Overview of digital examinations

Presentation of options for application in practice

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Management summary

Secure digital examinations are possible and can improve the efficiency and quality of teaching. There are different methods, each with its own advantages and disadvantages depending on the application. This document offers a concise overview and provides guidance on which variant is suitable when.

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1 Introduction

There are many different ways of carrying out a digital competency assessment. This document is intended as a guide for BFH lecturers and compares the advantages and disadvantages of the individual solutions. The appendix also contains a glossary of the most important terms.
The fundamental principle to be followed here is that competency assessments should be effective, fair and user-friendly, regardless of the form they take.

2 Definition of digital competency assessment

The term "**digital** competency assessment" is broadly defined: already the use of a tablet in an expert discussion falls under this category, because the technical framework and conditions must have been set in place. The question arises as to what materials, software and resources are permitted, for example, or how notes made during the examination are managed. Interactive content, such as a gap-fill text or a memory game, can also be considered digital competency assessments, especially if their purpose is to test knowledge and skills through gamification.

3 Advantages of digital competency assessments

Digital competency assessments have the following advantages:

- Faster/more efficient correction:
  - If desired, candidates can receive immediate feedback
  - Less bias
  - Automatic testing can reduce errors during correction
  - Automatic feedback e.g. for multiple-choice questions
- Reusability of questions: a question database contains a broad catalogue of questions that can be reused and adapted as needed, making the creation of examination papers more efficient.
- Contemporary setting

- Variety of question types: expanded and new question types (e.g. submission of programming/parameterisation, or multimedia use) are possible, allowing knowledge and skills to be tested more broadly.
- Sustainability: no physical materials such as paper are required. What's more, the examination and the answers can still be retrieved years later.
- No illegible handwriting to decipher
- Random sequence of questions and answer options prevents students from committing malpractice through pattern recognition, memorisation or copying.
- Data-based analysis/learning analytics: analytics/analysis of the results makes it possible to identify learning difficulties in certain topics and adapt the teaching accordingly.
- The 'Facility Index' can be used to check whether the questions are too difficult or too easy. This prevents frustration among students during the assessment and ensures that it gives an accurate picture of the knowledge they have acquired.
- Badly worded questions and instructions can be found quickly and easily.
- The required duration can be clearly understood.
- *If necessary*: Individual performance reports can be generated automatically to provide students with targeted feedback on their progress.
- Simplified administration makes for clear organisation based on:
    - A role, group and rights concept that facilitates flexible assignment and management
    - Scheduling: the timeframe in which the assessment can be completed
    - The ability to assign answers unambiguously to a candidate

4 Criteria for a good competency assessment

Regardless of the form (analogue, digital, hybrid), competency assessments should meet the following five criteria:

- Representative: the assessment reflects the content that was covered in the course.
- Valid: the examination assesses the knowledge or skills that are required to be tested.
- Reliable: identical answers always result in an identical grade, regardless of the examiner, the lecturer or the circumstances.
- Economical: examinations are implemented efficiently in terms of time and resources.
- Transparent: the examination process is communicated clearly and comprehensibly to all parties involved.

5 Conditions

5.1 Easy to use and accessible

Competency assessments should always be designed intuitively to ensure that the questions are clear and understandable, so that the candidates can concentrate on answering them instead of having to waste time trying to understand the format of the tasks or how the digital platform works. ((*Link zu «wie man gute Prüfungsfragen erstellt»,* Kurs von Stephan)
All BFH students should find it equally easy to access and complete the competency assessments, i.e. both technical and structural barriers must be removed.

5.2 Question types and design

There should be a wide range of questions that test both the knowledge acquired and the ability to apply it in practice.
Different difficulty levels and longer versions (e.g. essays) should also be possible. A digital competency assessment also offers the option of using novel question types. This would include, for example, asking questions with multimedia elements such as videos or interactive tasks.

The user interfaces of the examination platform should comply with the BFH corporate identity/corporate design (CI/CD). This makes for a uniform, professionally designed user interface that is familiar to students and supports the BFH brand recognition.
Both the questions and the answers should be generated in a random order to prevent any copying of answers or memorisation of patterns. With analogue competency assessments, both the examination creators and the candidates tend to place the correct answers in the middle (Attali & Bar-Hillel, 2003). This can be resolved by using a digitally randomised sequence, to avoid this psychological effect and create fair examination conditions.

5.3 Identity verification and security

It should be possible to verify the candidates' identity unequivocally and lastingly. In addition, security mechanisms that report/detect attempted malpractice must be defined, depending on the requirements of the examination (e.g. interim test vs. end-of-course exam).
At the same time, all personal data should be handled in accordance with data protection requirements (*Link Vorgaben BFH*?).
If a candidate loses their internet connection during the test due to technical problems, it must be guaranteed that they can continue the test without loss of data (data retention).
The submitted answers must be reliably stored for a defined period of time so that they can be used as evidence in the event of an appeal.

5.4 Integration

All digital formats are embedded in BFH's Moodle, so there is no need for a separate login. The feedback and grades are also saved in Moodle, enabling students to access their answers and grades at any time after the results have been released.

6 Solutions

6.1 Interactive content and gamification

6.1.1 What it is

Digital learning games, interactive content and simulations of everyday situations to test knowledge can be created directly in Moodle, e.g. with H5P or StudentQuiz.

6.1.2 Advantages

- Variety of question types
- Quick and easy to create, use and customise
- No further infrastructure needed
- Candidates can use all materials (internet, documents, etc.)
- Activity is completed directly in the Moodle course

6.1.3 Disadvantages

- No proof of the candidate's identity
- No control over chat and browser history
- Only limited analysis (how long do candidates take, how difficult is the exercise, etc.)

6.1.4 When is it suitable?

- Testing knowledge
- Monitoring learning progress and increasing motivation to learn (when using gamification)
- Ideal as an interim test or to see where students stand
- Formative assessment

6.1.5 How quick to implement?

- Immediately, provided the Moodle course already exists

6.1.6 Effort required?

- Little
- Existing or new activities can be created and modified directly in Moodle.

6.2 Online test (in Moodle)

6.2.1 What it is:

Written mode via the "Quiz" activity in Moodle, which can be implemented either synchronously or asynchronously. This means that candidates either take the test on campus in a controlled room at a specified time, or they set the time themselves (e.g. open-book examinations).

6.2.2 Advantages:

- Quick and easy to create, use and customise
- No further infrastructure needed
- Candidates can use any materials (internet, documents, etc.) (open-book)

6.2.3 Disadvantages

- If not on campus: monitoring/proof of identity and situation require much effort
- Candidates can use any materials and communicate with each other

6.2.4 How quick to implement?

- Immediate. Any course that has a corresponding Moodle course can create and publish tests.

6.2.5 Effort required?

- Little. Existing or new questions can be edited or created directly in Moodle.

6.2.6 When is it suitable?

- Ideal for smaller tests of knowledge without strict monitoring
- For checking learning progress
- Ideal as an interim test or to see where students stand
- Formative assessment

6.3 Safe Exam Browser (SEB)

6.3.1 What it is

Stand-alone browser for malpractice-proof competency assessments in Moodle. The SEB blocks certain functions on candidates' devices. Candidates cannot open any other tabs or windows, software or files during a session with the SEB. Shortcuts are also inactive. Moreover, no screenshots can be made and later used elsewhere. After installation, the SEB runs locally on any end device.

6.3.2 Advantages

- High security level
- Relatively simple to implement
- The SEB recognises when the environment is a virtual machine and refuses to launch
- Features a URL filter, allowing specific websites to be accessed (whitelist)

6.3.3 Disadvantages

- Currently only Windows and Apple devices are supported

- Candidates must always have the latest version of the SEB installed
- It requires the version to be installed and kept up to date
- Access to pdf files and websites must be set manually
- Access to other resources is not possible

6.3.4 When is it suitable?

- For major examinations leading to a qualification
- To monitor learning progress
- When a high level of security is required
- Summative assessment

6.3.5 How quick to implement?

- Does not take long. Any course that has a corresponding online course in Moodle can use the SEB. The candidates install the SEB on their devices.

6.3.6 Effort required?

- Medium effort due to software installation

6.4 Safe Exam Browser Server

6.4.1 What it is

Centralised examination management system that provides information about the candidates' devices (the SEB Server can remotely monitor multiple SEB instances during an examination). The SEB Server allows the examiner to monitor all candidates in real time and intervene as needed.

6.4.2 Advantages

- High security level
- Real-time monitoring of all devices during the examination
- Remote: intervention options e.g. if malpractice is suspected
- Controlled, restricted environment
- Cloud connection for flexible updates and management

6.4.3 Disadvantages

- Not fully BYOD-compatible
- Loan laptops must be available for students with unsupported devices (Linux)
- High administrative effort in the preparation phase

6.4.4 When is it suitable?

- Major competency assessments leading to a qualification (e.g. semester examinations) that require real-time monitoring
- When a high level of security is required
- Summative assessment

6.4.5 How quick to implement?

- Does not take long, as the configuration and installation has to be organised centrally.

6.4.6 Effort required?

- Medium effort as the configuration and installation must be organised centrally.

6.5 Lernstick EXAM

6.5.1 What it is

USB boot stick that launches a preconfigured operating system on the candidate's device. The examination takes place exclusively on the stick; access to the computer's hard drive and other storage media is blocked by default. In this environment, Moodle and permitted software, websites and files can be enabled. The Lernstick EXAM includes backup functions for automatically saving the edited artefacts; screenshots can likewise be generated at intervals. The Lernstick is in read mode only and does not install anything on the private device; neither is any personal data saved on the stick. See also the entry in the Knowledge Base

6.5.2 Advantages

- Offline possible
- Recognises manipulation attempts, e.g. launches from virtual machines
- Broad BYOD support on laptops, only needs a USB port
- Very high level of control over what the candidates can use and when
- Simple to use/administer
- No installation on the student's own device necessary

6.5.3 Disadvantages

- Hardware procurement: one preconfigured stick is required per candidate; but they can be reused
- One-off investment of time required for introduction and a brief test run, as well as for device configuration (third-party certificates, Apple M1/M2)
- Loan laptops must be available for students with unsupported devices (Apple M3 and Windows ARM)
- Changes cannot be made to the setting at short notice. However, changes of examination are possible, as these are run via Moodle
- High administrative effort in the preparation phase

6.5.4 When is it suitable?

- Examinations with very high security requirements
- Practice-based examinations using open-source software such as RStudio, Python with IDEs, Git, LibreOffice, etc.
- Summative assessment

6.5.5 How quick to implement?

- Does not take long, as the Lernsticks have to be configured and distributed.

6.5.6 Effort required?

- Medium effort, as the hardware has to be procured and configured

6.6 CAMPLA Lernstick (cloud)

6.6.1 What it is

Centralised examination management system that provides information about candidates' devices. CAMPLA allows the examiner to monitor all candidates in real time and intervene as needed.

6.6.2 Advantages:

- High security level
- BYOD-compatible
- Controlled, restricted environment
- No local installation required (exception Apple Silicon M1/M2)
- Cloud connection for flexible updates and management
- Specialist applications that require Windows or are subject to a licence can be used
- USB flash drives rarely need updating

6.6.3 Disadvantages

- Requires USB flash drives
- Hardware-dependent (USB ports required)
- Technical challenges in distribution
- High security requirements for cloud infrastructure
- Loan laptops must be available for students with unsupported devices (Apple M3 and Windows ARM)

6.6.4 When is it suitable?

- Examinations with very high security requirements; ideal for BYOD and decentralised examinations.

6.6.5 How quick to implement?

- Does not take long: configuration of USB flash drives and distribution required; cloud-based infrastructure must be set up.

6.6.6 Effort required?

- Medium effort: configuration and provision of the flash drives
- Management of the cloud solution required

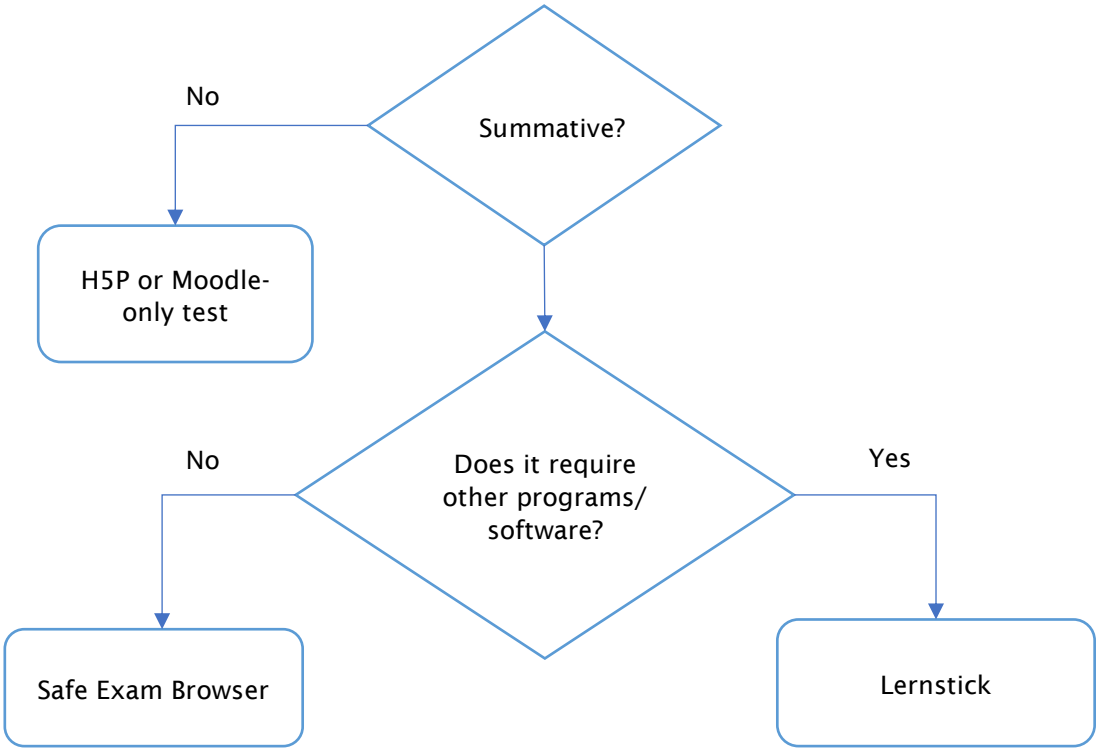
6.7 Overview

Security: How well can attempted malpractice be prevented/monitored?
Preparation: How quickly can an implementation be realised?
BYOD: How wide is the range of devices supported?
Implementation of monitoring: How easy is it to manage the devices during the examination?
Cost: How economical is this variant?
Offline: How easy is it to run the examination offline?

	H5P	Moodle Test	SEB	SEB Server	Lernstick	Campla
Security	--	-	+	++	++	++
Preparation	++	+	-	--	-	--
BYOD	++	++	+	++	+	++
Implementing monitoring	--	--	+	++	+	++
Cost	++	++	++	+	-	-
Offline	--	--	--	--	++	--

Key:
-- Very negative/very bad/very expensive
- Negative/bad/expensive
+ Positive/good/economical
++ Very positive/very good/free

If I want to assess student performance digitally:



7 Conclusions/summary

Efficient digital examinations can be designed in such a way that they are user-friendly, secure, sustainable, motivating and fair. Automated feedback can minimise the time required to grade the examinations.
To successfully perform a digital competency assessment, answer the following question in advance: who is to be examined, how, in what form, about what and with what means?

8 Glossary

Config Key
A cryptographic key used to encrypt and authenticate the configuration file in the Safe Exam Browser. It ensures that only authorised users can make changes to the configuration.

SEB Server Exam Key
A cryptographic key generated by the Safe Exam Browser Server. It identifies the examination and ensures that only authorised devices can access the examination.

Additional Browser Exam Key (BEK)
An additional cryptographic key used to enhance the security of the examination by providing additional layers of authentication to access the examination.

App Signature Key (ASK)
A cryptographic key used to verify the integrity and authenticity of the Safe Exam Browser application to ensure that the application has not been tampered with.

Formative assessment

Ongoing assessment of learning performance. The result, or the grade attained, is irrelevant. Its primary purpose is to give students an idea of where they stand.

Summative assessment
Checks learning goals have been met; focus is on grade awarded; usually at end of course. High standards of monitoring and security; this form should be as malpractice-proof as possible.

Analytics (Moodle)
Evaluation of questions and behaviour. Reveals how easy or difficult a test was.

Facility Index
Numerical value in the "Quiz" activity in Moodle, indicating how easy or difficult a question was.

9 Bibliography

Literature

Attali, Yigal & Bar-Hillel, (2003): Guess Where: The Position of correct Answers in Multiple-Choice Test Items as a Psychometric Variable. *Journal of Educational Measurements*, Vol. 40

Khabbachi, Abdelhamid & Aziz (2023): An Intelligent Solution based on a Multi-agent System for the Detection of Cheating in Online Exams. *International Conference on Networking, Intelligent & Security NISS*

10 Digital examination checklist

Tips and tricks for the SEB

10.1 Before the examination:

What are my school's requirements?
- Ensure that the requirements are met.

Who is to be examined, how, in what form, about what and with what means?
- Analogue
- Digital
- Summative
- Formative
- With or without a server?

What should my students know in advance?
- Ensure that all students are informed well ahead of time:
  - What can they expect?
  - Which devices can be used for what?
  - Does everyone have the latest version/updates?
  - Where can they find their SWITCH edu-ID?
  - Where can they find their BFH login details for the Wi-Fi?

Do they know how to contact IT support?
- Ensure that all students know where to turn to if they have technical difficulties.

What devices do my students use?
- Ensure that a device survey is conducted in advance.

Will the examination take place with a Lernstick?

- Ensure that all students have a Lernstick.
- Ensure that all students have access to the preparation presentation.

Will the examination take place with the SEB?
- Ensure that all settings in the Moodle test are correct.

Will the examination take place with server support?
- Ensure that all candidates are registered.
- Ensure that all required keys are known (Config Key, SEB Server Exam Key, BEK & ASK)

How does the examination mechanism/software work?
- Familiarise yourself with the chosen variant and, if possible, do a trial run yourself.

Does the internet work at the examination location?
- Ensure that the Wi-Fi is working.

Plan a test run

Clarify any uncertainties regarding the implementation of the examination well ahead of time

10.2 In the examination

Have a spare USB Wi-Fi dongle with you

Have loan devices available

Hand out checklist to candidates

Important: Do not close your laptop during the examination!

10.3 After the examination

Get feedback from the students

Evaluate Moodle Analytics and Facility Index

Make any necessary adjustments to the examination for the next time

Report technical problems to the responsible office