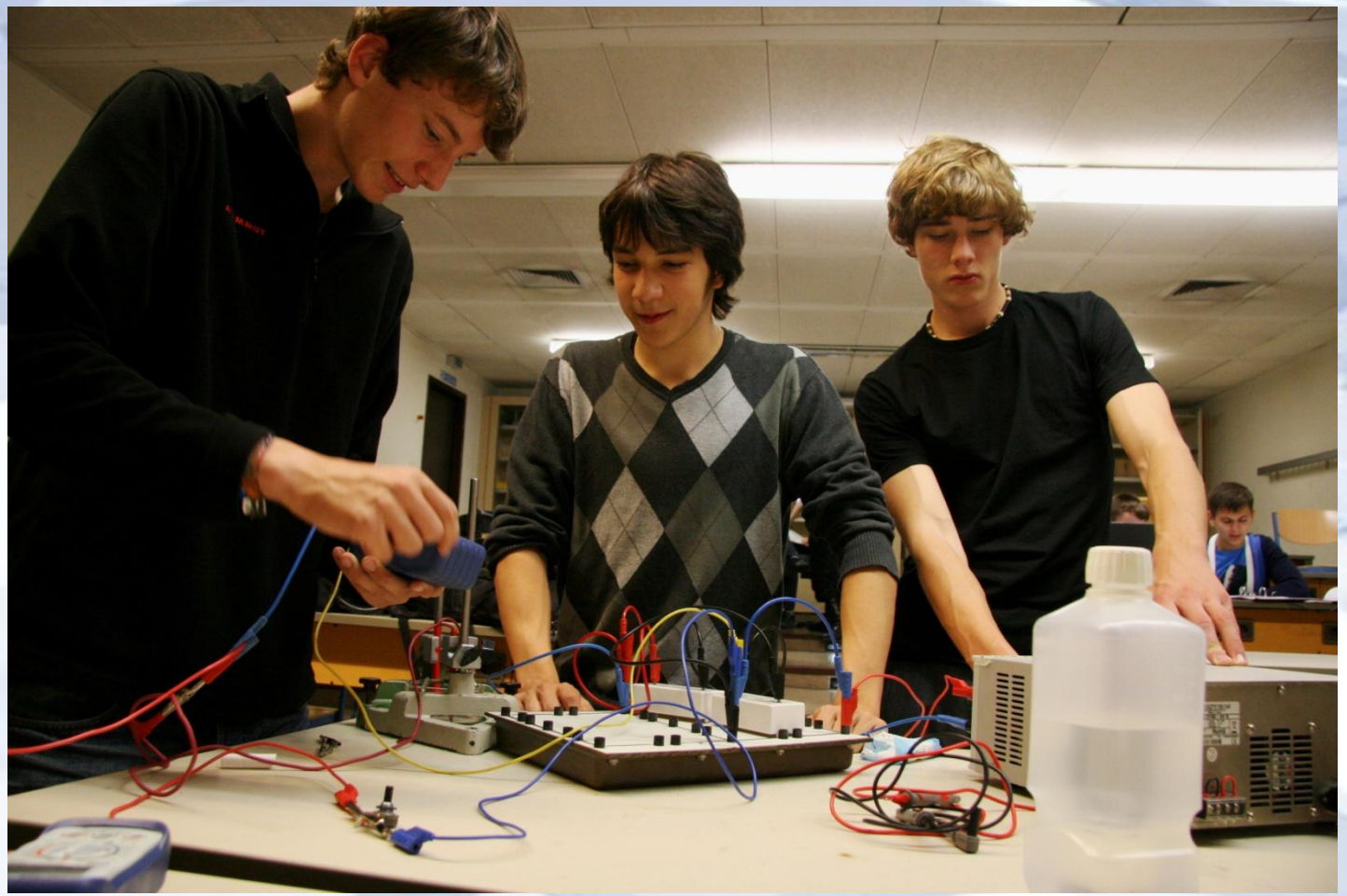
Building blocks for IBL

- Students organize and control their *exercises*
- Students practice *self-diagnosis*
- Students know the *objectives* and *evaluate* their self-concept
- *Asking questions*: creating lists of questions, structure them, find topics and specify more questions

Procedure instructions for IBL

- Problem and objective
- Activate your previous knowledge
- Search for information, make experiments, discuss your difficulties
- Express your knowledge, question it, improve it
- Assessment: do you succeed?
- Presentation, recapitulation
- Practice and exercise

Part 2:
IBL in the PhysikClub and Youth Research Center



Organisation: Youth Research Centre

- Cooperation between:
  - Albert-Schweitzer-Schule (ASS) Kassel (general secondary school)
  - City of Kassel, Hesse
  - Ministry of Education, Hesse
  - University of Kassel, Hesse
  - Ministry of Science, Hesse
- Research in all MINT-classes:
  - Physics/Astrophysics
  - Biology
  - Chemistry
  - Maths
  - Engineering

Staff

Head & Founder:
Klaus-Peter Haupt

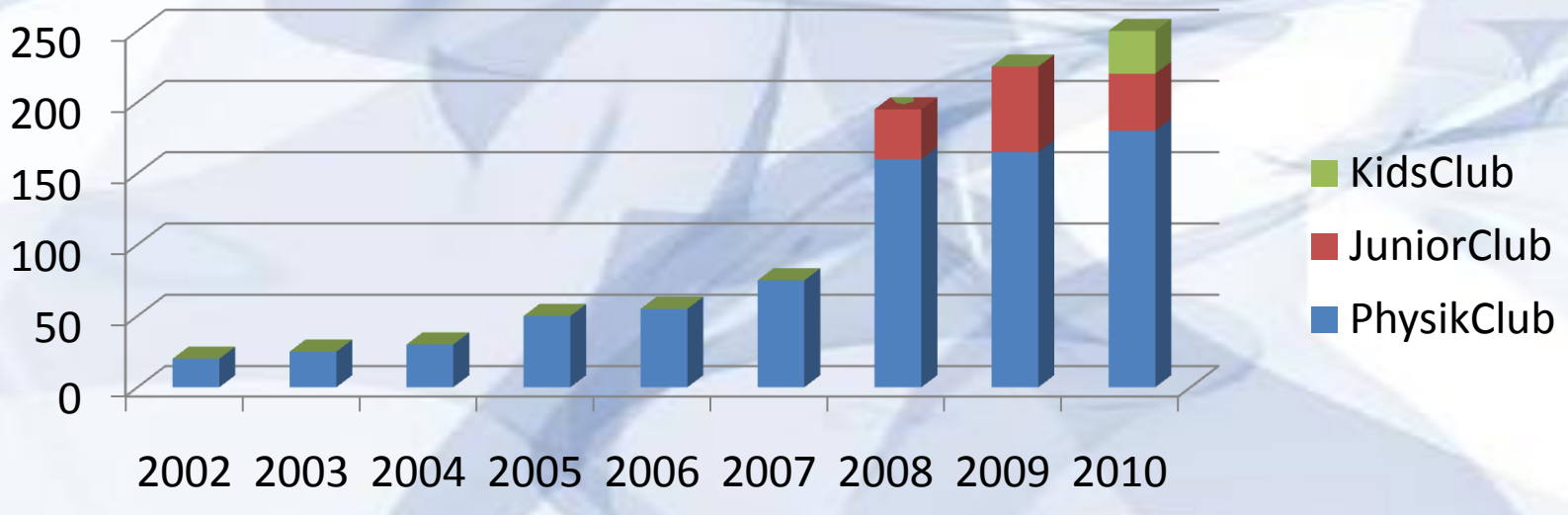
Staff:
20 collaborators:

- students
- teachers
- freelancers

Alumni-concept: Most students were formerly participating students in the PhysikClub

Internal structure and participants

- KidsClub: classes 5 - 6, age 10 - 11, tuesdays, 14:00-15:30
- JuniorClub : classes 7 – 8, age 12-13, fridays 13:45-15:15
- ScienceClub: classes 9 – 13, age 14 – 19, fridays 15:30- >18:30,Saturday 11:00-14:00
- Students come from different schools in northern Hesse



Principles

- No time-pressure
- No testing
- No grades
- Knowledge is a tool for solving problems
- Interdisciplinary work
- Competence-orientated
- Long-term researches
- Authentic projects
- Teamwork

Presentations

- Scientific lectures an presentations on thursdays and fridays
- Running presentations of research groups every Friday
- Annual presentations at the end of every school year
- Participation in national science fair („Jugend forscht“)
- Participation in several different fairs and exhibitions
- Students congress (2010: 1200 visitors)

Workshops

- Annual workshops to one distinctive subject
  - Working groups
  - Lectures held by scientists
  - Presentations of the results
  - Excursions
- Examples:
  - Cave-exploration
  - Navigation
  - Mountains and stars
  - Cosmic sounds
  - Philosophy of time






Holiday-academy

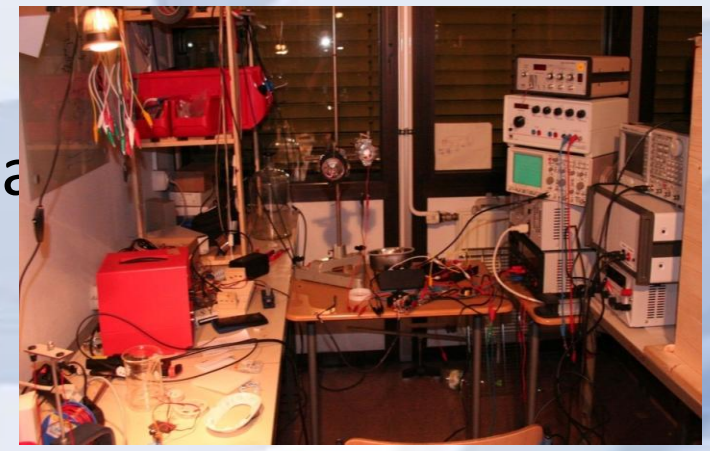
- Academy for younger students (8-10) in the summer holidays
- Hands-on-experiments and smaller projects
- ~20 students
- Duration: one week
- Presentation and lunch at the final day

Examples for projects

- **Bunching-effect and the Taylor- experiment with single photons**

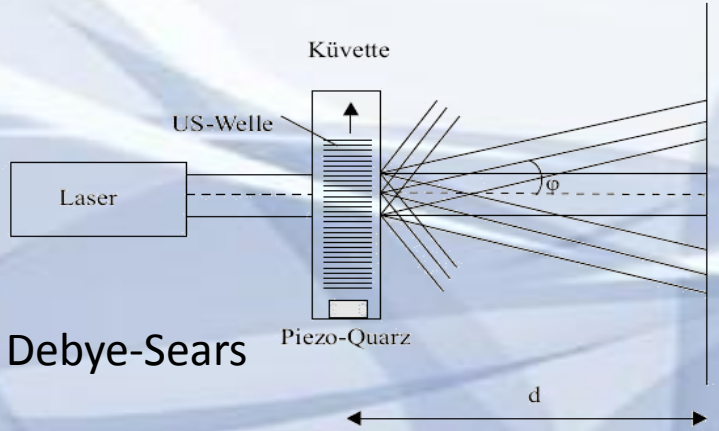
Examples for projects

- **Sonic modulation of solid foam**

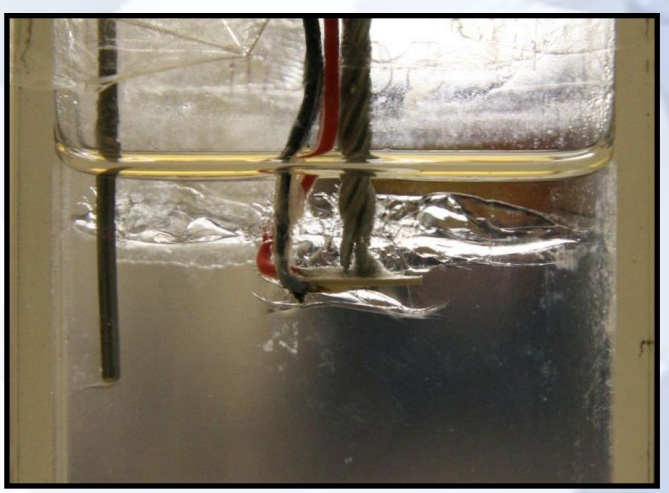


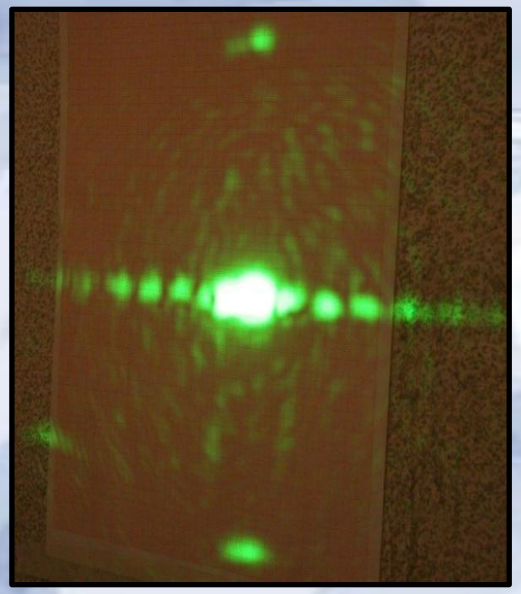
laboratory

aerogel

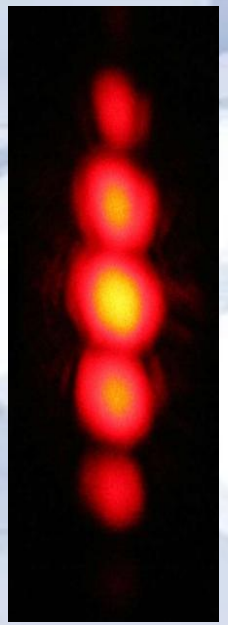


Debye-Sears





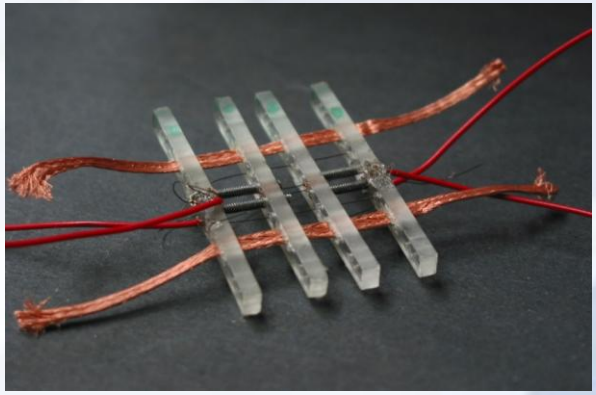
Longitudinal and transversal diffraction



Longitudinal diffraction

Examples for projects

- **A silent underwater drive propulsion system with nitinol**



Examples for projects

- **Adjusting optical properties at nano scale - The plasmon resonance of gold particles**

Awards

Klaus-von-Klitzing-Preis
Förderpreis für engagierte Lehrerinnen und Lehrer naturwissenschaftlicher Fächer

DPG

Georg-Kerschensteiner Award

HELMHOLTZ GEMEINSCHAFT

Teacher Award

JUGEND FORSCHT

Regional and National Youth Research Competitions

65 projects in the 1. round
28 projects in the 2. round
10 projects in the final round
3 winner of the national price in physics

P&G MINT AWARD

1. prize: 2006, 2007
2. prize: 2010

Special prize: 2009

Nat-Working Award
Robert-Bosch-Foundation

Networking

UNIKASSEL VERSITÄT

- Institute of physics
- Institute of didactics
- Department of genetics
- Institute of engineering

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

- Institute of physics
- Institute of astrophysics

PHYSIKCLUB

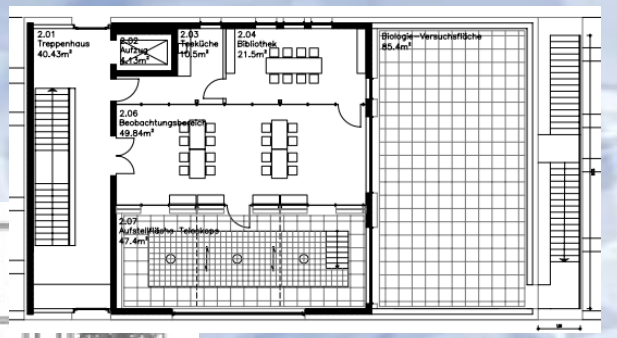
- Didactics of Physics, University of Mainz
- Astronomical-Physical Cabinet, Kassel
- German Aerospace Centre, Cologne
- MPI Katlenburg-Lindau
- MPI Göttingen
- NAT-working program, Robert-Bosch-Foundation
- Astronomical Association Kassel
- Alfred-Wegener-Institut, Bremerhaven

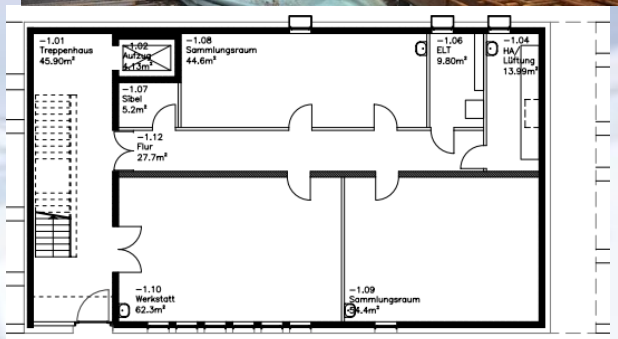
IJSO

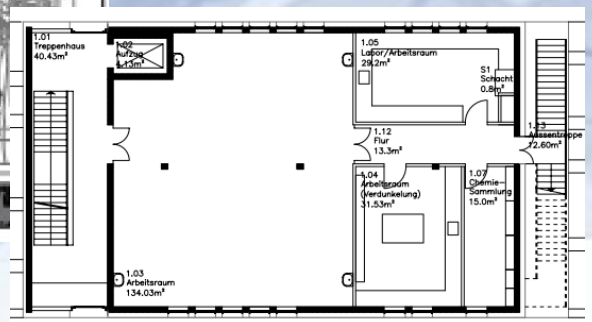
IPhO

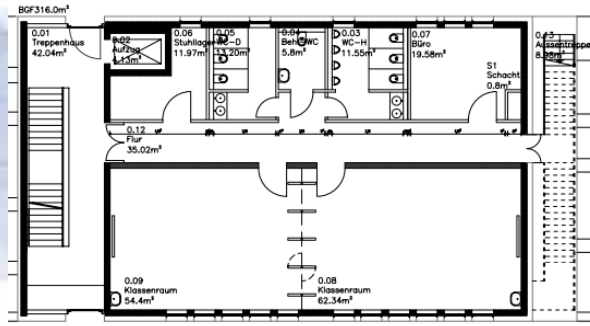
Expansion

- 2011-2012 an own building for the PhysikClub/SFN is built
- 900m² for research and education
- observatory









PhysikClub

Schüler Forschungs Zentrum

Thank you for your attention!

Any Questions?

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