

Transforming Chemical Reactor Engineering

From classic full frontal to a blended learning environment

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Chemical Reactor Engineering – Old school

- 2nd year mandatory BSc-course, Q4
- 5 ECTS
- 2 x 4 hours, 2/2 lectures/guided self-study
- Intermediate exam (30%) + Final exam (70%)
- Low attendance guided self-study (20-30%)
- Historical success rate **~33%**
- Causes delay in student progress
- **FEAR** and **STRESS** before the course even started
- In the end every student passes (4, 5, 6, ... attempts)

How is this possible?

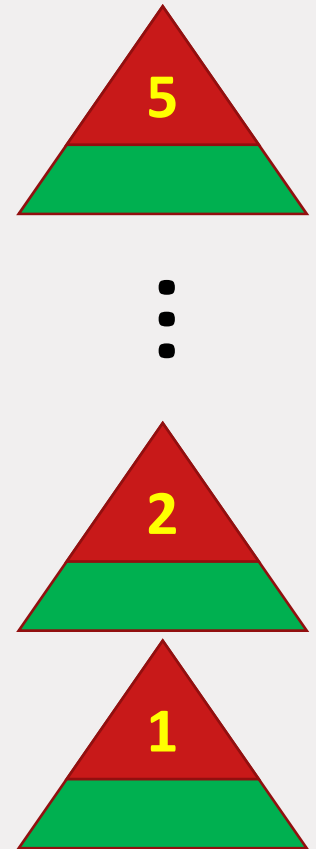
Students

- Are Lazy
- Have too low skill levels in calculus
- Have no focus, commitment, ownership
- Procrastinate
- Are immature
- Are stupid

So all responsibility lies with the student...
(we are perfect)

How to help students spend **Time-On-Task?**

- Course split in 5 modules
- 24/7 digital content on CANVAS
 - Weblectures (7 min)
 - Pencasts
 - Lightboard
 - OnCourse Digital Exercises (50)
- Assess with OnCourse (STEP)
 - 40% grade Easy questions (90)
 - 60% grade Difficult questions (40)
- 18 attempts in total for 5 quizzes
- Grade = average 5 quizzes



Teacher – Student interaction

- No lectures
- Students reserve time from their budget
 - (6 min/week, 48 min total)
 - grouping is allowed max 6 students
- Students are prepared with specific questions
- Discussion forum on CANVAS

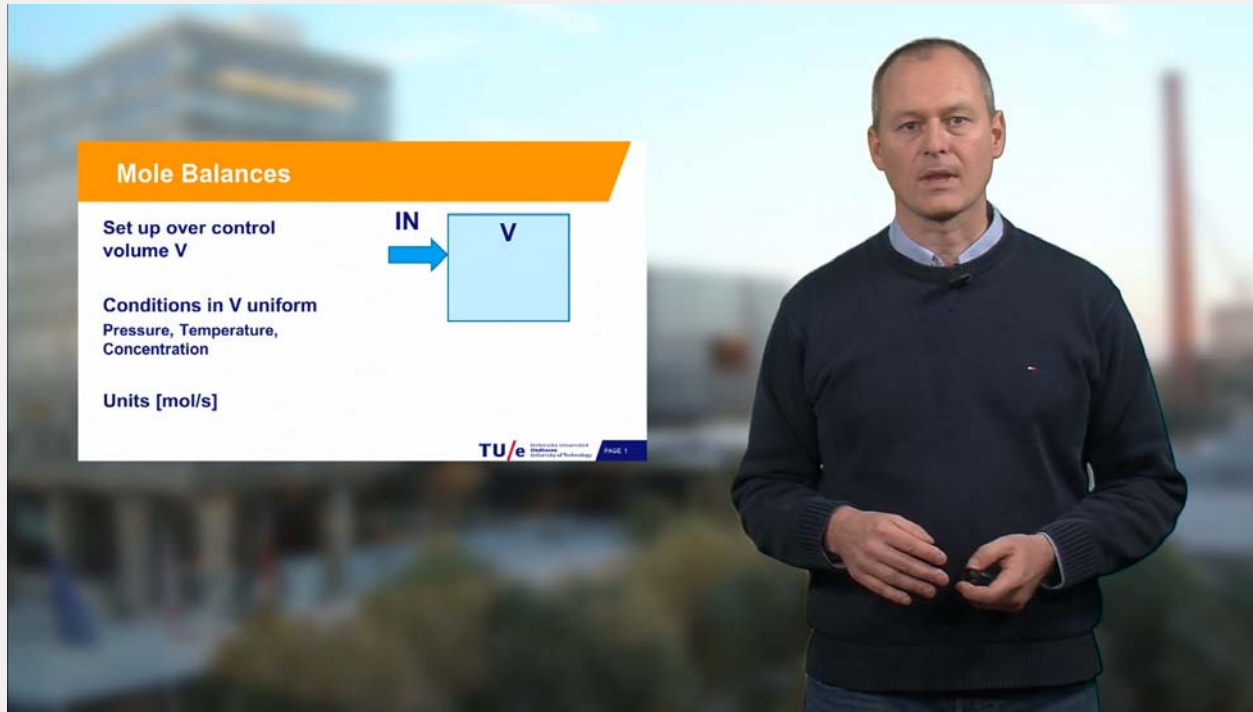
Support

- Running website for OnCourse Exams
- Secure Test Environment Protocol OnCourse Quizzes
 - Bring Your Own Device
 - Boot From USB stick
- Studio (Weblecture/Lightboard)
- PhD students as proctors

Future:

- Small room(s), 40 p, in which quizzes can be taken at will by students under STEP (for any course) with permanent proctor

Example Weblecture



Mole Balances

Set up over control volume V

Conditions in V uniform
Pressure, Temperature,
Concentration

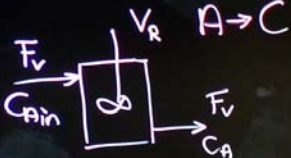
Units [mol/s]

IN → V

TU/e TU/e Technische Universiteit Eindhoven University of Technology PAGE 1

Example Lightboard


$HCC = IN - OUT - RX$



$-r_A = k_A \cdot C_A$

$X_A?$

$t=0 \quad C_A = C_{Ain}$



Example OnCourse

Basic Chemical Reactor Engineering (6P3X0)

Question 1

Not complete

Mark 1.00 out of
1.00

Flag question

Given the following differential equation for concentration C :

$$\frac{d}{dt}(C) = -k \cdot C$$

Derive an explicit equation for C when $C = C_0$ at $t = 0$.

$C =$

✘

Check

Attempts and passes per quiz

Q1: $116/141 = 82,3\%$

Q2: $111/141 = 78,7\%$

Q3: $106/141 = 75,2\%$

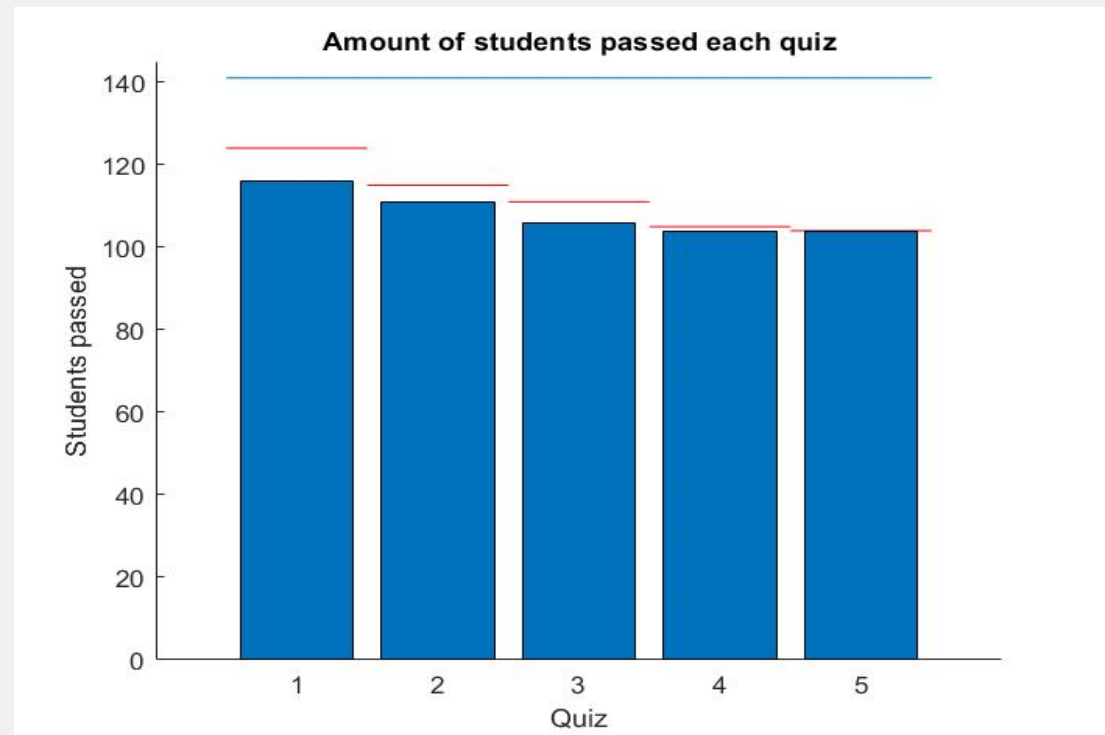
Q4: $104/141 = 73,8\%$

Q5: $104/141 = 73,8\%$

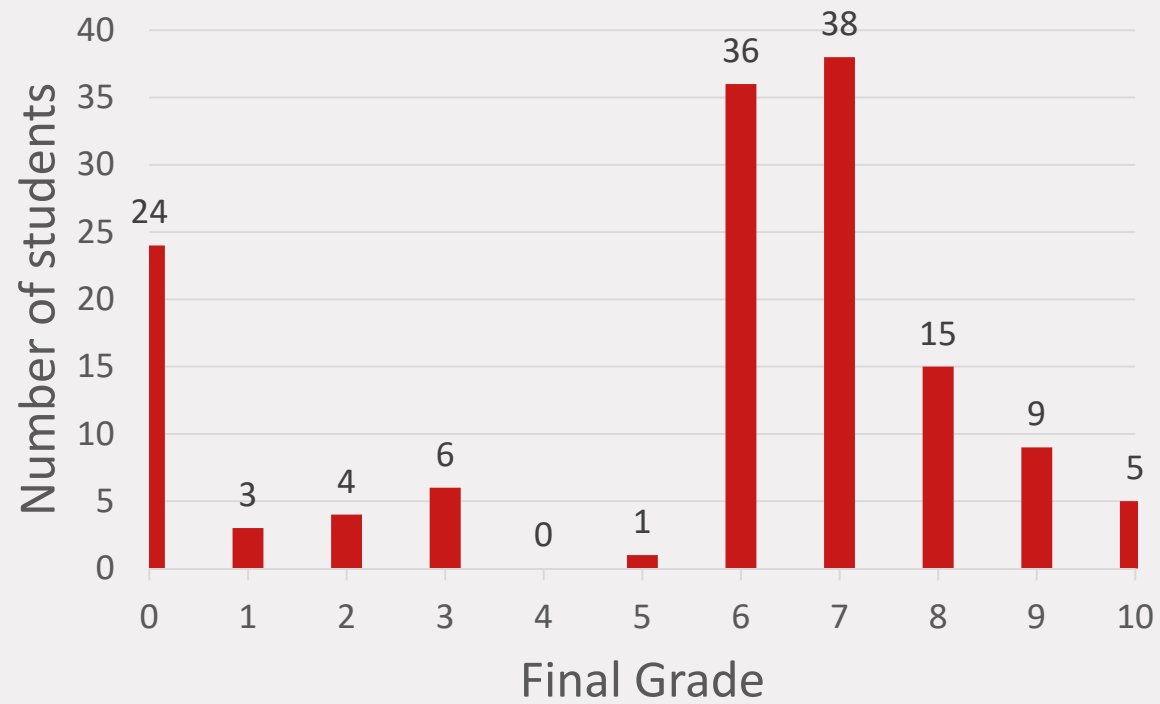
17 students never did Q1

18 students did only 1 attempt

(25% drop out)



Final Grades

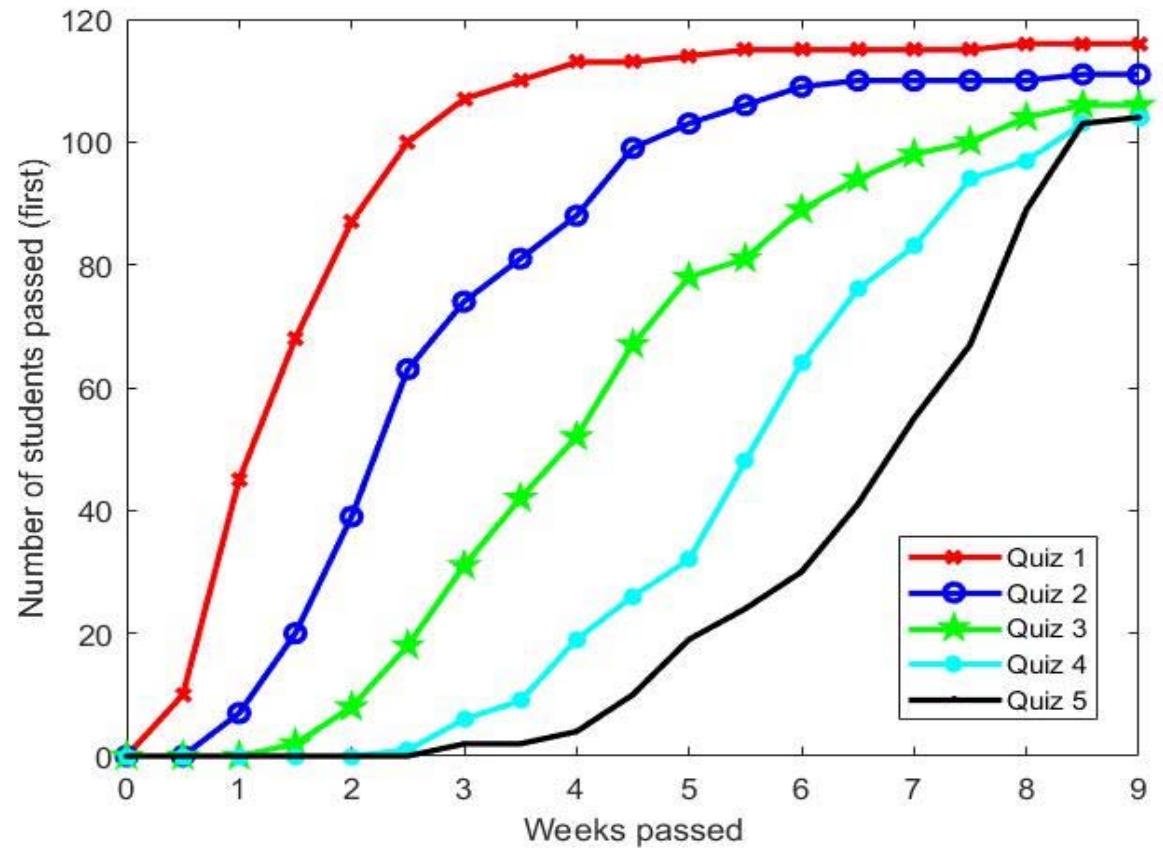


Retakes

QUIZ	Re-takes: 1x	2x	3x	>4x	Average grade improvement
1	18	4	-	-	+2.2
2	21	5	2	1	+1.7
3	14	2	-	-	+2.6
4	12	1	-	-	+2.0
5	24	3	1	-	+1.4

Number of retakes is not so high...

Time line



Success factors?

- **Time-on-task** in this system of very regular testing would be the main reason for its success
- Regular feedback on level of understanding (you are not there **yet**)
- Passing quizzes gives confidence and motivation
- Quick retake of tests (less stress)
- Very extensive testing of knowledge and skill level

Student-Teacher Interaction

- Schedule time for teacher-student 1-on-1:
 - Only 10-15 students choose this option
- Most students get help from peers (Whatsapp)
- Second option was Q&A threads on the discussion forum on Canvas.
 - Two PhD students daily check for questions
 - Feedback within one day
 - This stimulated students to ask more questions on topic and reply to other students questions

Memorizing Answers to Questions

- Some students memorize solutions to certain 'standard' questions, without deep understanding (observation from fellow students)
- Exact problem text is not available to the students, some memory of questions remains and is shared
- Mitigate by:
 - Increasing the number of questions
 - More similar questions with different boundary conditions; only systematic problem approach leads to the correct answer

Digital vs. Conventional (written)

- Students memorize a standard solution model to a problem and copy this onto their exam paper.
- Where the exam question differed from the exercise, convenient writing mistakes were made and the standard solution was obtained.
- For the first general parts points are obtained. This way students would scrape enough points to pass the course.

Finally... Did it save time?

- Digital testing runs very smoothly and almost effortlessly
- Very scalable and generally applicable
- Saves a tremendous amount of time
 - Possibility of 1-to-1/1-to-6 feedback on specific questions
 - Students get support through peers and the discussion forum
- Information on student progress, statistics
 - Advanced fine tuning of the learning process
 - Identify and target different learning behaviours