Part 1

Inquiry based learning IBL
and
the constructivist learning theory
Learning is like exploring an undiscovered country...
Removing the blocks...
What teachers must not do!

- Solving all problems
- Dictating everything
- Controlling everything
- Feeling responsible for everything
- Deciding everything
- Planning everything
- Visualizing everything
- Writing down everything
- Correcting everything
- Giving always instructions
What teachers should do!

LETTING LOOSE

Scaffolding, coaching, moderating, workspace, advising
Knowledge can’t be absorbed or transferred, 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
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 and 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

  sonic modulation

  aerogel

  Debye-Sears
don't understand this line

  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

Georg-Kerschensteiner Award

Teacher Award

Nat-Working Award
Robert-Bosch-Foundation

2. prize: 2010
Special prize: 2009

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
Networking

• Institute of physics
• Institute of didactics
• Department of genetics
• Institute of engineering

• 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

• Institute of physics
• Institute of astrophysics
Expansion

- 2011-2012 an own building for the PhysikClub/SFN is built
- 900m² for research and education
- observatory
Thank you for your attention!

Any Questions?