



Lessons from Nine Years Online Examination Practice at ETH Zurich

Tobias Halbherr, ETHZ



Introduction: A brief overview of online examination practice at ETH Zurich

Online Exams at ETH Zurich

- 2007 first pilots, 2010 regular service
- ~55 exams with ~5'000 students in autumn semester 2016
- Invigilated, for-credit performance assessments
- Large percentage of high-stakes examinations





Part I: Assessments for a digital world

What is the most important question when studying?

Will this be on the exam?

- **Performance assessments drive and direct student learning**
 - «Non vitae sed scholae discimus» (Seneca)
 - Nec vitae nec scholae sed examini discimus. (?)
- **Examinations are important gatekeepers**
 - Which students will graduate – and which will not?

Goals

1. Improve learning outcomes
by making examinations more meaningful and motivating to students
2. Improve measurement quality
of competence assessments
3. Improve efficiency
of preparing, conducting, and scoring examinations
4. Create additional points of contact
with examiners for pedagogical support

<https://www.youtube.com/watch?v=qMHqykRYt64&feature=youtu.be&t=22>

Examinations in a digital world: The current situation



learning



exam



learning outcome

Example: Programming

```

13 - M = 10^5; % Number of Monte Carlo samples
14
15 - g1 = @(x) (x+0.25).^3; % integrand 1
16 - exact_g1 = (1.25^4-0.75^4)/4; % exact value
17
18 % Applying MC and antithetic MC
19 - [Smean1, Svar1] = MC(g1,2*M);
20 - [antiSmean1, antiSvar1] = MCantithetic(g1,2*M);
21
22 % parameter for 0.95-confidence interval
23 - beta = norminv(0.975, 0, 1);
24
25 % Output:
26 - fprintf('\nQuestion 5:\n\n')
27 - fprintf('Exact value = %.5f\n\n', exact_g1)
28 - fprintf('standard Monte Carlo with M = %d\n', M)
29 - fprintf('Sample mean is: %.5f\n', Smean1)
30 - fprintf('Asympt. valid 0.95-confidence interval is: [%f, %f]\n', Smean1 - beta*sqrt(Svar1/2/M), Smean1 + beta*sqrt(Svar1/2/M))
31 - fprintf('antithetic Monte Carlo with M = %d\n', M)
32 - fprintf('Sample mean is: %.5f\n', antiSmean1)
33 - fprintf('Asympt. valid 0.95-confidence interval is: [%f, %f]\n', antiSmean1 - beta*sqrt(antiSvar1/M), antiSmean1 + beta*sqrt(antiSvar1/M))
34 - fprintf('length of asympt. valid 0.95-confidence interval is: %f\n', 2*beta*sqrt(antiSvar1/M))
35 - end

function [Smean, Svar] = MC(g,M)
% This function computes a Monte Carlo approximation of the integral
% \int_{-1}^{1} g(x) dx with M samples.
% Input: g = function handle for the integrand
% M = number of Monte Carlo samples
% Output: Smean = sample mean
% Svar = sample variance

```

learning

function zahlen
 % Dies ist ein Zahl
 % Ziel ist es ein
 % in möglichst we
 zahl = randi(10)
 test = -1;
 while (test ~= zahl)
 test = input('Ra
 versuche = versuche + 1;
 if (test == zahl)
 disp('Zu
 elseif (test > zahl)
 disp('Zu
 end

exam

```

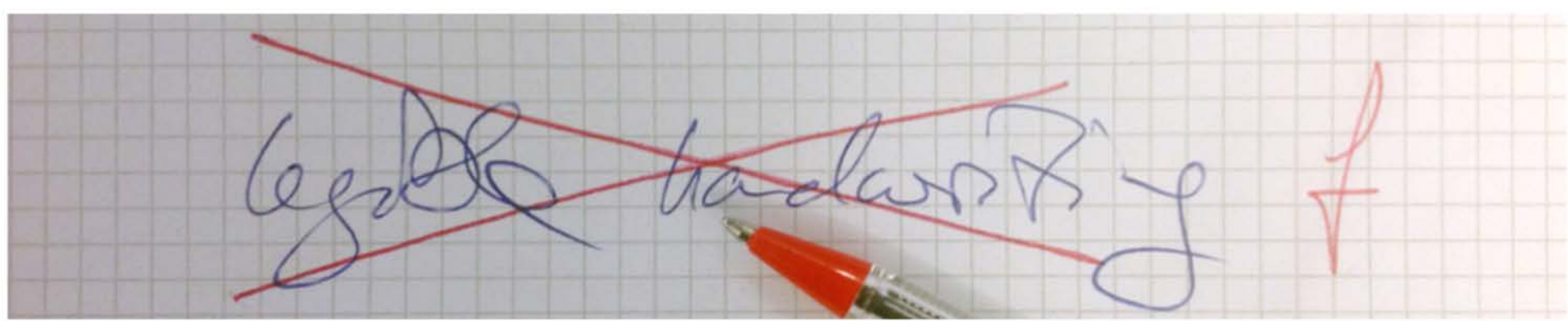
16 - exact_g1 = (1.25^4-0.75^4)/4;
17
18 % Applying MC and antithetic MC
19 - [Smean1, Svar1] = MC(g1,2*M);
20 - [antiSmean1, antiSvar1] = MCantithetic(g1,2*M);
21
22 % parameter for 0.95-confidence interval
23 - beta = norminv(0.975, 0, 1);
24
25 % Output:
26 - fprintf('\nQuestion 5:\n\n')
27 - fprintf('Exact value = %.5f\n\n', exact_g1)
28 - fprintf('standard Monte Carlo with M = %d\n', M)
29 - fprintf('Sample mean is: %.5f\n', Smean1)
30 - fprintf('Asympt. valid 0.95-confidence interval is: [%f, %f]\n', Smean1 - beta*sqrt(Svar1/2/M), Smean1 + beta*sqrt(Svar1/2/M))
31 - fprintf('antithetic Monte Carlo with M = %d\n', M)
32 - fprintf('Sample mean is: %.5f\n', antiSmean1)
33 - fprintf('Asympt. valid 0.95-confidence interval is: [%f, %f]\n', antiSmean1 - beta*sqrt(antiSvar1/M), antiSmean1 + beta*sqrt(antiSvar1/M))
34 - fprintf('length of asympt. valid 0.95-confidence interval is: %f\n', 2*beta*sqrt(antiSvar1/M))
35 - end

function [Smean, Svar] = MC(g,M)
% This function computes a Monte Carlo approximation of the integral
% \int_{-1}^{1} g(x) dx with M samples.
% Input: g = function handle for the integrand
% M = number of Monte Carlo samples
% Output: Smean = sample mean
% Svar = sample variance

```

learning outcome

Example: Essay Tasks



legible typewriting

Path: p » span



Examinations in a digital world: What we should be doing



Lernsituation



Prüfung

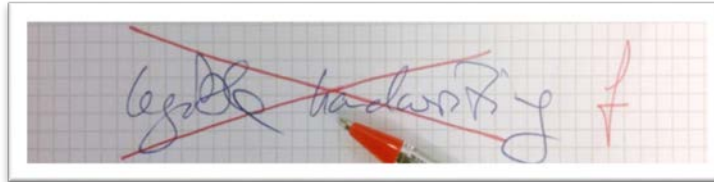


Zielkompetenz

Advantages of online exams



complex tasks



legible handwriting



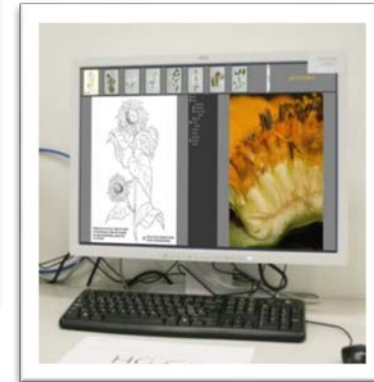
efficiency



quality control



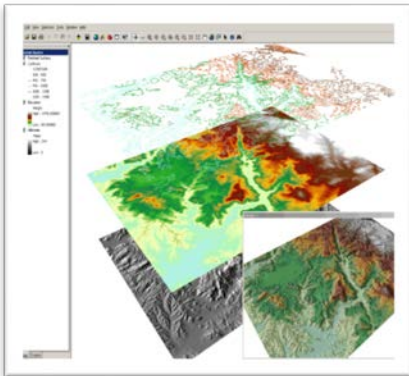
alignment



competence-orientation



facilitated administration



authentic assessment



Improved learning motivation



validity

Examinations in a digital world: 'Lessons'

- Advantages for 'traditional' task formats (MC, essay) with online exams
- Increasingly poor fit between conventional, paper-based tasks and learning outcomes...
- ...*because* many/most learning outcomes are associated with skills that rely on ICT...
- ...increasing importance of computer-based examination tasks
- Large potential for improvements in examination quality
 - Student learning
 - Validity



Part II: Infrastructure

Online exams at ETH Zurich: Task formats

Online Exams

Conventional task formats

Short-answer

Antwort:

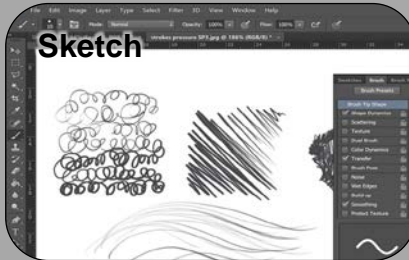
Essay



SC/MC

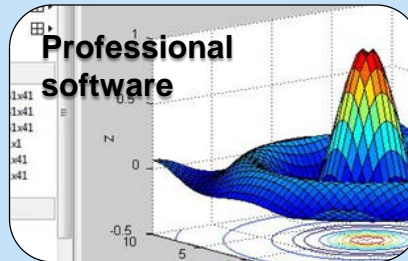


Sketch



Novel computer-based task formats

Professional software



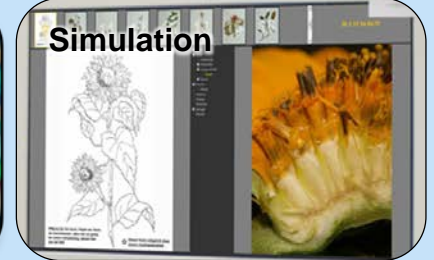
Data & information



Peripheral hardware



Simulation



Service Portfolio


Service Portfolio Online Exams ETHZ



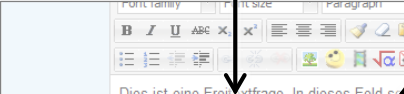
SEB & Moodle



VDI & SEB (& Moodle)



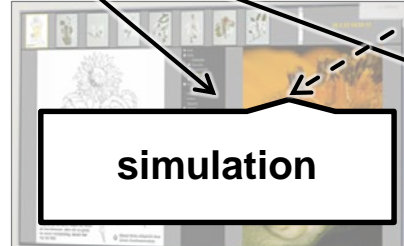
Linux



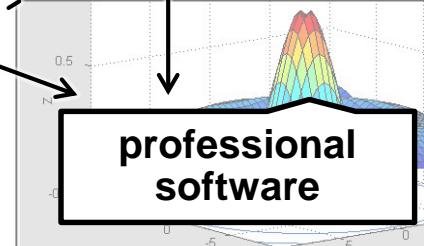
conventional task formats



data & information

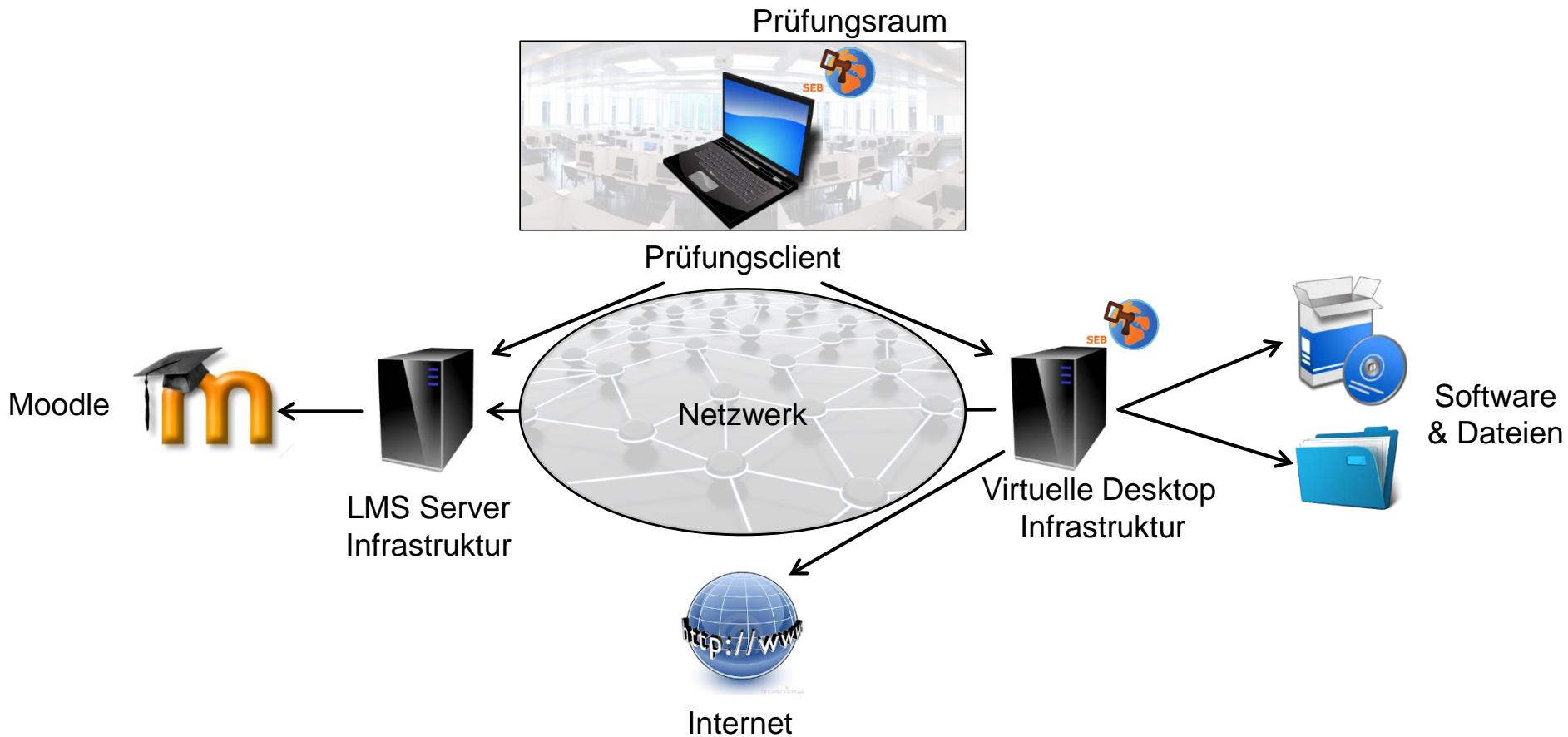


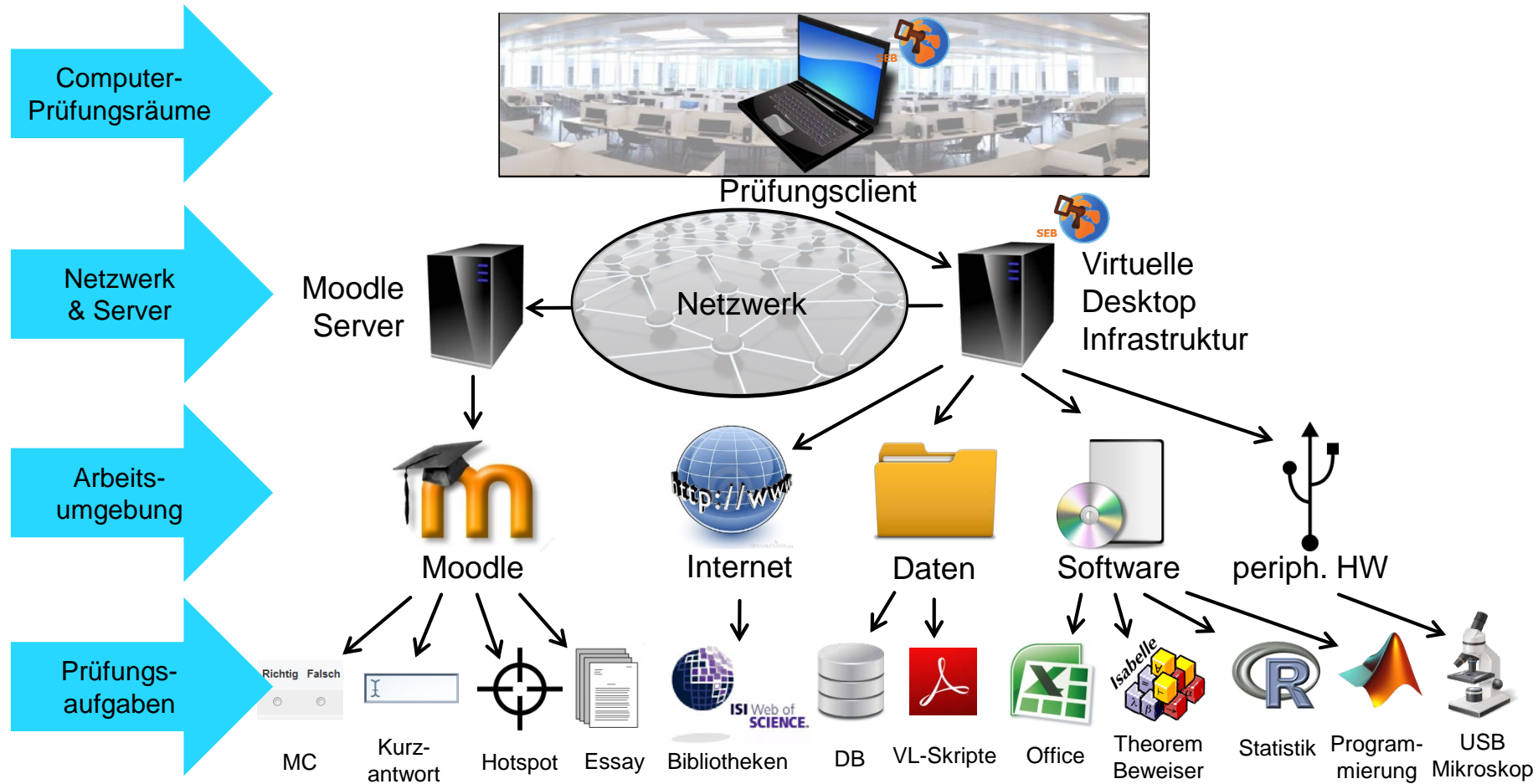
simulation



professional software

Infrastruktur Online-Prüfungen





Room Infrastructure

HG G1



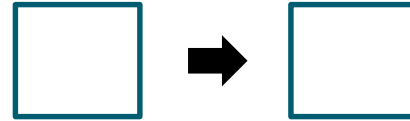
bis 160

HG G1 & E-Stock



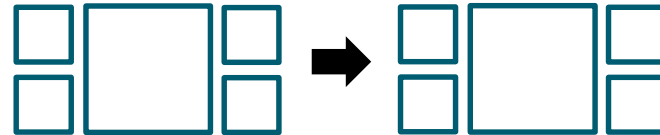
bis 290

**HG G1
Schleuse**



bis 320

**HG G1 & E-Stock
Schleuse**



bis 580



What is required for operating online exams? Infrastructure and people

Infrastructure

- IT infrastructure
 - Network
 - Servers
 - Software
 - Lock-down technology (e.g. SEB)
 - Exam environment (e.g. Moodle)
 - Screen recording software
 - Virtual Desktop Infrastructure
 - Client computers
- Room infrastructure
 - Workdesks
 - Wardrobe
 - Climate control
 - Toilets
 - Congregation area

Services & Administration

- IT administrators
(see IT infrastructure on the left)
- Monitoring & on-site support
- Examiner support
(didactics & technology)
- Central coordinating unit as service provider

Infrastructure: Lessons

- Online exams are resource intensive
- Implement redundancies
- KISS: keep it simple
- Invest where it makes a difference...
 - Not all technological innovations facilitate better exams
 - Not all didactic improvements require technological improvements



Part II: Processes

What is required for operating online exams?

Procedures and protocols

Intrastructure

- Regular software updates
- Routine testing of
 - all IT infrastructure components individually
 - ...and in conjunction
 - every individual exam
- Redundancies on all levels of infrastructure
 - Servers
 - Spare clients
 - Backups
 - Screen recording

Services & Administration

- Interoperability with institutional processes and compliance with regulations
- Standardized operational protocols and procedures
- Independent controls/checks of critical procedures
- Redundancies on all levels of operations

Processes: Lessons

- Online exams are resource intensive
- Make Murphy your friend: test, test, test
- Not all technical problems require technical solutions
- Simplify, standardize

Real Exams are Different

The real exam

- High pressure/stress
 - Students
 - Examiners
 - On-site support
- Level-headed handling of unforeseen incidents challenging
- Students focussed on exam
 - Reduced attention for everything else
- Students in 'high-performance mode'
 - Increased stress on IT-infrastructure

Mock exams and tests

- Relaxed vibe
 - Students
 - Examiners
 - On-site support
- Level-headed response to incidents
- Students focussed on exam and exam environment
- Students in 'casual mode'
 - Comp. low stress on IT-infrastructure

Real Exams: Lessons

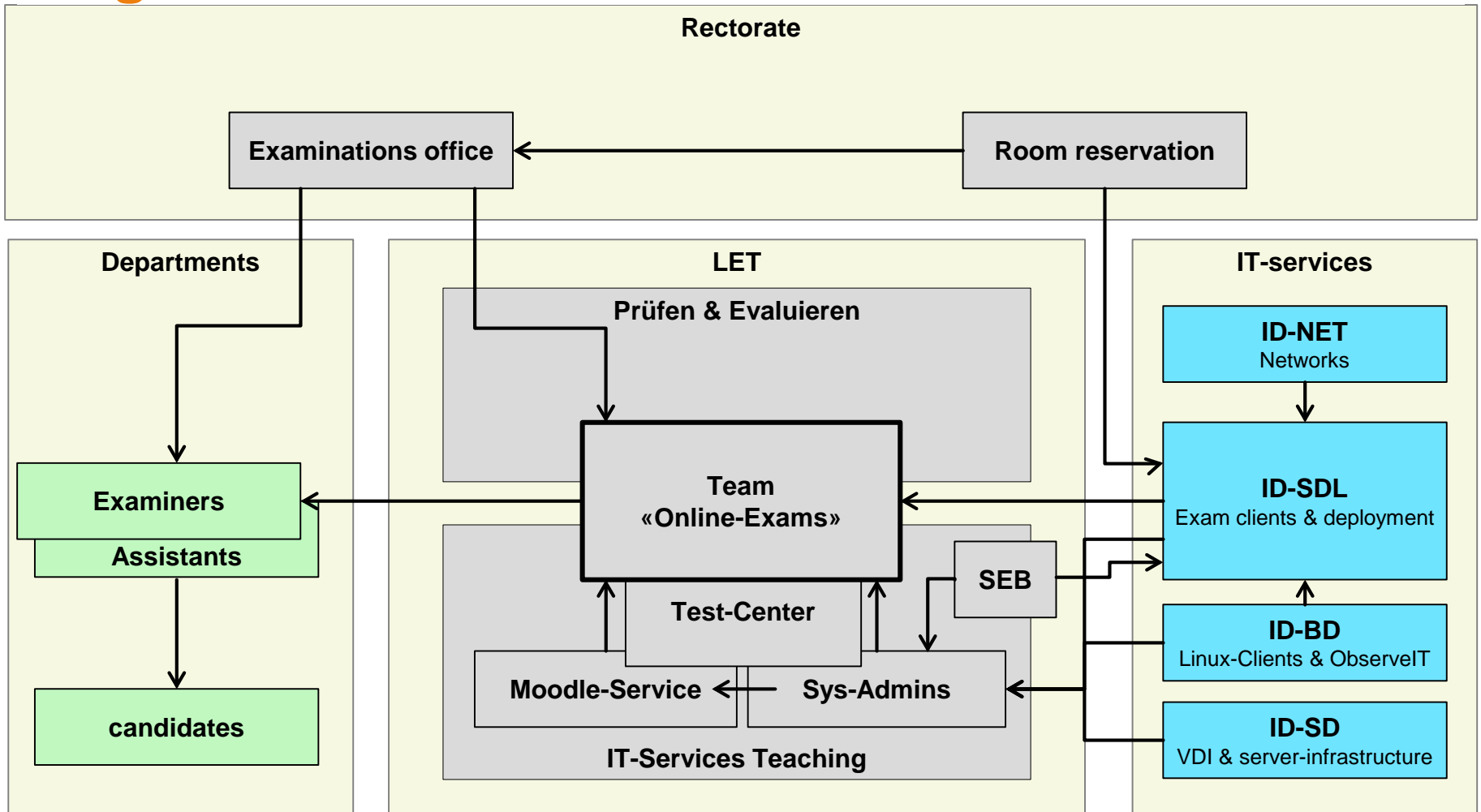
- Provide for a relaxed atmosphere
- Standardize incident handling procedures
- All students start exam together, wait until everyone is ready
- Have spare machines at hand
- Instruct students on how to use exam environment and how to behave in case of technical incidents
- Document time lost and extend it accordingly
- Do screen recordings (logfiles will not suffice)
- Mock-/test-exams are usually not necessary
- Do student evaluation directly after exam



Part II: Organisation

Organisational Chart Online Exams

erbringt Dienstleistung für →



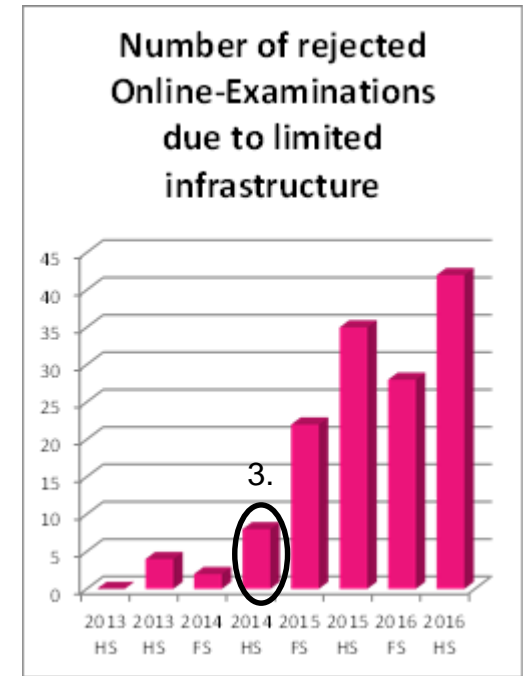
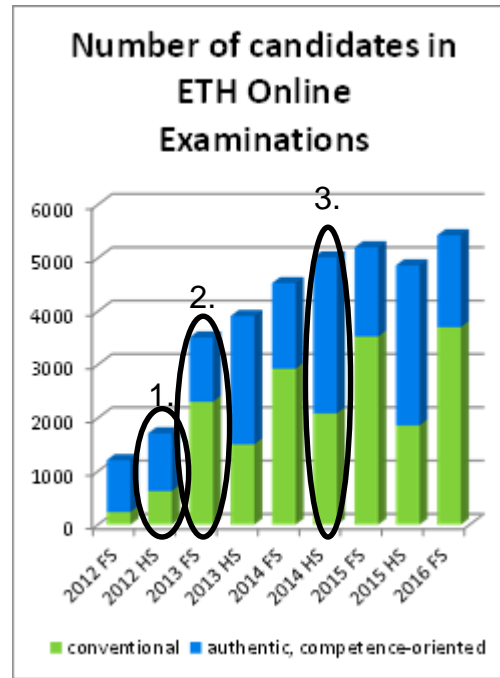
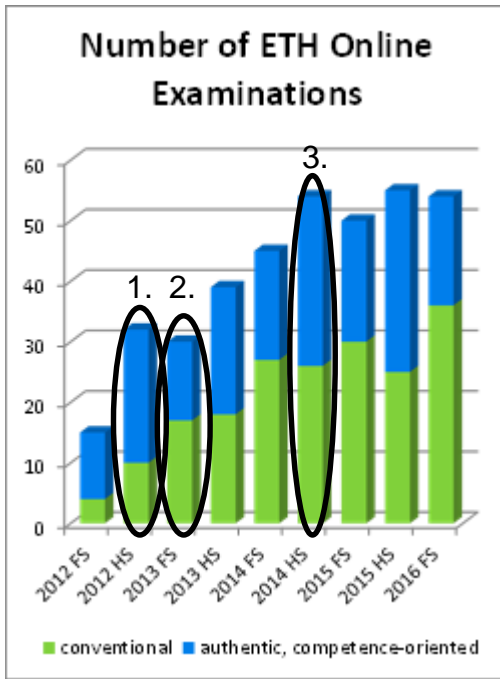
Organisation: Lessons

- Didactics lead, technology follows
- Define responsibilities and escalation routes clearly
 - Cross-disciplinary teams
 - Units from across an institution involved
- ‘Fehlerkultur’ // dealing with mistakes
- Avoid bottlenecks and single points of failure in service operations



Part II: Practical Lessons

Demand



1. 2012 HS: Dedicated position online exams
2. 2013 FS: HG G1
3. 2014 HS: Capacity reached

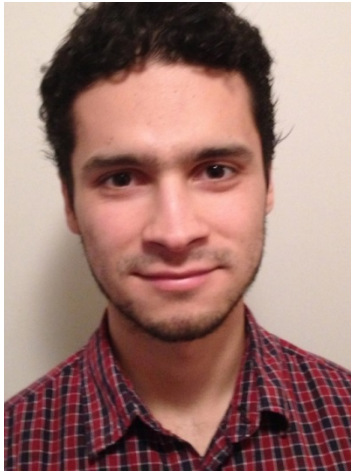
Start Simple, Start Early

Move forward in incremental steps

Institutional support is critical for success

Innovate – Consolidate – Standardize – Automate

Online Exams: A Student's Voice



«Ich habe während meines Studiums zwei Onlineprüfungen abgelegt und habe durchwegs positive Erfahrungen gemacht. Die Prüfungssituation habe ich als motivierend erlebt. Gerade für uns Informatiker sind Onlineprüfungen viel realistischer, da wir wie im späteren Job unsere Ideen direkt am Computer testen können. [...] Die Aufgaben sind jedoch viel zu komplex, als dass man sie mit dem Trial-Error-Verfahren lösen könnte. Man muss schon eine grosse Menge an Hintergrundwissen mit in die Prüfung bringen.»

Prüfungen sauber getippt statt schludrig geschrieben
TagesAnzeiger 23.2.2015



Thank you for your attention.