

Long-term operation of industrial-academic research and education

Hans Henriksson, SKC, Sweden



Nuclear technology in collaboration between industry and academia

- Created in 1992 at KTH: soon 25 years!
- Swedish NPPs and Fuel manufacturer
- Research projects
 - Nuclear technology
 - Ageing of materials
 - Fuel development
- Education
 - M.Sc/B.Sc. programmes
 - Under-graduate courses
 - Advanced courses
- Total budget:
3,5 MEUR / 3 year agreement



Vision and goals

*SKC shall provide long-term support to **securing knowledge** and **competence development** at an academic level for the Swedish nuclear technology programs. This shall be a basis for providing resources to the Swedish nuclear industry and its regulators.*

*It means that SKC will contribute to a **safe, effective** and thus **reliable nuclear energy production**, which is an important part of the Swedish energy supply.*

- Encourage students to choose nuclear technology education
- Provide resource of qualified personnel through attractive education
- Develop strong research groups in nuclear technology
- Perform research on account of the end-users of the SKC

SKC and the human capital needs from industry



Budget and activities

Present agreement runs for three years: 2014 - 2016

Total budget: 3,5 MEUR

Fixed funding: 0,5 MEUR/year (for three universities)

Project funding: 0,6 MSEK/year

Main project: Collaboration on Material, Ageing and Fuel: 0,4 MEUR/year

Annual Symposium:

Symposium 2015: 60 participants, 3 industrial talks, 14 PhD presentations, dinner, prizes

Participation at career days:

ARMADA (KTH), CHARM (Chalmers), UTNARM (Uppsala University)

The Sigvard Eklund Prize

- SKC rewards students the Sigvard Eklund Prize in three categories:
 - best BSc thesis work,
 - best MSc thesis work, and
 - best PhD thesis.

Winners 2015:

(from left) Cheuk Wah Lau (PhD), Giulio Imbalzano (MSc), Hans Henriksson (Director of SKC) Klara Insulander Björk (PhD), and Johan Larsson (BSc).



Research areas with direct industrial impact

Main programmes

- Reactor Physics
 - Reactor Diagnostics, Detectors and Measurement
 - Core Physics
- Nuclear Power Plant Technology and Safety
 - Plant Dynamics
 - Thermal Hydraulics
- Materials and Chemistry
 - Chemistry, Material Physics and Engineering
 - Fuel Technology

Project MÅBiL (Material, Ageing, Fuel):

- Study of materials with respect to Accident Tolerant Fuels (ATF)
- Study of materials with respect to ageing
- Study of nuclear physical processes during normal and transient conditions

Examples of education funded via SKC

Chalmers: *International Master in Nuclear Engineering*

- Engineering oriented and aims at students with backgrounds in physics, chemistry, mechanical or electrical engineering.
- The only nuclear education in Sweden combining physics and chemistry in one educational program.

KTH: *Master's Programme in Nuclear Energy Engineering*:

- Several elective courses choose from, and summer school activities (ex. CLAB nuclear repository).
- International profile with links to:
 - KIC InnoEnergy EMINE (European Master in Innovative Nuclear Energy Engineering): Dual Diploma with either Universities Paris-Saclay, Paris or Grenoble-INP
 - Dual Diploma with Tsinghua University, Beijing
 - Dual Diploma with KAIST (Korea Advanced Institute of Science and Technology)

Uppsala University: **Bachelor of science in nuclear engineering**

- Aims at increase volume of employable people available to the nuclear industry
- Cost-efficient training cost for industry
- Reduced need for on-the-job education and training.

Example of pedagogical approach - Chalmers

- Incentives in flipping:
- Low-order thinking skills triggered in the classroom in the traditional model
- High-order thinking skills triggered in the classroom in the flipped model

Traditional Model

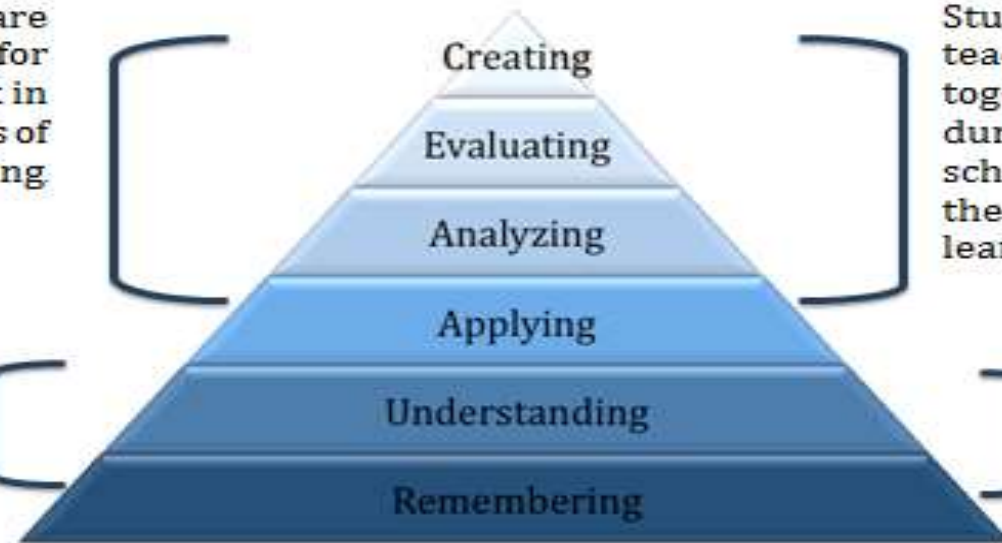
Students are responsible for homework in these levels of understanding

Teachers introduce new material to students.

Flipped Model

Students and teachers work together during the school day on these levels of learning.

New material is introduced to students outside of class as their homework.

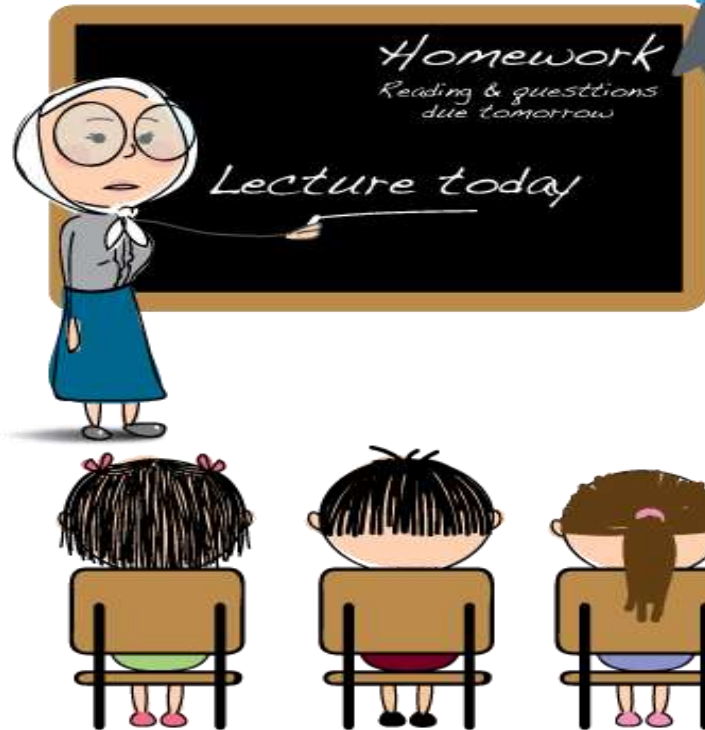


**Revised Bloom's taxonomy
for the cognitive domain (2001)**

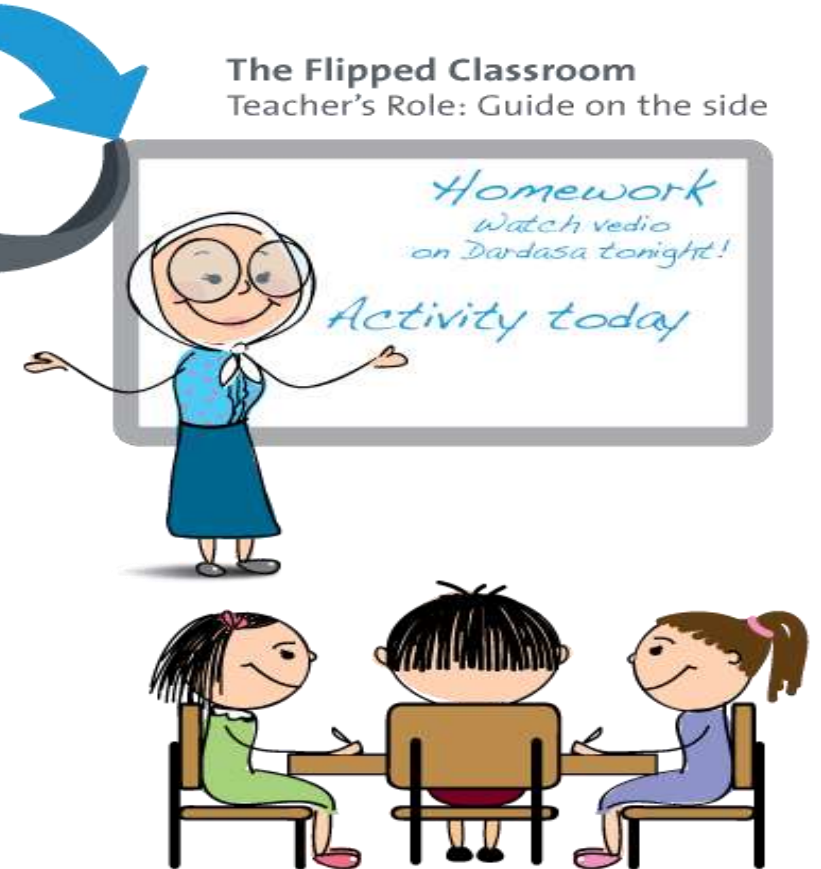
Pre-class activities (out-of-class):

- Reading the lecture notes
- Watching the webcasts
- Answering the quizzes
- Sending possible questions and feedback to teachers

The Traditional Classroom
Teacher's Role: Sage on the stage



The Flipped Classroom
Teacher's Role: Guide on the side



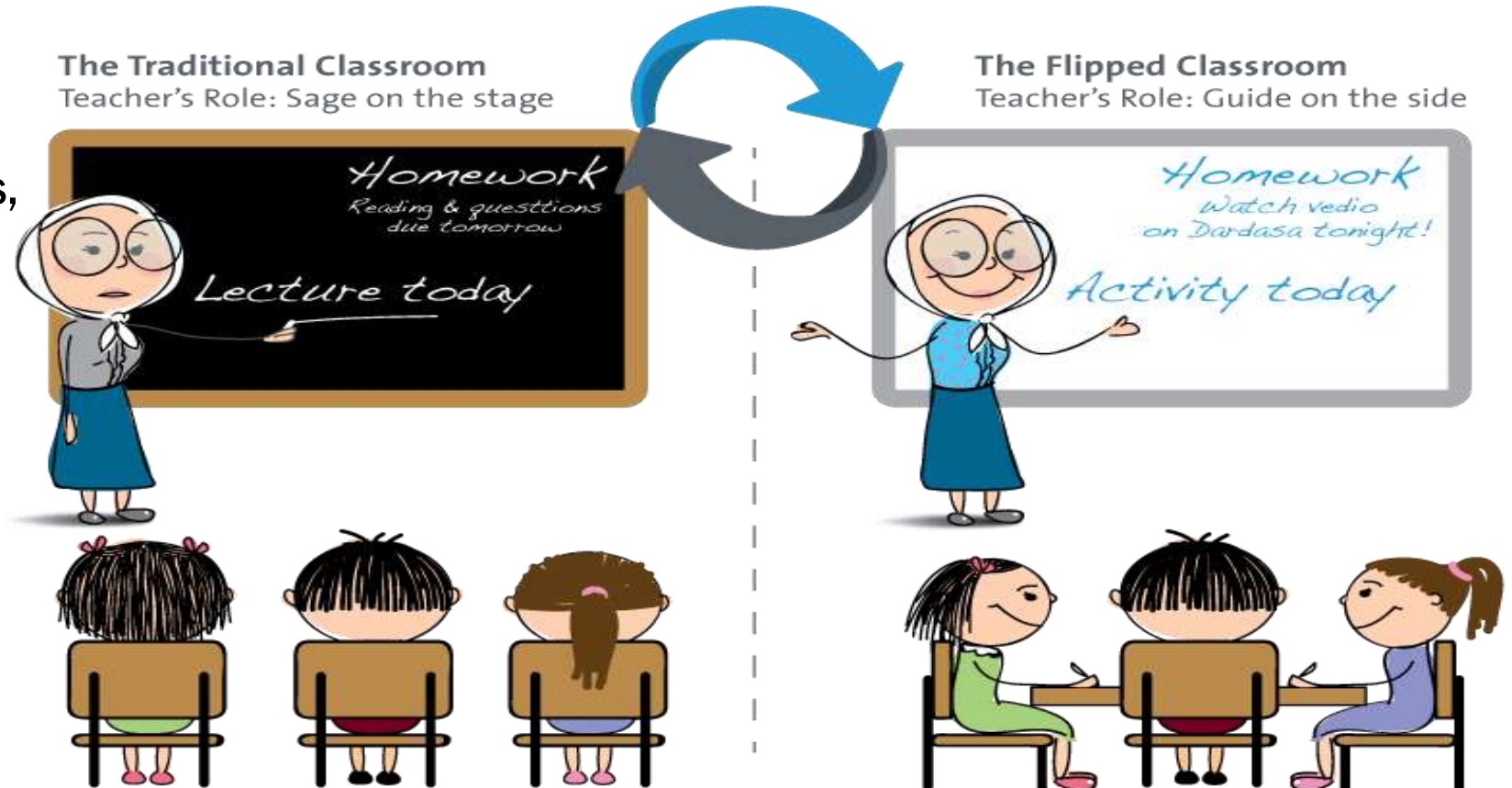
In-class & Post-class activities:

In-class activities

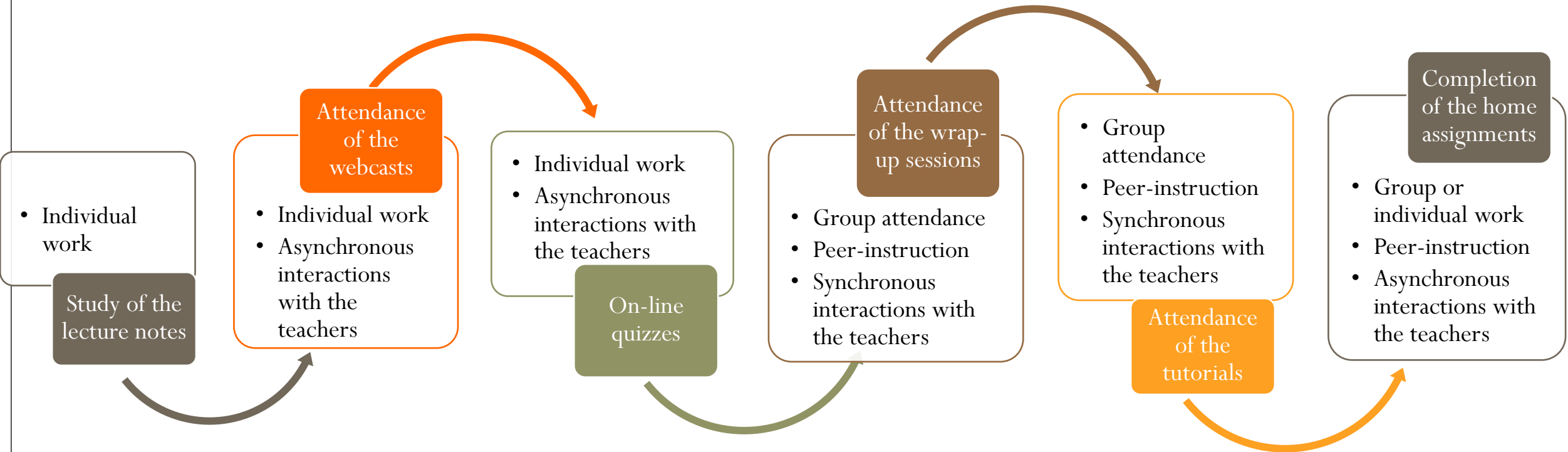
- Wrap-up sessions:
brief chapter summary, quizzes,
peer discussion, additional
questions
- Tutorials
- (Laboratory exercises)

Post-class activities (out-of-class):

- Discussion fora
- Home assignments
- (Lab reports)



Chain of Class-pedagogy



IT tools used:

- Learning Management System: Ping-Pong
- Webcast recording and broadcasting: Mediasite
- Live sessions broad-casting and recording: Adobe Connect

The screenshot displays the Adobe Connect interface during a webcast. The main window shows a presentation slide titled "CHALMERS" with the subtitle "2.1.1 Cross-section preparation for core calculations". The slide content includes:

- **Condensation** into fewer energy groups:
- Equation (2.26):
$$\Sigma_{\alpha, i, g_c} = \frac{\sum_{g \in g_c} \Sigma_{\alpha, i, g} \phi_{i, g}^{L, P}}{\sum_{g \in g_c} \phi_{i, g}^{L, P}}$$
- and **homogenization** into coarser volumes:
- Equation (2.27):
$$\Sigma_{\alpha, i, g_c} = \frac{\sum_{i \in I_c} \Sigma_{\alpha, i, g_c} \phi_{i, g_c}^{L, P} V_i}{\sum_{i \in I_c} \phi_{i, g_c}^{L, P} V_i} \text{ with } \phi_{i, g_c}^{L, P} = \sum_{g \in g_c} \phi_{i, g}^{L, P}$$
- for subsequent core calculations.

Handwritten red notes on the slide include "2-group" and a diagram of a 2D grid. The slide footer reads "TIF205 - Modelling of Nuclear Reactors" and "23".

The interface includes several panels:

- Events Index** (left): Search bar, Filter Events, Chat Messages, and a Sharing timer at 0:00:00.
- Attendees (7)** (right): List of participants including Christophe Demaziere (Host), and six other participants: Athanasios Stathis, Marco Viebach, Markus Mybeck, Peter Wolniewicz, Rasmus Andersson, and Ville Valtavirta.
- Chat (Everyone)** (bottom left): A message from Peter Wolniewicz: "thx".
- Notes** (bottom center): A blank area for taking notes.
- Video** (bottom right): A placeholder for a video feed.
- Progress Bar** (bottom): A timeline showing the current position at 1:32:49 / 3:19:02.

E-learning platform for the KTH Master in Nuclear Energy Engineering

E-Learning:

On-line education

New-media education

Computer aided/supported education

Internet based education

Distance Education (partly E-learning)

MOOC:

Massive Open Online Courses – MIT/Harvard initiative. Three software solutions: EdX, Coursera, Udacity

Incentives

Main mission of E-learning at KTH:

- “Campus-based” education supported by E-learning to enhance learning pace and student through-put.
- main platform for “education on demand” and “distance education” for NON-ACADEMIC customers: professional education for nuclear industry.
- **Self quality improvement** of pedagogical level: for example through video recording of lectures is self-stimulating to improve the pedagogical level.
- Improvement of educational level through home assignments and students own activities: ”Exerciser/Maple TA” module.
- Instant results of examinations and home/test assignments. Extremely important argument for an effective education. It meets very well students expectations.

Strategy for KTH E-learning platform – Four pillar strategy

Pillar I:

Video navigation

Objective:

- Promotion of the program for potential applicants
- Navigation through the program to select elective courses.

Means: short video clips (pitches) of each course

Pillar II:

Support for Campus education

Objective:

- Support and optimization of “on-campus” education
- Enhanced learning pace and through put.
- Interactivity with students

Means: Video presentations of all lectures and student projects.
“Exerciser” for home assignments, examinations and projects.
E-learning lab instructions

Pillar III:

E-learning for International programs

Objective:

Support for navigation and program insight for exchange students.

Means:

Link to Pillar I and II at KTH and corresponding web-locations at partner Universities.
Live seminars and/or selected lectures of interest.

Pillar IV:

Distance education

Objective:

Tailored education and specially developed distance education courses: “education on demand” for non-academic stakeholders

Means:

Pillar I and II adopted to distance education.
Webinars: streamed lectures on line.
Interactivity with students

Pillar II: under testing and implementation:

Exerciser module: Maple Software – Maple T/A and next version Maple – Möbius

Courses under processing:

Reactor Physics SH2600 (9ECTS) and SH112N (Preparatory course in physics)

FIRST E-LEARNING EXAM AT KTH – January 15, 2016. SUCCESS, in spite of some small problems. Every student got **DIFFERENT RANDOMISED** problems. No practical risks for copying.

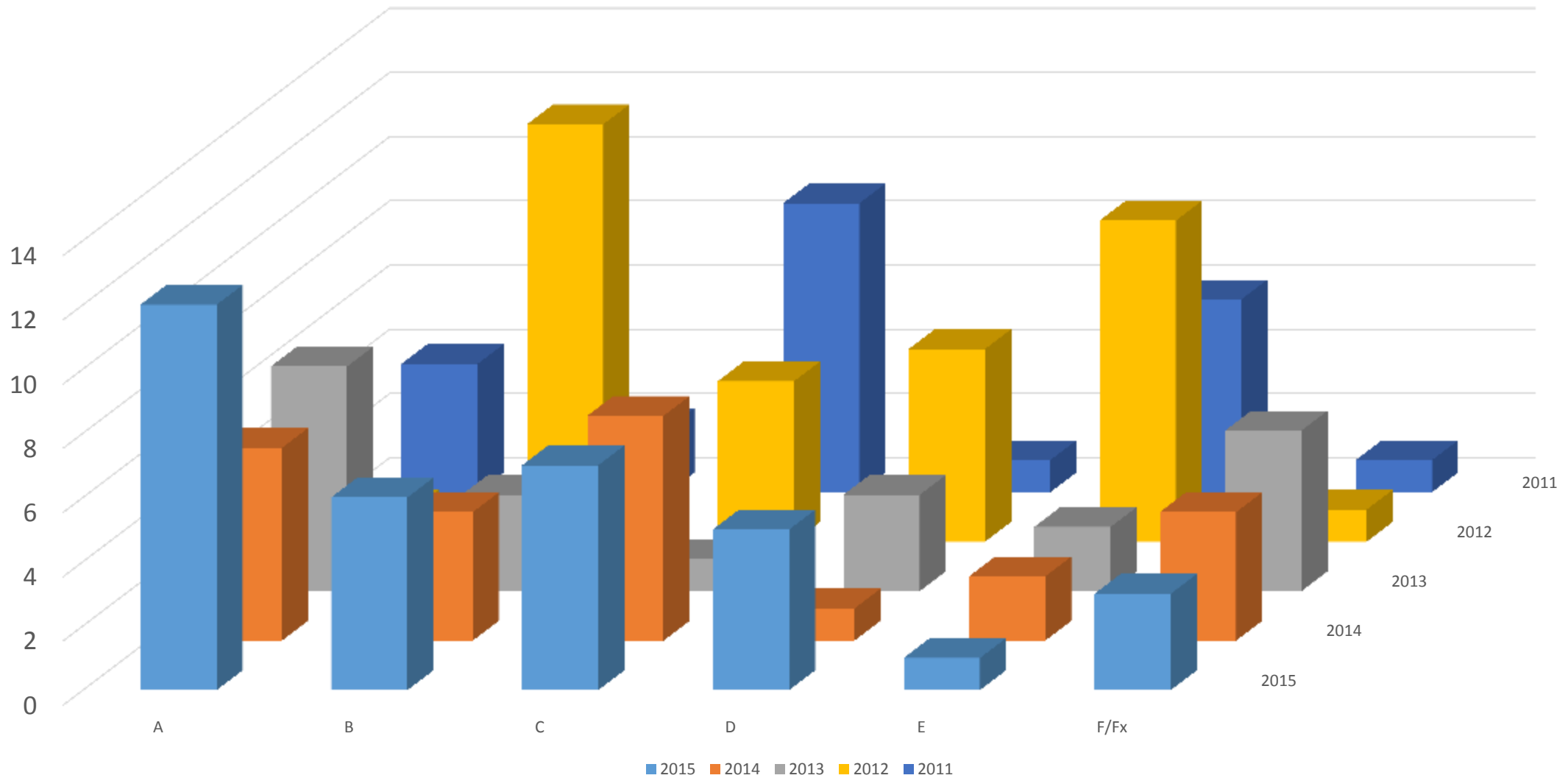
As preparation for this exam: 9 Home Assignments in Maple T/A, each week, corrected and discussed on the spot.

Example from E-learning exam: Maple T/A “Exerciser” tool

The screenshot shows the MapleTA Gradebook interface for the course "Reactor Physics - 2015/2016". The interface is divided into several sections:

- View Panel:** Shows "Showing Best grades, Completed assignments, All students". A "Style" dropdown menu is set to "Numeric".
- Student Assignment Details:** Displays details for "Weekend With Reactor Physics 1". The score is 24/24.0. Duration is 2 min. Started: 11/16/15 12:52:42 AM CET. Finished: 11/16/15 12:54:47 AM CET.
- Magdalena Kutera:** Displays student information: Login: kutera, Email: kutera@kth.se, Student ID: u1o45d0a. Assignments: Completed: 115, Active: 0, To Be Reviewed: 0, Passed: 50.
- Buttons:** "Update selected grades as", "Update Grades", and "Save Question Details".
- Page Information:** "Page: 1 of 1 Rows: 1 - 6 of 6 - 0".
- Question Details:** A table showing the question grade, weighted grade, and new grade. The question is "The complete combustion of 1 kg of bituminous coal releases about 3×10^7 J in heat energy. The conversion of 10 g of mass into energy is equivalent to the burning of how much coal?". The correct response is "The complete combustion of 1 kg of bituminous coal releases about 3×10^7 J in heat energy. The conversion of 10 g of mass into energy is equivalent to the burning of how much coal?". The student's response is "The complete combustion of 1 kg of bituminous coal releases about 3×10^7 J in heat energy. The conversion of 10 g of mass into energy is equivalent to the burning of how much coal?". The student's answer is marked as "Correct" with a green checkmark.
- Footer:** "Search", "Export to CSV", and "Rows: 20".

Reactor Physics Examination Grade Distribution



Pillars III and IV: more work needed

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Interactivity with students

SKC - Swedish Centre for Nuclear Technology

Nuclear technology in collaboration between industry and academia
for many more years to come!

Thank you!

Contact:

Hans Henriksson, skc@kth.se

www.swedishnuclear.se

Forsmarks Kraftgrupp AB



Ringhals AB



SKC

Swedish Centre for Nuclear Technology



Co-authors:

Chalmers:

Christan Ekberg, Christoph Demazière,

KTH:

Henryk Anglart, Wacław Gudowski,

UU:

Michael Österlund, Ane Håkansson