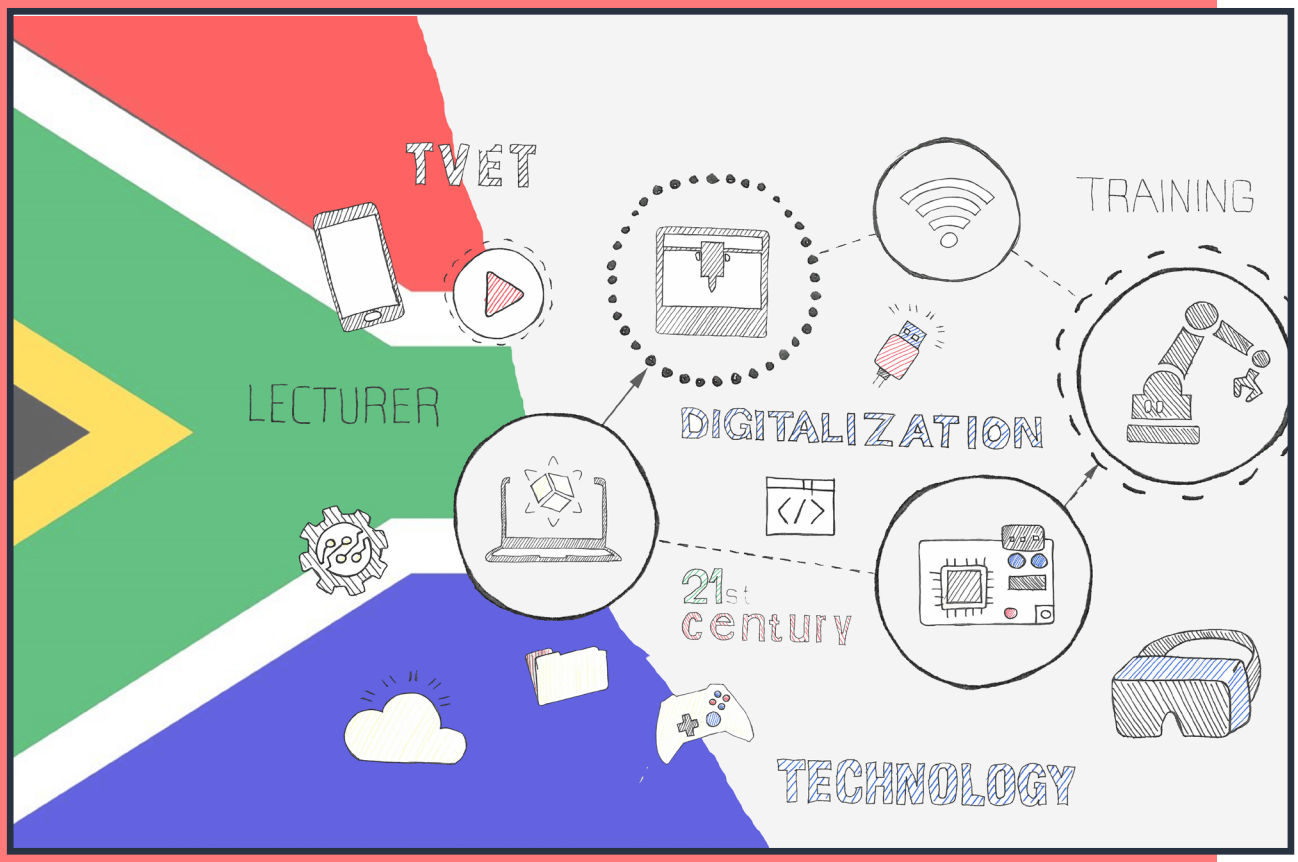
STUTTGART 2023

MODULE I.1

DIGITAL TEACHING AND LEARNING IN TVET

Activities



TRAINME 2 - ADVANCED MODULAR TRAINING & EDUCATION

IN MECHANICAL & ELECTRICAL ENGINEERING

Education is Future

TRAINME 2

Modular training and further education of South African TVET-lecturers in mechanical and electrical engineering

EDITING

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This book has been developed within the bilateral programme TRAINME 2 in order to promote in-service lecturers' Technological Pedagogical Content Knowledge (TPACK). The programme has been designed by the Inter-Company Training Center in Easter Bavaria (ÜBZO) and University of Stuttgart, Department of Vocational Education focused on Teaching Technology (BPT) on behalf of the German Federal Ministry of Education and Research and DLR in cooperation with the South African Department of Higher Education (DHET).

Stuttgart, January 2024

TRAINME 2
Modular training and further education of South African TVET-lecturers in mechanical and electrical engineering

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ABOUT THE ACTIVTIES

These are the companion activties for Module I.1 of TRAINME 2.

Inspired by the DigComp, DigCompEdu and TPACK (see chapter 1 and 2 in the course book of Module I.1), a wide variety of activities faciliate your competence to make efficient and innovative use of digital technologies when planning, implementing, and assessing teaching and learning.

You make use of various technologies in order to create and modify educational content and share the content with your colleagues and students. You learn and implement new teaching methods to make your lessons or instruction more interesting, engaging, and effective.

Some activties are adaptable and can be used for classroom activities.

1. Selecting, Creating & Modifying Content
2. Sharing, Researching & Documenting
3. Communicating & Collaborating
4. Visualising, Animating & Simulating
5. Structuring & Systemising
6. Assessing & Diagnosing
7. Facilitating Learners' Digital Competence

Explanation of Icons

Document, text etc.
Click on it and download content from Moodle@IfE-BPT

Adaptable activties

Applicable to mobile learning

CONTENT

ACTIVITY 1 READ, PRESENT, DISCUSS: DIGITAL TRANSFORMATION AND CONSEQUENCES FOR TVET

1. Skim the three texts and summarise the keypoints of the Industry 4.0 concept.
   - What is digital transformation? What is digitalisation?
   - What is the impact of the digital transformation on South Africa?

Text 1: *Rojko, A (2017). Industry 4.0 Concept: Background and Overview. International Journal of Interactive Mobile Technologies.*

Text 2: *Levin, S (2018). World Economic Forum and the fourth industrial revolution in South Africa.*

Text 3: *Dewa, M et al. (2018). Industry 4.0: A myth or a reality in South Africa?*

2. Brainstorm changes in the Mechanical and Electrical sector due to digital transformation.
3. Reflect the consequences of digital transformation for TVET.
4. Summerise your results in a Power Point presentation format (use images, videos etc.) and present them. Provide an opportunity for discussion.

ACTIVITY 2 READ & REFLECT: DIGITAL DIGITAL / ICT LITERACY, DIGITAL SKILLS, DIGITAL COMPETENCE

Part 1

1. Familiarise yourself with the concept digital digital / ICT literacy, digital skills, digital competence (see course book Module I.1, chapter 01).

   - What are the definitions of digital digital / ICT literacy, digital skills, digital competence?
   - What are the components of digital competence?

Part 2

Findings reveal that the youth in South Africa, despite born as digital natives, are not confident enough to complete tasks using ICT (Twinomurinzi & Msweli 2019).

1. Skim **text 1** and **text 2**.

   - What are the challenges faced by students while using technology for learning purposes?
   - What are technological skills required by South African public TVET college students?
   - Which are technological skills required by South African public TVET college students?

Text 1: *Denhere, V & Moloi, T (2021). Technologies, technological skills and curriculum needs for South African public TVET college students for relevance in the 4IR era.*

Text 2: *Faloye, S T & Ajayi, N (2021). Understanding the impact of the digital divide on South African students in higher educational institutions.*

Text 3 (Optional): *Twinomurinzi, H & Msweli, N T (2019). Digital Natives Still Need Intentional Digital Skills in the 4IR: Comparing the General and ICT Self-Efficacy of South African Youth.*

ACTIVITY 3 READ, REFLECT, CREATE: EFFECTS OF USING DIGITAL TECHNOLOGIES FOR TEACHING AND LEARNING

When you design technology-enhanced learning experiences, you must understand the potential and effects of technologies to meet different objectives (e. g., managing data, understanding a principle of a magnetic field).

Part 1 - Research of the effects of using digital technologies for teaching and learning

What does the academic literature tell us about the effects of using digital technologies for teaching and learning? This assignment may be a group work. Each group works through a text.

1. Skim the empirical results on the effectiveness of digital technologies for
   - learning motivation and outcome (Text 1 & 5)
   - mathematic literacy (Text 2)
   - collaboration & communication (Text 3)
   - 3D Printing skills (Text 4)
2. What are the effects? Which technologies are used?
3. Summerise your results in a mind map.
4. Create this mind map with the tool Canva. Use handout 1 »How to use Canva and Create a Mind Map«.
5. What does your mind map look like? Present it to the group.

Part 2 - Benefits of visuals for teaching and learning

1. Discuss the benefit of visuals (e. g. a mind map) for teaching and learning?
   - Every mind map on paper can also be created digitally. What are the advantages and disadvantages?
   - How can you use tools such as Canva in your lessons? Which 21st century skills and digital competences would be developed?

Text 1: *Chen, Y-C (2017). Empirical Study on the Effect of Digital Game-Based Instruction on Students' Learning Motivation and Achievement.*

Text 2: *Pant, P (2021). An Empirical Study on impact of using geogebra on achievement in Mathematics.*

Text 3: *Ansari, J & Khan, N A (2020). Exploring the role of social media in collaborative learning the new domain of learning.*

Text 4: *Chien, Y-H (2017). Developing a Pre-engineering Curriculum for 3D Printing Skills for High School Technology Education.*

Text 5: *Hediansah, D & Surjono, H (2019). Building Motivation and Improving Learning Outcomes with Android-based physics books: Education 4.0.*

Self-Study

ACTIVITY 4 FACILITATING INFORMATION AND MEDIA LITERACY

According to various frameworks and policies, teachers should facilitate learners' digital competence in:

- Information and media literacy
- Digital communication and collaboration
- Digital content creation
- Responsible use
- Digital problem solving (cf. Redecker & Punie 2017)

Inspired by the competence area 1 of DigComp and competence area 6.1 of DigCompEdu, this activity is to facilitate your digital competence in the area of information and data literacy in order to deal with your students' needs for information and media literacy.

In order to facilitate learners' information and media literacy, teachers should incorporate learning activities, assignments and assessments which encourage and require:

- learners to articulate information needs;
- to find information and resources in digital environments;
- to organise, process, analyse and interpret information;
- and to compare and critically evaluate the credibility and reliability of information and its sources.

Part 1 - Data literacy

1. Review the video on data literacy and identify key issues you need to address.

Click to watch

Part 2 - Searching quality information

The internet has become a useful tool for research, because it offers massive databases, digital libraries, academic publications, and other accessible online resource. However, the digital technologies pose risks and present challenges for teachers (and learners).

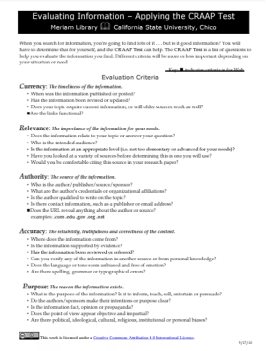
Often, people automatically search Google first, regardless of what they are looking for. Today, in 2024, students can write their prompt into ChatGPT, and in seconds, the artificial intelligence (AI) will compile all of the information they need, pulling from potentially thousands of sources across the internet without citing any of them. But do you trust that the program is accurate?

Anyone can put information online and for any number of reasons. However, digital content — digital resources and data — can contain dis- and misinformation. In particular, Fake news are very problematic. Hence, being able to identify good quality digital content is critical. The CRAAP Test is a list of questions to help you evaluate the information you find.

> It is essential for teachers to incorporate the skill of critically evaluating sources into every research assignment they give.

- Currency: the timeliness of the information
- Relevance: the importance of the information for your needs
- Authority: the source of the information
- Accuracy: the reliability, truthfulness, and correctness of the content

In order to find find good quality information:


Evaluating Information – Applying the CRAAP Test
Meriam Library, California State University, Chico

Evaluation Criteria

Currency: *The timeliness of the information.*
- When was the information published or posted?
- Has the information been revised or updated?
- Does your topic require current information, or will older resources work as well?
- Are the links functional?

Relevance: *The importance of the information for your needs.*
- Does the information relate to your topic or answer your question?
- Who is the intended audience?
- Is the information at an appropriate level (i.e. not too elementary or advanced for your needs)?
- Have you looked at a variety of sources before determining this is one you will use?
- Would you be comfortable citing this source in your research paper?

Authority: *The source of the information.*
- Who is the author/publisher/source/sponsor?
- What are the author's credentials or organizational affiliations?
- Is the author qualified to write on the topic?
- Is there contact information, such as a publisher or email address?
- Does the URL reveal anything about the author or source?
examples: .com .edu .gov .org .net

Accuracy: *The reliability, truthfulness and correctness of the content.*
- Where does the information come from?
- Is the information supported by evidence?
- Has the information been reviewed or refereed?
- Can you verify any of the information in another source or from personal knowledge?
- Does the language or tone seem unbiased and free of emotion?
- Are there spelling, grammar or typographical errors?

Purpose: *The reason the information exists.*
- What is the purpose of the information? Is it to inform, teach, sell, entertain or persuade?
- Do the authors/sponsors make their intentions or purpose clear?
- Is the information fact, opinion or propaganda?
- Does the point of view appear objective and impartial?
- Are there political, ideological, cultural, religious, institutional or personal biases?

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- Choose the right search tool (source).
  A specialised database, such as Proquest, allows targeted searching on one or more specific subject areas (e.g., engineering), for a specific format (i.e., books, articles, video, images, etc.), or for a specific date range during which the information was published. Most of what specialised databases contain can not be found through open web search engines like Google.
- Search for primary sources: Primary sources are generally more reliable than second-hand information.
- Check the domain name: Look at the three letters at the end of the site's domain name, such as "edu" (educational), "gov" (government), "org" (non-profit), and "com" (commercial). Generally, .edu and .gov websites are credible.

Part 4 - Fake news

1. Everybody knows the expression ‚fake news', but what does it really mean? What do we mean by fake news?
2. Check if there is a Fact Checker from your country who is member of the International Fact-Checking Network (IFCN) from https://ifcncodeofprinciples.poynter.org/signatories.

Part 5 - Data protection and data security

Using the Internet and browsing on the World Wide Web also pose risks and presents challenges for teachers (and learners) with respect to safety online and specifically protecting personal data and privacy (see chapter 03 Security & Privacy, page 119, in your digital coursebook).

When you navigate the web, you are exposed to a series of laws and regulations linked to browser cookies. It is fundamental that before accepting them you are aware of what cookies are and how they can influence your activity and privacy online.

1. Do the computer-based training on data protection and data security.
2. Search the web for “Online safety rules” or “Online safety tips” or similar search query.
   - Pick at least 3 of the top results from the search engine, containing some kind of list with safety rules and tips.
   - Compare the safety tips/rules and check how many of their suggested guidelines are the same.
   - Gather all tips in one list (only their title, not the whole information and delete duplication).
   - Create a 3-column table with the following column names “I know and I follow it”, “I know but I do not follow it”, “I didn’t know it” and put every safety tip into the according column.
   - Study the two safety rules that you are not following in your daily tasks and try to adopt them.
3. Visit the following resources and list information on the questions below about cookies. You can search on the web for more resources.
   - What information can cookies hold?
   - Is it obligatory to accept cookies?
   - Can cookies be dangerous and how?

The web-based training was developed by Meggy Seidita. The WBT is part of her master‘s thesis at the department. The training is a component of TRAINME 2 - Module 3 Cross-occupational competences.

Self-Study

ACTIVITY 5 READ, WATCH, REFLECT, COLLABORATE: DIGITAL TECHNOLOGY INTEGRATION

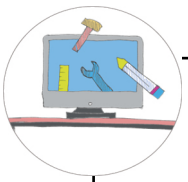
Digital technologies can be integrated in different ways to promote teaching and learning. Models and frameworks of digital technology integration offer structured approaches to guide teachers by effectively incorporating technology into their instructional practices.

Whether the integration of digital technologies leads to a better learning outcome is a complex question. To explain the effective use of digital technology, an understanding of learning theories can assist us in the design and implementation of an effective digital learning environment.

Part 1 - Web-based training on technology integration

1. Do the web-based training on technology integration.
   - Compare the two examples of models / frameworks for technology integration. Read the texts and watch the videos in the training.
   - Test your knowledge and join quizzes.

Time required: 2 h - 3 h



You can find all interactive tools used in this activity in the toolbox in the workshop section of your coursebook.

In the next face-to-face contact sessions, you'll be provided with a practical introduction on to how use and implement them in your courses.

Part 2 - Your technology integration

1. Reflect on your technology integration. Take one or two of your courses you are teaching.
   - Which technologies and activities do you use?
   - Which learning theories underpin the learning in your course?
   - Which skills / abilities, according to Bloom's Digital Taxonomy, do the activies, tools etc. that you implement in your course support?
   - In which way would you change your technology integration?
   - Use Table 2 »My Technology Integration«. We will discuss it in the next face-to-face contact sessions.

Figure 1 My Technology Integration


TABLE 2 MY TECHNOLOGY INTEGRATION

Course / Subject

Technology	Skill and Ability (LOTS and HOTS)	Activity	Learning Theory

Comments

Course / Subject

Technology	Skill and Ability (LOTS and HOTS)	Activity	Learning Theory

Comments

SUBMIT

Time required: 0,5 h - 1h

Part 3 - »Padagogy Wheel«

1. Let's create together our own »Padagogy Wheel«.
2. Open the project »The TRAINME Padagogy Wheel« on Canva.com.
3. Add the technologies that you already use, related activties and skills to the wheel on the whiteboard. You can use handout 2 »How to Use Canva and Collaborate«.

Figure 2 The TRAINME »Padagogy Wheel«

Time required: 0,5 h - 1h

Self-Study

ACTIVITY 6 CREATE, DOCUMENT & SHARE: QR CODES & PADLET

Inspired by the competence area 1 and 2 of DigCompEdu, this activity is to facilitate your digital competence in the area of creating, documenting and sharing digital content. In reference to the TPACK model, this activity also improves your skills of integrating digital content into your lesson planning.

According to various frameworks and policies, teachers should be able to use digital technologies to engage in collaboration with other educators, sharing and exchanging knowledge, resources and experiences with colleagues. Futhermore, teachers should be able to use technologies in order to provide students with content and learning material (e.g. technical information, worksheets, data sheets, etc.).

Content can simply be attached to an e-mail, copied to the school server, uploaded to a learning platform such as Moodle or uploaded into a cloud service such as Dropbox or Google Drive. Content can also be shared via messaging apps.

Part 1 - QR codes

QR codes (Quick Response) in education is one of the latest technological trends to share course content (including videos, applets, and documents). In addition, QR codes can complement the design of more interactive and engaging learning experiences in higher education.

1. Do you already design lesson units supported by QR codes? If yes, how do you implement QR codes in the lesson unit? Which activities do you combine with QR codes? How do you distribute QR codes? Let us know. Just use this Mentimeter form to respond.
2. There are many ways in which QR codes can be used. You can make regular old worksheets come alive by adding QR codes that take students off the page and onto a relevant website, interactive game, or video. On page 12 you find some ideas for classroom activities. Choose one idea and plan activities for your next lesson supported by QR codes. Implement the activities. What was your experience? How did your students react? In Part 2 of this activity you will provide documented evidence of the implementation.

   Handout 3 »How to Create and Distribute QR Codes« contains all of the information you need to create and distribute QR codes.

Time required: 2 h - 3 h

Figure 3 10 fun QR code lesson ideas for in the classroom

Source: https://www.bookwidgets.com/blog/2017/06/the-best-qr-code-classroom-activities-infographic

TIP

Download the free BookWidgets iPad / Smartphone app to scan the first 9 QR codes on the infographic. You can open them with an ordinary QR code scanner, but everything will fall better into place with the app from BookWidgets. Once you downloaded the app, click on "Add short code" to scan the QR code.

Part 2 - Digital pin board *Padlet*

Another way to share content is through a digital pin board where texts, pictures, videos, links, voice recordings, screen recordings and drawings can be stored and shared.

1. Open TRAINME's Padlet »Show and Tell« and add post. How was your week at college? How did you start your first lesson? What mistake did you make? What can you learn from that? Was there a special moment? Which learning activities from which unit did you use? Show and tell. Use videos, images etc. Use handout 4 »How to Use Padlet« to get started.
2. Now make your own Padlet. Create a portfolio that collects the activities you developed and implemented in your lesson (see Part 1 of this activity). The portfolio should also involve a section for the reflection of the implementation. Add your padlet to TRAINME's Padlet, section »Portfolios« to share.
   You can use handout 4 »How to Use Padlet«.

Time required: 2 h - 3 h

Part 3 - Lessons and homework assignments on *Padlet*

Padlet is more than a tool to share content. With Padlet you can create a complete online lesson.

1. Look at this example of a lesson.
2. Create a short lesson that you can use for homework.
   - Consider the target group, objectives, instructional content (e. g. presentation slides), activities, discussion question and exit tickets & feedback. Here are examples of exit tickets & feedback.
   - You can also add a familiar online quiz related to the topic from another source.
   - Prepare a lesson plan that provides objectives, target group, activities etc. Use the lesson plan template for your college.
   - Add your lesson plan to TRAINME's Padlet, section »Lessons and Homework Assignments« to share with colleagues.

Time required: 2 h - 3 h

ACTIVITY 7 TEMPERATURE AND HUMIDITY MEASUREMENT USING A DHT11 SENSOR

Self-Study

In this activity you will

- use an active sensor for temperature and humidity measurement
- use of a serial bus system (e.g. „Single-wire serial interface“)
- integrate libraries and explain the benefits of their use
- display the measured values via the serial monitor and plotter
- create an instructional video

Part 1 - Measurements

1. Measure humidity and temperature with the DHT11 and display them on the serial monitor.
2. Build the circuit.
3. Create or complete the sketch.
4. Use Worksheet No. 5a.

In Part 2 of this activity you will create an instructional video in which the procedure for solving the tasks is explained and the result is briefly shown.

Time required: 1 h

Part 2 - Instructional video

1. Do the web-based training »Videos in Education«.
2. Create an instructional video in which the procedure for solving the tasks is explained and the result is briefly shown (see Part 1). Consider the following points:
   - Your video should be 4–7 minutes in length.
   - Choose an appropriate video type and production style. Eplain the choice for the video type and production style.
   - Consider the design principles for effective educational videos.
   - Define a target group (students or other lecturers?).
   - Use methods of simplification & idealisations (Didactic Reducation, see Module 2 - Pedagogical Content Knowledge of TRAINME).
   - Your video should begin with a descriptive title, your name, and the year in which it was created.
   - Use the Video Planning Document template.
3. Add your video to the section »Instructional Videos« on TRAINME's Padlet to share with colleagues.

What is an instructional video?

An instructional video is any type of educational video. It's a general term that unites different types of videos that contain educational information.

Time required: 3 - 4 h

Video production as an instructional strategy

A very promising way of using videos involves assigning learners the task of producing a video (Cavanagh & Peté, 2017; Masats, Dooly & Costa, 2009; Schwartz & Hartman, 2007; Snelson, 2018). Engaging in video production not only allows learners to acquire content-area knowledge but also facilitates the development of essential technology skills. Furthermore, research indicates that such tasks not only enhance proficiency in the specified content area but also nurture cross-cutting skills like negotiation, organisation, division of labor, and decision-making (e.g., Zahn et al., 2010; 2005). Incorporating university students' video production into project-based learning (Hung, Keppell, & Jong, 2004) and case-based teaching (Hakkarainen, Saarelainen, & Ruokamo, 2007) has been demonstrated to be beneficial for fostering meaningful learning.

ACTIVITY 7 2D PRACTICE DRAWING IN FUSION 360

Self-Study

In this activity you will

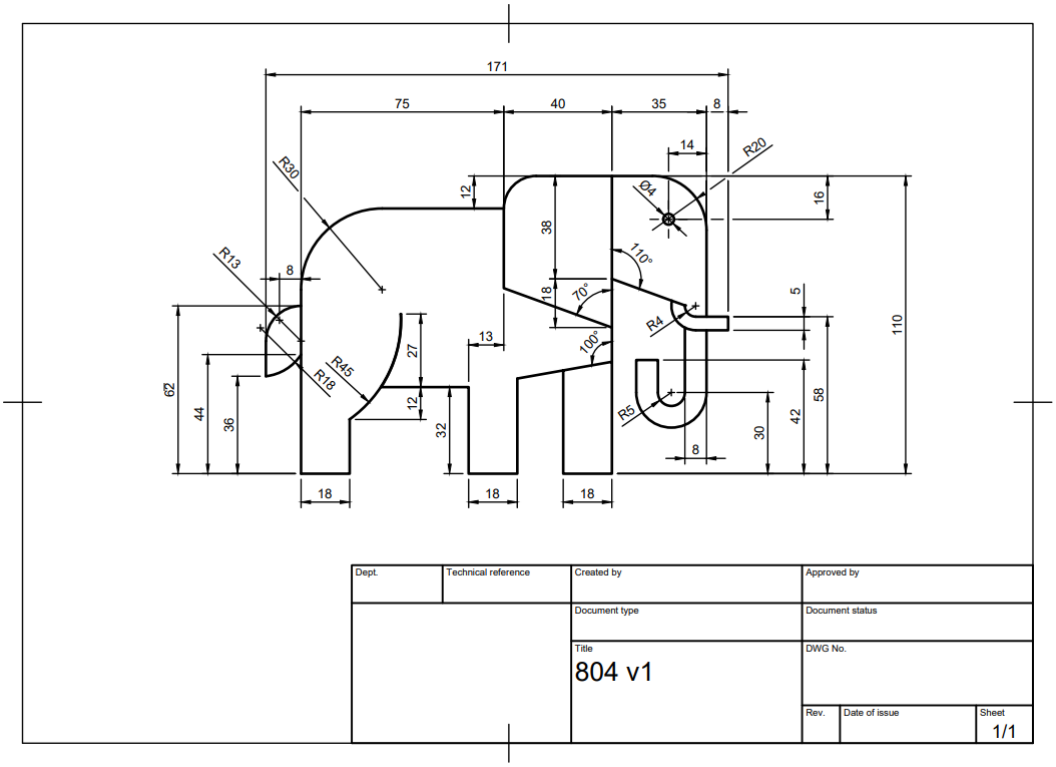
- draw an elephant in Fusion 360°
- create an instructional video

Part 1 - 2D drawing in Fusion 360

1. Create a 2D drawing in Fusion 360.
2. Use the drawing template 804 v1.

In Part 2 of this activity you will create an instructional video in which the procedure for solving the tasks is explained and the result is briefly shown.

Time required: 1 h



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ACTIVITY 8 CREATE A COMPUTER-GENERATED ANIMATION

Inspired by the competence area 1 and 2 of DigCompEdu, this activity is to facilitate your digital competence in the area of creating and sharing digital content. More precisely, you create a computer-generated animation to explain a topic or concept within your subject discipline in order to implement it in your lesson planning.

Animation - as a form of video - has become a crucial part of education, providing an important content-delivery tool, often, concepts or a work process cannot be experienced directly, either because systems or equipment are not accessible, or because an intervention is too dangerous. Many technical artefacts are also complicated, so that their mode of operation is not immediately comprehensible. Animations (a form of visualisation) of concepts and problems can help to meet these challenges.

If students do not receive any recommendations from their teachers, they quickly access freely available videos, e.g. on YouTube. However, the reliability of online video content is often uncertain and students are rarely able to assess properly whether internet videos are relevant to their learning outcomes. Therefore, your own produced videos can be adapted individually to the specific situation. Furthermore, the copyrights are clearly defined. Lastly, creative work is inherently fun.

Part 1 - Explainer video storyboard

1. Make a storyboard to detail your video before it's produced.
2. Learn how to effectively storyboard an explainer video. You can open the guide here.
3. Use ChatGPT to help you create the storyboard. Enter prompts, for example: "Make a storyboard for an animated video on topic *xy*".
4. Share your ideas in a discussion round. Discuss possible challenges, opportunities.

What is a storyboard?

A storyboard is a visual representation or a sequence of illustrations that outline the key scenes, actions, and flow of a video or film. It serves as a blueprint for the visual elements, helping to plan and organise the content. Each frame in a storyboard typically includes drawings or descriptions of the scenes, actions, dialogue, and camera angles, providing a visual guide for the production team.

Time required: 1 h

Preparation & required elements for the video

- Form your group (maximum of 4 people).
- Brainstorm a topic / concept that you want to explain in the video.
- Your animaton should be 3–5 minutes in length, plus time for a "credit roll" to show your references.
- Determine the expected outcome for your video.
- Take into account the age group of the students, and the teaching objectives.
- Determine what props, images and music you will need. Be sure that you only use material which falls under Creative Commons licence (that you can use and modify without breaking copyright laws).
- Consider the criteria of an effective educational video (see: Activity 7).

Part 2 - Create an animation with Powtoon or PowerPoint

1. Now create your own animation on a topic within your subject discipline with the video creation tool Powtoon or PowerPoint.
   - Work through the storyboard (see part 1).
   - If you choose Powtoon, familiarise yourself with the tool. You can use handout 5 »Creating a Video with Powtoon«.
2. What animation did you create? Present your video.
3. Upload your video to TRAINME YouTube Channel (Invitation to upload your video will be sent by email).

Time required: 2 - 3 h

ACTIVITY 9 CREATE AN INTERACTIVE VIDEO WITH EDPUZZLE

Inspired by the competence area 1 and 2 of DigCompEdu, this activity is to facilitate your digital competence in the area of creating and sharing digital content. More precisely, you create an interactive video with the Web 2.0 tool Edpuzzle. The application allows you to add interactions on top of video clips and to view students' progress and grade answers. In reference to the TPACK model, this activity also improves your skills in integrating an interactive video into your lesson planning.

From activity 7, you know only sharing videos with students does not mean that they are pedagogically effective, or facilitate effective learning or teaching. A traditional video often leaves the student as a passive viewer, while an interactive video will engage the student and demand interactions, thus activating the student. In order to offer a meaningful learning experience and facilitate active learning, interactive videos need to be carefully designed and developed, incorporating pedagogical techniques and elements.

Part 1 - Didactic embedding of videos in practice

1. Familiarise yourself with various tested ways of integrating interactive video in a learning scenario in the context of vocational education and training.

Time required: 1 h

Part 2 - Create an interactive video with *Edpuzzle*

1. Create an interactive video with the Web 2.0 tool Edpuzzle.
   - Choose an already existing video on a topic within your subject discipline.
   - Use handout 6 »Creating Projects with Edpuzzle«.
2. Discuss how to include the interactive video in an educational setting.
3. Add the link to your interactive video to the section »Interactive Videos with Edpuzzle« on TRAINME's Padlet to share with colleagues.

Time required: 2 - 3 h

Self-Study

Part 3 - Video Annotation

1. Familiarise yourself with video annotation. Read text 1 and text 2.
   - Which ways of annotating a video are explained?

Text 1: *Lam, N C C & Habil, H (2021). The Use of Video Annotation in Education: A Review.*

Text 2: *Rich, P & Trip, T (2011). Ten Essential Questions Educators should ask when using video annotations tools.*

2. Create and implement a lesson unit (homework) for critical video analysis with the annotation tool VideoAnt. Use handout 10 »How to use VideoAnt«.

VideoAnt WEB APP

3. Add the link to your video to TRAINME's Padlet, section »Video Annotation« to share with colleagues. Add a comment to your post and share your experiences with video annotation in your classroom.

Time required: 2 - 3 h

Some ideas

You can plan a scenario involving your students while being trained for mechanical maintenance. Use a video that shows maintenance mechanical safety for instance. Then combine the video with commentary function that allows annotations to be made at the same interface as the video (video annotation). Learners watch the video of a maintenance scenario and analyse it with the help of the annotations in order to learn from mistakes.

ACTIVITY 10 CREATE DIGITAL GAME ACTIVITIES WITH THE TOOL LEARNINGAPPS.ORG

Inspired by the competence area 1 and 2 of DigCompEdu, this activity is to facilitate your digital competence in the area of creating and sharing digital content. More precisely, you create small interactive multimedia exercises with the application learningapps.org.

The integration of digital games, quizzes and exercises in the classroom can promote deeper learning and can effectively support learning in their content area (Stieler-Hunt & Jones, 2015; Liu et al., 2014). A study on the use of games (as an alternative to paper-and-pencil tasks) shows that computer games are more effective in promoting learning motivation (Li et al. 2024; Ke 2008). Nuci et al. (2021) show a significant increase in students' engagement and interaction levels in lectures with systematic in-lecture quizzes. Further, the results indicate that the learning curve is steeper (with 73%) when using in-lecture quizzes in contrast to classes where in-lecture quizzes are not used (57.5%).

The use of gamification as a formative assessment tool allows the teacher to obtain initial information concerning individuals' learning processes.

Part 1 - Use and evaluation of digital games

Skim the text on the development, use and evaluation of digital quizzes with the tool learningapps.org.

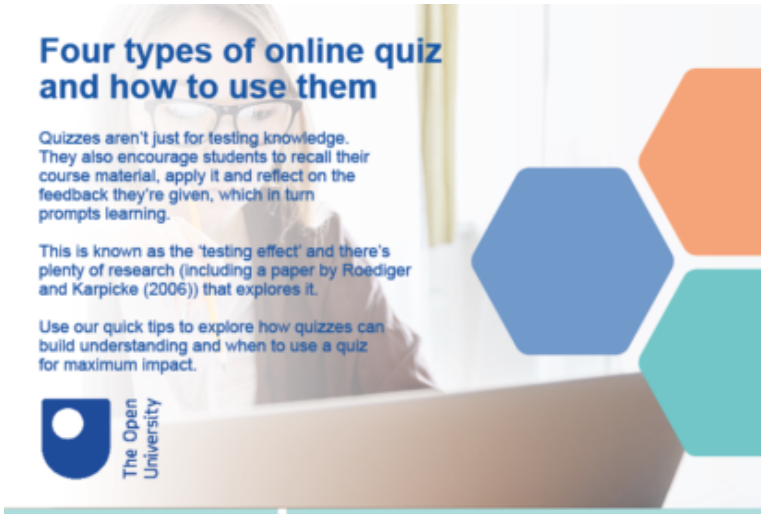
Time required: 0,5 h

Text 1: *Hermanns J & Keller D (2022). The Development, Use, and Evaluation of Digital Games and Quizzes in an Introductory Course on Organic Chemistry for Preservice Chemistry Teachers.*

Part 2 - Create interactive multimedia exercises with *learningapps.org*

1. Familiarise yourself with the tool and create interactive multimedia exercises with learningapps.org. You can use handout 7 »Creating Content with Learningapps.org«.
2. Add the link to your multimedia exercises to the section »Interactive Multimedia Exercises with learningapps.org« on TRAINME's Padlet to share with colleagues.
3. Discuss how to include the exercises in an educational setting.

Time required: 2 - 3 h



Diagnostic quizzes

Include a diagnostic quiz at the start of your course to give students the opportunity to self-assess their skills and knowledge.

You can use feedback to prompt students to reflect on whether they're ready for the course, which topics they might want to review and/or to direct them to preparation materials.

Consolidation quizzes

Use consolidation quizzes at the end of blocks of study to prompt students to review on the material they've covered. You can also use them to break up material into small chunks, providing students with an opportunity to think back on a recent topic.

You should aim to give formative feedback (feedback that prompts students reflect on their learning and redirects them to materials they need to review). Consolidation quizzes should be low stakes: their aim is to encourage students to think about their learning, not to assess their knowledge formally.

Formative assessment

Use formative quizzes as part of your assessment strategy. Like consolidation quizzes, they're designed to check students' understanding and provide formative feedback, but unlike consolidation quizzes, they focus on evaluating students' progress towards the course learning outcomes rather than a section of material.

Consider keeping them low- or no stakes to encourage students to benefit from reflecting on their progress without being penalised.

Summative assessment

Summative assessments are end-of-course quizzes or assessments that check whether students have reached the learning outcomes.

As with other kinds of quiz, it's important to provide feedback – especially as students may not engage with this material again for a while. Make sure feedback addresses any misconceptions and signposts to other helpful material.

Learning Design

ACTIVITY 11 CREATE AN INTERACTIVE VIDEO WITH THE TOOL LEARNINGAPPS.COM

In this actvitiy, you create an interactive video with learningapps.org on a curriculum topic. The application allows you to add interaction onto video clips. Interactions such as notices and quizzes pop up while the learner watches the video.

From Activity 7, we know that simply sharing videos with students does not mean that they are pedagogically effective or facilitate effective learning or teaching. In order to offer a meaningful learning experience and facilitate active learning, videos need to be carefully designed and developed, incorporating pedagogical techniques and elements.

A traditional video often leaves the student as a passive viewer, while an interactive video will engage the student and demand interactions, thus activating the student.

1. Create an interactive video with learningapps.org.
   - Choose an already existing video on Youtube on a topic within your subject discipline.
   - Use handout 8 »Creating an Interactive Video with Learningapps.org«.
2. Add the link to your interactive video to TRAINME's Padlet, section »Interactive Video with learningapps.org«, to share with colleagues.

Time required: 2 - 3 h

Self-Study

ACTIVITY 12 ASSIGN A VIDEO PROJECT

VIDEO PRODUCTION AS AN INSTRUCTIONAL STRATEGY

A very promising way of using videos involves assigning learners the task of producing a video (Cavanagh & Peté 2017; Masats, Dooly & Costa 2009; Schwartz & Hartman 2007; Snelson 2018). The expansion of technology necessitates that TVET lecturers adopt innovative methods to captivate students (Kereluik et al. 2013). Hence, it is essential for TVET Electrical Engineering lecturers to implement a pedagogical shift from teacher-centered approaches to a student-centered paradigm. Technology (here: video technology) serves as a tool to mediate the teaching of discipline-specific content. Engaging in video production not only allows learners to acquire content-area knowledge but also facilitates the development of 21st century skills (Herrera 2022; Hobbs et al. 2013; Norton & Hathaway 2010; Teis & Els 2021). The Framework for 21st learning also suggests that the creation of digital content supports the developmentof communication and media literacy skills in multiple content areas including sciences, technology, engineering and mathematics. Furthermore, research indicates that such tasks not only enhance proficiency in the specified content area but, additionally, student-generated video production has been linked to authentic real-world learning (Kearney & Schuck 2006) and meaningful learning in problem-based coursework (Hakkarainen 2011). Incorporating university students' video production into project-based learning (Hung, Keppell, & Jong 2004) and case-based teaching (Hakkarainen, Saarelainen, & Ruokamo 2007) has been demonstrated to be beneficial for fostering meaningful learning.

In this activity you assign a video project in one of your next lessons.

Part 1 - Research on student-generated video creation

Read text 1, 2 and 3 on student-generated video production as an instructional strategy and alternative assessment method.

Text 1: *Hawley, R & Allen, C (2018). Student-generated video creation for assessment: Can it transform assessment within Higher Education?*

Text 2: *Herrera, L M M (2020). The Use of Videos to Develop and Evaluate Mathematical Skills.*

Text 3: *Norton, P & Hathaway, D (2010). Video production as an instructional strategy: Content Learning and teacher practice.*

Part 2 - Have your students create a video

1. Give your students the task:
   - "Find an example of context XY and show it on video.", or
   - "Carry out experiment Z and document it on video."
2. Ask your students to share their videos with us in one of our next sessions.

There are no restrictions on the style of the video (i.e., your students may use a narrated slide show, a recorded student lecture, a digital whiteboard, animated graphics, a scripted scene, artisans at work, "expert" interviews, or a combination of the above, etc.).

Tips

1. Use the material "Video Planning" document for your students to help them plan and organize their project.
2. Give your students a few weeks to complete this project. Each week students should submit a progress report to ensure they are on track.
3. Explain copyrights and privacy rules to your students.
4. Use a grading rubric to clearly communicate how this type of project will be graded. You can download it right here.

Self-Study

ACTIVITY 13 CREATE INTERACTIVE LEARNING CONTENT IN CHAT FORMAT WITH LEARNING SNACKS

Inspired by the competence area 1 and 2 of DigCompEdu, this activity is to facilitate your digital competence in the area of creating and sharing digital content. More precisely, you create digital learning content in chat format with the application Learning Snacks.

The integration of digital games, quizzes and exercises in the classroom can promote deeper learning and can effectively support learning in their content area (Stieler-Hunt & Jones, 2015; Liu et al., 2014). A study on the use of games (as an alternative to paper-and-pencil tasks) shows that computer games are more effective in promoting learning motivation (Li et al. 2024; Ke 2008). Nuci et al. (2021) show a significant increase in students' engagement and interaction levels in lectures with systematic in-lecture quizzes. Further, the results indicate that the learning curve is steeper (with 73%) when using in-lecture quizzes in contrast to classes where in-lecture quizzes are not used (57.5%).

The use of gamification as a formative assessment tool allows the teacher to obtain initial information concerning individuals' learning processes.

Part 1 - Get to know Learning Snacks

1. Scan the QR code or click the link.
   For the best experience use your smartphone.

WEB APP

Arduino Programming Quiz

Fusion 360 Quiz

2. Carry out the Learning Snack »What is a Learning Snack«.
   Scan the QR code or click the link to open the Snack.

Time required: 0,5 h

Part 2 - Create a Learning Snack

1. Choose a topic within your subject discipline and create a Learning Snack.
   - Use handout 9 »Creating Interactive Learning Content with Learning Snacks«.
2. Add your Learning Snack to TRAINME's Padlet, section »Learning Snacks« to share with colleagues.

Time required: 1 h - 1,5 h

Part 3 - More digital game & quiz makers and assessment tools

Discover more digital game & quiz makers (e.g. Kahoot! and Quizizz), as well as, assessment tools (e.g. Edulastic, Socrative) in the digital course book. Look up in chapter 04 and chapter 09 of the workshop section.

> Did you know?
>
> Also Canva offers a free quiz maker. Open https://www.canva.com/create/quizzes/ or search "Quiz presentation" in Canva to begin. There are many types of quiz questions, including multiple choice, true or false, fill-in-the-blank, match the items, odd one out, and more.

ACTIVITY 14 SCIENTIFIC EXPERIMENTS WITH PHYPHOX PART 1

In reference to the TPACK model, this activity improves your skills in integrating digital technologies into your lesson planning.

You explore the smartphone lab Phyphox and discuss didactic-methodical concepts using this technology in your classroom.

You will be guided through a series of curriculum-specific experiments that you can conduct using the smartphone lab Phyphox.

1. Scan the QR code and install Phyphox on our smartphone.
2. Get into groups.
3. Follow the instruction in Station 1 - 5.

Preparation & implementation: 2 h

BACKGROUND INFORMATION

The experiments meet the demand for digitalisation in the classroom. Different forms of movement are examined with the help of a free smartphone app. It is extremely motivating for the learners to use their own smartphone in class and to use various sensors as a meaningful measuring device. The experiments can be carried out from home as a digital alternative to classroom teaching.

Competencies: Describe and evaluate diagrams; record measured values, visualise and evaluate measured values; plan, set up and conduct.

STATION 1| UNIFORM MOTION

Experiment: Measurement with bar magnets

Set up a bunch of magnets as marker, so you can use this experiment to measure the speed and distance while moving along these magnets.

Preparation & implementation: 0,5 h

Material

- Smartphone
- Phyphox App
- 4 bar magnets
- Toy car or locomotive
- (battery operated)
- Blocks and strips, ruler

Video Instruction

Watch on YouTube

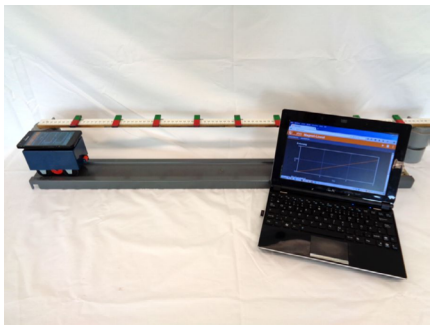
Click or scan to watch

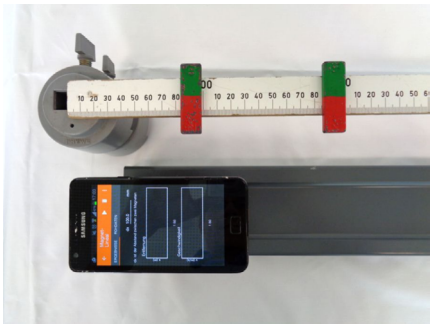
Part 1: Conducting the experiment

1. Watch the video to see important steps for conducting and implementing the experiment.
2. In the app, first select the **Magnetometer** in **Raw Sensors**, then select **Absolute** and start the experiment (▶).
3. Carefully(!) approach a bar magnet to the upper end of the smartphone until the displayed value for the strength of the magnetic field reaches approximately 200 µT. Under no circumstances should the value exceed 1mT. Measure the distance between the magnet and the smartphone.
4. Attach the smartphone to the vehicle.
5. Arrange the bar magnets at an equal, not too small distance on a board (see Images 1 & 2). The poles point consistently in one direction.
6. Select the height of the board so that it matches the height of the smartphone on the vehicle (see Images 1). In the app, select the **Magnetic ruler** in **Tools**.
7. Then use **Timed run** in the **Settings** (click on the three dots next to recycle bin); and specify a start delay and the duration of the experiment.
8. Enter the distance (in mm) between the bar magnets.
9. Start the experiment (▶). The vehicle must drive parallel to the board & the magnets.

Task:

1. Describe and explain the x-t diagram.
2. Describe and explain the v-t diagram.
3. Explain the relationship between the two diagrams.
4. Select the **Raw Data** Icon and explain the y-t diagram.
5. Do you have a steady hand? Try to move the smartphone in a steady manner.
    a) Describe your approach.
    b) Explain how you can use the three diagrams above to prove that you have moved the smartphone steadily.
    c) Now move the smartphone steadily, but at a greater speed.
6. Examine the effect on the three diagrams.





Images 1 & 2: Experimental Set-Up (Source: leifiphysik.de)

Part 2: Integration of the experiment into educational settings

Discuss the integration of this experiment into educational settings:

- What is the didactic concepts behind this experiment?
- In which of the subjects you teach is this experiment useful?

STATION 2| CENTRIPETAL ACCELERATION

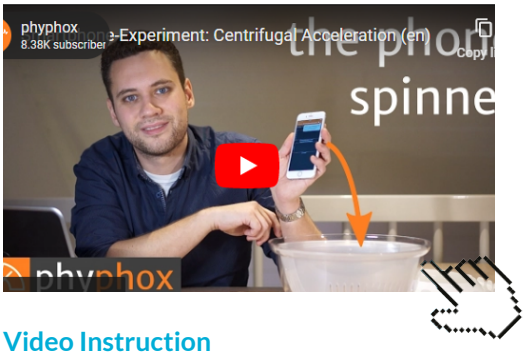
Experiment: Smartphone in the salad spinner

Explore the relation of angular velocity and centrifugal acceleration using the gyroscope and the accelerometer.

Preparation & implementation: 0,5 h

Material

- Smartphone
- Phyphox app
- Salad spinner
- Adhesive tape
- Graphing Calculator



Watch on YouTube

Click or scan to watch

Video Instruction

Part 1: Conducting the experiment

1. Watch the video to see important steps for conducting and implementing the experiment.
2. In the app, first select **Centripetal acceleration** in **Mechanics**. Then select the **Timed run** in the **Settings** (click on the three dots next to recycle bin); and specify a suitable start delay and the duration of the experiment.
3. Place the smartphone standing on the long edge on the outer wall of the salad spinner (see figure). Then start the experiment (▶), place the lid on the salad spinner and rotate the inner part using the button on the top.

Note: Increase the rotation frequency continuously, but very slowly.

Task:

After completing the experiment, you will find two graphical representations on the display under the Ratio Icon: the a-ω diagram and the a-ω diagram. By tapping you can call up one of the two diagrams and enlarge it if necessary.

1. Describe the $a\text{-}\omega^2$ diagram and explain what conclusion you can draw from it about the dependence of the centripetal acceleration a on the angular velocity ω.
2. Describe the $a\text{-}\omega^2$ diagram and investigate whether this supports your conclusion from subtask a).
3. Now place the smartphone closer to the pivot point, fix it and repeat the experiment described above. Compare the $a\text{-}\omega^2$ diagram with the one from subtask 2.) and explain what caused these differences.
4. Repeat the first experiment, call up the $a\text{-}\omega^2$ diagram by tapping on it, click on the More Tools and Balance Line Icon.
5. The corresponding equation is displayed. Interpret the gradient of the straight line with a view to the experimental setup.
6. Finally, summarise the parameters on which the centripetal acceleration a depends and how this dependence can be described by a formula.

Part 2: Integration of the experiment into educational settings

Discuss the integration of this experiment into educational settings:

- What is the didactic concepts behind this experiment?
- In which of the subjects you teach is this experiment useful?

STATION 3| HARMONIC VIBRATIONS

Experiment: Swing

Measure the frequency of a pendulum on a string. You can determine the gravity constant this way.

Preparation & implementation: 0,5 h

Material

- Smartphone
- Phyphox app
- 2 threads
- Paper or bubble envelope
- Graphing Calculator

Video Instruction

Watch on YouTube

Click or scan to watch

Part 1: Conducting the experiment

1. Watch the video to see important steps for conducting and implementing the experiment.
2. Make a sturdy paper bag with a cardboard insert or a suitably sized air cushion bag for the smartphone so that it cannot slide around in the packaging.
   The packaging is suspended from the side by two threads each (see **Instruction for the construction of a swing for smartphones**).
3. Measure the length of the pendulum from the pivot point to the center of gravity.
4. In the app, first select **Pendulum** in **Mechanics**. Then, select **Timed run** in the **Settings** (click on the three dots next to recycle bin); and specify a suitable start delay and the duration of the experiment. Select the AUTOCORRELATION tab. Then start the experiment (▶), place the smartphone in the box and set it into oscillation. After the experiment is finished, the period T or frequency f is displayed, among other things. The displayed graph virtually represents the deflection s as a function of time t.

Task:

1. Explain the mutual relationships between the graph, the period T and the frequency f.
2. Now select the Results Icon so that only the period and frequency are displayed. Repeat the experiment, changing the angle of deflection. Note your observations.
3. Repeat the experiment and change the mass by placing matching objects on the bag with the smartphone. Note your observations.
4. Repeat the experiment, but now the influence of the pendulum length ℓ on the period T is to be investigated quantitatively. Measure the period T for different pendulum lengths ℓ and compile the values in a table.
5. Create a T- ℓ diagram with the GTR, in which the dependence of the period T on the pendulum length ℓ becomes clear. Qualitatively determine a relationship between T and ℓ.
6. The graphs on the right show the deflection s as a function of time t, so to speak. Compare the two underlying pendulum motions qualitatively with each other.

Part 2: Integration of the experiment into educational settings

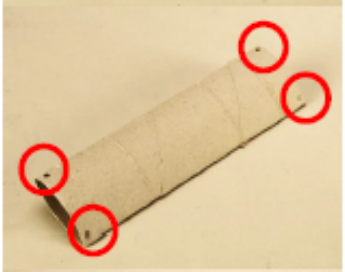
Discuss the integration of this experiment into educational settings:

- What is the didactic concepts behind this experiment?
- In which of the subjects you teach is this experiment useful?

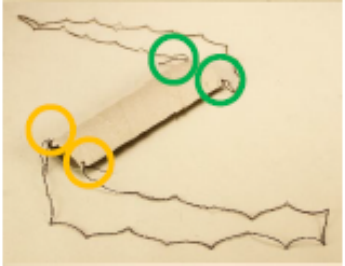
Instruction for the construction of a swing for smartphones

First, flatten the kitchen roll.

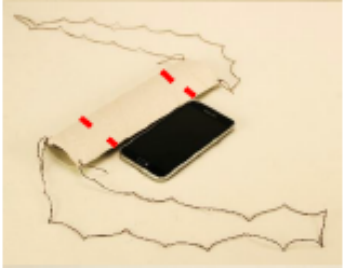
As shown in the sketch, all four corners are perforated with a punch or scissors.



Then, a thread is inserted in both yellow holes and another thread in both green holes



The width of the smartphone is marked as central as possible on the kitchen roll.



Now, the opening for the smartphone is cut into the kitchen roll with scissors. For that, an opening as wide as the smartphone x 2 mm is cut between the markings.

Now, the opening for the smartphone is cut into the kitchen roll with scissors. For that, an opening as wide as the smartphone x 2 mm is cut between the markings.

The finished swing is hung by the threads and the smartphone is inserted into the opening. If the smartphone sits too loosely in the holder, it is necessary to secure it extra with two rubber bands.

STATION 4| ACCELERATION & FREE FALL

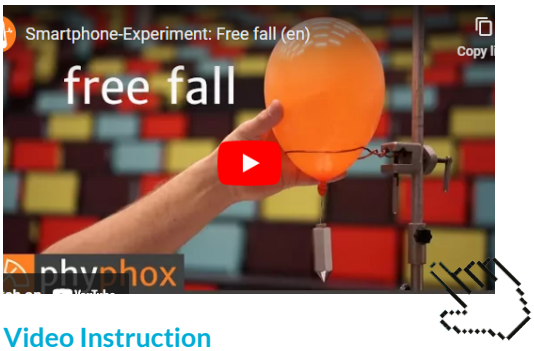
Experiment: Falling Coins

Using the acoustic stopwatch you can determine the duration of a free fall. (Note, that there is an alternative version using magnetic detection.)

Preparation & implementation: 0,5 h

Material

- Marble (if possible made of metal)
- Ruler and pen (both metal if possible)



Video Instruction

Watch on YouTube

Click or scan to watch

Part 1: Conducting the experiment

Watch the video to see important steps for conducting and implementing the experiment.

Recording of the measured values with phyphox

Phyphox's **Acoustic Stopwatch** in **Timers** starts and stops the smartphone's timer when the built-in microphone receives noises that are louder than a previously set threshold. A minimum delay can be specified so that a somewhat longer noise does not stop the timer immediately after it has started. During this time after the start, a second sound will not be interpreted as a stop signal. In the SIMPLE tab you can make these settings and the browsers measured will be able to distinguish between the two sounds. The measurement becomes more accurate the greater the height from which the ball falls. If you place the smartphone halfway down the fall, the influence of the speed of sound is eliminated from the measurement.

Task:

1. Determine the gravitational acceleration
2. Measure the height from which the ball is dropped and with phyphox the drop time, which the ball takes from the moment it starts moving until it hits the ground.
3. Use this data to determine a value for the gravitational acceleration

Part 2: Integration of the experiment into educational settings

Discuss the integration of this experiment into educational settings:

- What is the didactic concepts behind this experiment?
- In which of the subjects you teach is this experiment useful?

STATION 5| SOLAR

Experiment: Measuring power of a solar panel

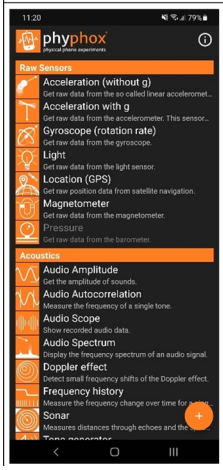
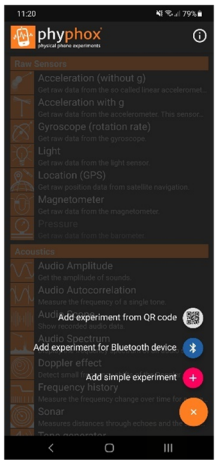
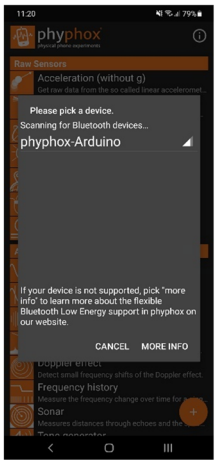
Measuring the power of a solar panel via ESP32 microcontroller using Phyophox.

Preparation & implementation: 0,5 h

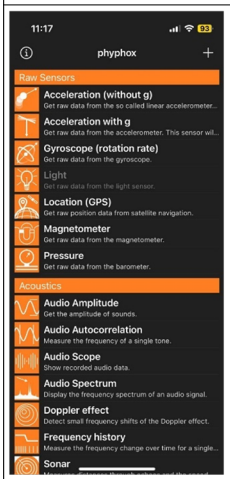
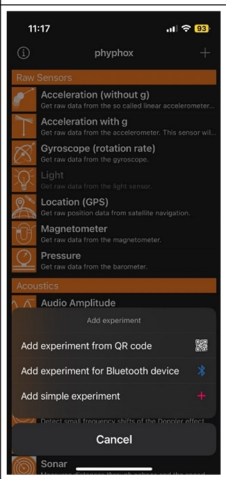
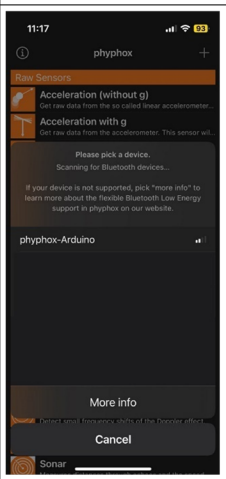
Part 1: Conducting the experiment

Start the phyphox app and connect to the ESP32 Devkit microcontroller (named phyphox-Arduino) via Bluetooth.

With Android

Step 1 Press the add (+) symbol	Step 2 Add experiment for Bluetooth devices	Step 3 Choose the phyphox-Arduino device
		

With iOS

Step 1 Press the add (+) symbol	Step 2 Add experiment for Bluetooth devices	Step 3 Choose the phyphox-Arduino device
		

Background / Theory:

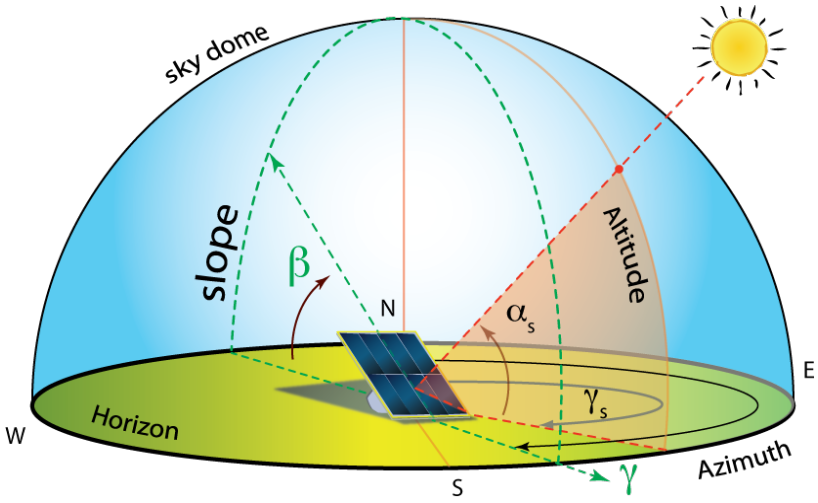


Figure 4 Sun's position (Credit: Jeffrey R. S. Brownson © Penn State University is licensed under CC BY-NC-SA 4.0)

Task 1: Find the optimum azimuth angle

1. Set the altitude angle to 45°.
2. Measure the maximum output voltage of the solar panel at the following azimuth angles.

Azimuth Angle	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°
Output Voltage												

Task 2: Find the optimum altitude angle

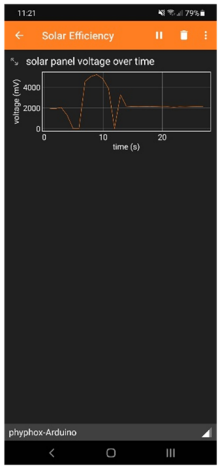
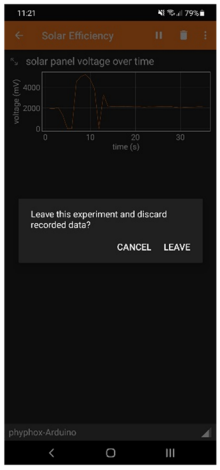
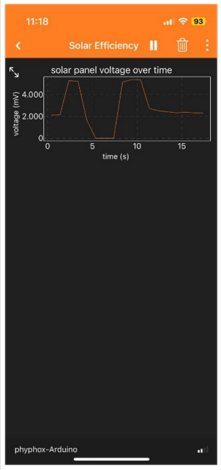
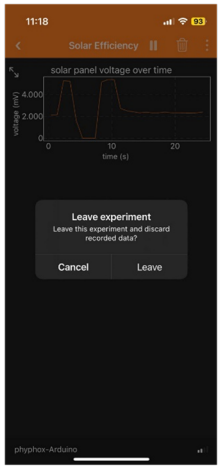
1. Set the Azimuth angle according to the best position previously (Tast 2) determined.
2. Measure the maximum output voltage of the solar panel at the following altitude angles.

Altitude Angle	90°	80°	70°	60°	70°	60°	50°	40°	30°	10°	0°
Output Voltage											

Task 3: Evaluate different weather conditions

1. Set up the solar panel according to the previously determined values of the best azimuth and altitude angle.
2. What is the maximum power output of the solar panel at sunshine? The load resistance on the solar panel has a value of 1 kΩ.
   $P_{maxSunshine}$=_____
3. What is the maximum power output of the solar panel under cloudy conditions? For simulation, hold the artificial cloud in front of the panel.
   $P_{maxCloudy}$=_____
4. What is the maximum power output of the solar panel when it is illuminated with artificial light? Bring the experimental setup indoors for this purpose.
   $P_{maxArtificialLight}$=_____

Task 4: Please log out of the microcontroller in the phyphox app so that the next group can log in again.

With Android		With iOS	
Step 1 Go to the back arrow	Step 2 Leave the experiment	Step 1 Go to the back arrow	Step 2 Leave the experiment
			

Part 2: Integration of the experiment into educational settings

Discuss the integration of this experiment into educational settings:

- What is the didactic concepts behind this experiment?
- In which of the subjects you teach is this experiment useful?

ACTIVITY 15 SCIENTIFIC EXPERIMENTS WITH PHYPHOX PART 2

Inspired by the competence area 1 and 2 of DigCompEdu, this activity is to facilitate your digital competence in the area of creating and sharing digital content. In reference to the TPACK model, this activity improves your skills in integrating digital technologies into your lesson planning.

You design and conduct an experiment with your smartphone using the app phyphox. You also develop a lesson plan for implementing the experimental learning unit.

1. Design an experiment of your choice using the phyphox app. The only restriction: it should not be an exact copy of an experiment on phyphox.org.
2. Document your approach, observations and results for the oral discussion.
3. Make a video showing your experiment in action and presenting the way of function as well as explaining the underlying physical / technical concept. All participants of the group need to appear in the video (5 - 10 min).
4. Develop a lesson plan for implementing your experiment as part of a learning unit (see **Example Lesson Plan for harmonic vibration**).
5. Add your video and lesson plan to the section »Scientific Experiments with PHYPHOX« on TRAINME's Padlet to share with colleagues.

Preparation & implementation: 2 h

Lesson Plan for Harmonic Vibrations

Phase / (Time) / Method	Description / Content	Material / Media
Opening (5 min)	Presenting the topic for the lesson, showing the youtube video as an impulse. The SuS should investigate throughout the lesson if the commercial is realistic. Meaning, if the thread length needed is realistic. The students discuss about the possible dependency factors of the periodic duration.	https://www.youtube.com/watch?v=ZOHbzYg7FWE
Introduction / (5 min) alternatively, if the app is still unknown	The experiment will be presented to the students in relation to the app "Phyphox" (this can be downloaded for free in the app store), and the functions explained. Especially the function "thread pendulum". The video for the tutorial of the exercise sheet can be contemplated through the beamer in the plenum or later in groups.	Smartphone, "phyphox" app ("thread pendulum")
Experiment / (5 min) / group work	The students carry out the experiment, document the measure results and orientate on the exercise sheet.	Smartphone with "phyphox", tripod, long thread, scissors, exercise sheet
Evaluation / (20 min) / plenum	Students evaluate the data	The measurement data can also be introduced in Excel and the function equation determined with a plotter.
Closing (10 min)	securing the results and a formula for the periodic duration (at the end or as homework) calculate the thread length of the Yogurette commercial with the won formula and assess the results.	

Objectives of the lesson:

The students

- plan the experiment, and think about what sizes the periodic duration might depend on.
- prepare the experiment in small groups and carry it out.
- optimise the experiment by adapting it to external conditions.
- determine the periodic duration of the thread pendulum.
- practice dealing with smartphone sensors and the app Phyphox.
- practice the evaluation of the experientially won data with the help of mathematical means.

ACTIVITY 16 VIDEO ANALYSIS AND MODELING FOR EXPERIMENTS

Self-Study

In reference to the TPACK model, this activity improves your skills in integrating digital content into your lesson planning.

You prepare an experiment of an physical and/or technical event. You record a video of this experiment and analyse it using the VidAnalysis app on your smartphone. Then you import the video into Tracker, a video analysis and modeling tool, that can make a physical analysis of the selected phenomenon.

Part 1 - VidAnalysis (only for Android)

1. Scan the code with your smartphone and install VidAnalysis, or download it right here.
2. Now choose an experiment and take a video of this event. Watch this sample video.
3. Open the app and load the video for analysis. Use the How-to guide. You can open it right here.

Preparation & implementation: 2 h

Examples for the experiment

- An inclined throw of a basketball
- A horizontal throw of a basketball
- A free fall and vertical throw of a ball
- Acceleration of a cyclist on a horizontal surface (using different gears)
- Downhill free acceleration of a cyclist (or any other vehicle)
- Harmonic and damped oscillations of a spring
- Circulation of the tip of the second hand of a watch
- Circulation of a car on a roundabout
- Elastic and inelastic collisions on the air slide

Part 2 - Tracker

1. Download the free video analysis and modeling tool Tracker on your computer or USB stick. You can download it right here.
2. Watch the video tutorials that can help extend your knowledge of Tracker.
3. Now choose an experiment and take a video of this event. Watch this sample video. You can also use the video from Part 1 of this activity.
4. Start to analyse and model the event. Use the How-to guide. You can open it right here.

Preparation & implementation: 2 h

ACTIVITY 17 EXPLORE VIRTUAL AND AUGMENTED REALITY

In reference to the TPACK model, this activity improves your skills in integrating digital content into your lesson planning.

You explore different Virtual Reality and Augmented Reality applications and scenarios. You also discuss didactic-methodical concepts using these technologies in your classroom.

Part 1 - Virtual and Augmented Reality tour

You will be guided through a series of Virtual and Augmented Reality content to learn more about different applications and use cases of this technologies in educational settings.

1. Get into groups.
2. Follow the instruction in Station 1 - 3.

Preparation & implementation: 2 h

Part 2 (optional) - Further reading

Read the following papers on virtual and augmented reality in education.

Text 1: *Lin, Y. P., & Yu, Z. G. (2023a). A meta-analysis of the effects of augmented reality technologies in interactive.*

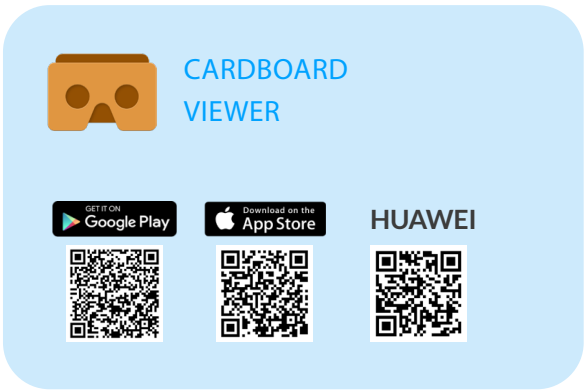
STATION 1| VIRTUAL REALITY / 360 DEGREE VIDEO

Part 1: Cardboard assembly

Take one of the cardboards and follow the step-by-step instructions on how to assemble the cardboard.

Part 2: Install a cardboard viewer

Scan the QR code and install a cardboard viewer on your smartphone.



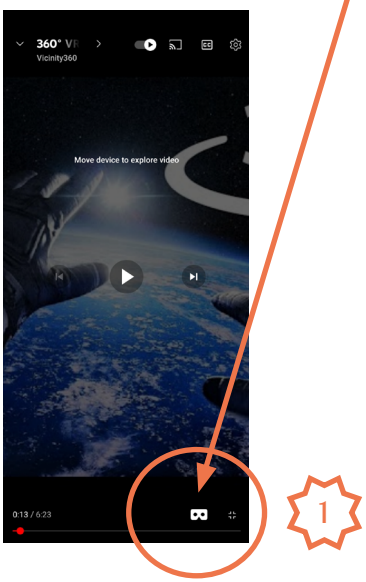
Requirements / Material

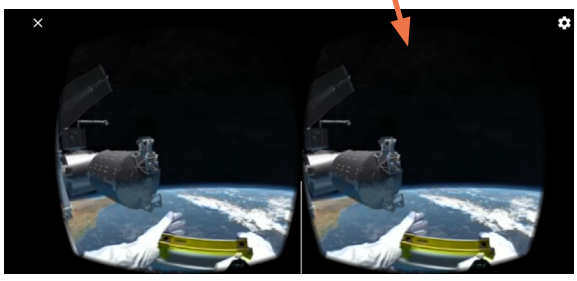
- Smartphone
- YouTube Mobile App
- Cardboard

Part 3: Experience Virtual Reality

1. Scan the QR code below with your smartphone.

- To start playback, tap the play button.
- Tap the Cardboard icon (1).
  The screen split will split into two smaller screens (2).
- Insert your phone into Cardboard.
- Look around to view the video in VR180 or 360 degrees.





2. Now scan the QR codes below with your smartphone.

SAFETY IN BOX / MANUFACTURING

FALL PROTECTION

Collection of educational VR content to view with a cardboard

TRAINME YOUTUBE CHANNEL

TIP
When you search for 360° Videos on Youtube look for this icon to find the right content.

Part 4: Integration of Virtual Reality into educational settings

1. What was your experience with the technology?
2. How can you use Virtual Reality content in your classroom? Which activities would you use? Which skills / abilities would the technology and activties support?
3. We will discuss key points in a wrap-up.

STATION 2| AUGMENTED REALITY (PART 1)

Part 1: ZappAR & AR Physics

1. Scan the QR code and install ZappAr on your smartphone.

ZAPPAR APP

GET IT ON Google Play

Download on the App Store

2. Scan the QR code below with your smartphone.

MAGNETIC FIELDS

Draw a path in 3D space and magnetic field lines from a current travelling along that path will be shown. The right hand rule for finding direction of the field is also presented.

ABOUT AR PHYSICS

AR Physics is a collection of augmented reality physics demonstrations that use the free Zappar app on a mobile phone. You can download QR codes to various AR demonstrations on https://www.sjsu.edu/faculty/beyersdorf/ARPhysics/

AR Physics from SAN JOSÉ STATE UNIVERSITY

Part 2: CG-physics

1. Scan the QR code and install cg-physics on your smartphone.

CG

https://apkpure.com/cg-physics-ar/com.cg_physics.cg_physicsAR

HOW-TO TO INSTALL .APKS

Here is a simple how-to guide to install .apks straight from apps or web browsers.

https://www.wikihow.com/Install-APK-Files-on-Android

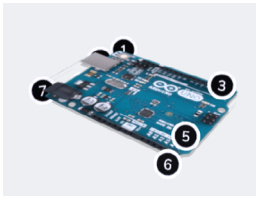
2. Point the camera of your phone at the sheets 1 - 4, three-dimensional figures should appear.

You can download the sheets from https://www.cg-physics.org/index.php/en/ar-e and use as markers on work sheets.

STATION 3| AUGMENTED REALITY (PART 2)

Part 1: Arduino

1. Scan the QR code with your smartphone.
2. Now place your smartphone in your room. Click **Play** and allow access to your device‘s camera and motion sensors.



Part 2: Internal Wiring

1. Scan the QR code next to the dual wall socket outlet with your smartphone.
2. Now point the camera of your phone at the socket outlet.
   The socket outlet is an object marker to trigger the AR content.

Part 3: Delta robot

1. Scan the QR code next to the delta robot (see figure 5). The figures are extracted from the NC(V) student book Robotics Fundamentals L2.
2. Now point the camera of your phone on the image of the delta robot and scan the image. The image of the delta robot is an image marker to trigger the AR content.

Figure 5 Delta robot (Adapted from Benefeld et al., 2023: 27)

Part 4: Integration of Augmented Reality into educational settings

1. What was your experience with the different applications and scenarios?
2. How can you use Augmented Reality content in your classroom? Which activities would you use? Which skills / abilities would the technology and activties support?
3. We will discuss key points in a wrap-up.

AR ANNOTATIONS

Some of our Augmented Reality examples use annotations. An annotation is an object that floats in the AR environment or somewhere near an AR object. The annotation is an interaction technique (see annotation and interactive videos, Activity 9) labeling and highlighting key features within an Augmented Reality environment. The information may be simple text, image, video or audio.

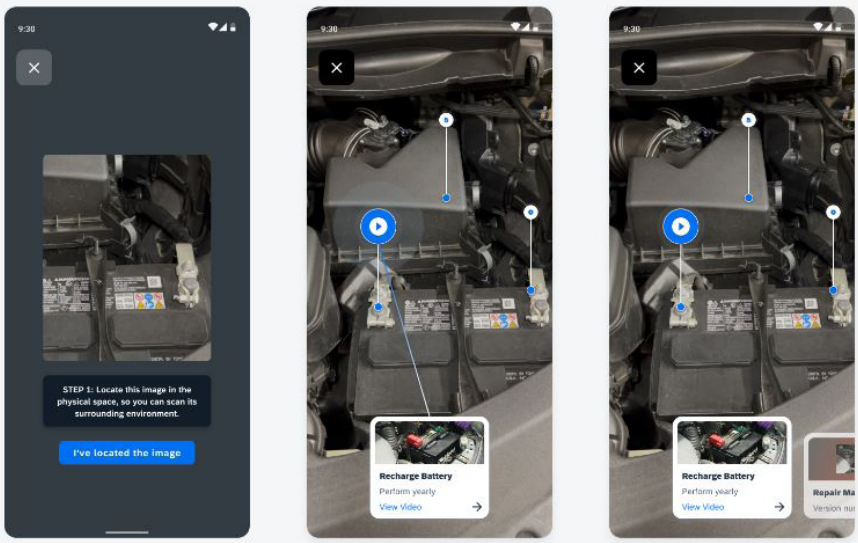


Figure 6 Examples of a scan screen (left) and markers (middle & right) (Source: experiences.sap/fiori-design-android/ar-annotations/)

ACTIVITY 18 360° VIDEO PRODUCTION

Inspired by the competence area 1 and 2 of DigCompEdu, this activity is to facilitate your digital competence in the area of creating and sharing digital content. More precisely, you create a 360° video on a curriculum topic.

As a teaching and learning medium, 360° videos provide innovative educational experiences. By enabling immersion, offering individual 360° panoramic views, multi-perspective viewing options, and interactive features, they enhance the benefits of traditional video technology.

1. Create a 360° video on a topic within your subject discipline.
2. Use Insta360 Studio to edit your video and to export the video into .mp4 (Encoding Format: H.264).
3. What video did you create? Upload your video to TRAINME's YouTube Channel in order to view it with a cardboard (invitation to upload your video will be sent by email).

Insta360

Click to download

Time required: 2 - 3 h

Preparation & required elements for the video

- Form your group (maximum of 4 people).
- Brainstorm a topic / concept that you want to explain in the video.
- Your video should be 3–5 minutes in length, plus time for a "credit roll" to show your references.
- Determine the expected outcome for your video.
- Take into account the age group of the students and the teaching objectives.
- Consider the criteria of an effective educational video (see: Activity 7).

Some ideas

You can plan a fire alarm scenario in a workshop, i. e. create a video that shows escape and rescue plans and explain the correct behavior in case of fire.

ACTIVITY 19 AUGMENTED REALITY CONTENT CREATION

Inspired by the competence area 1 and 2 of DigCompEdu, this activity is to facilitate your digital competence in the area of creating and sharing digital content.

You design Augmented Reality content that will transform your teaching material into interactive multimedia libraries.

For the Mechanical Engineers

You create an epicyclic gear that you can use to transform existing curriculum-aligned material (e. g. Mechanotechnics N5, figure 7) into interactive multimedia libraries.

1. Download the 3D model file from TRAINME 2 Moodle course, section 3D Models.
2. Create an animation of the gear using Fusion 360. Export the data to a glb file.
3. Now create the Augmented Reality of the animated 3D model with Assemblr Studio. Use AR annotations to highlight key features of the 3D object.
   You can use handout 11 »Creating AR Content with Assemblr Studio«.

Time required: 1 - 2 h

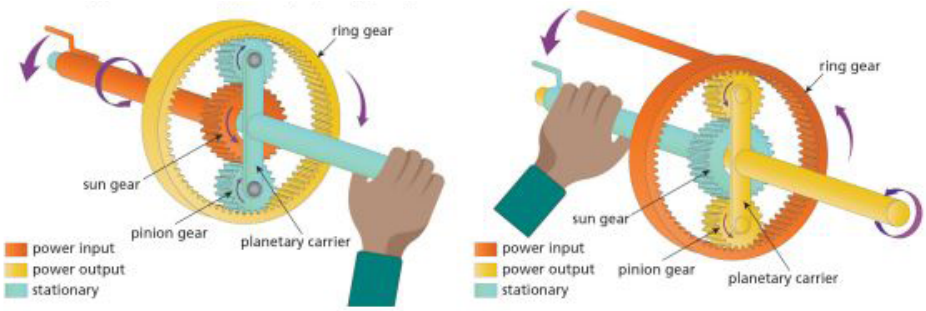


Figure 7 A typical epicyclic gear system (Extracted from Fihla & Tangirai, 2023: 5)

For the Electrical Engineers

You create an Augmented Reality contactor that you can use to transform existing curriculum-aligned material (e. g. Electrical Trade Theory N2, figure 8) into interactive multimedia libraries.

1. Download the 3D model contactor from TRAINME 2 Moodle course, section 3D Models.
2. Now create the Augmented Reality of the 3D model with Assemblr Studio. Use AR annotations to highlight key features of the 3D object.
   You can use handout 11 »Creating AR Content with Assemblr«.

Time required: 1 - 2 h

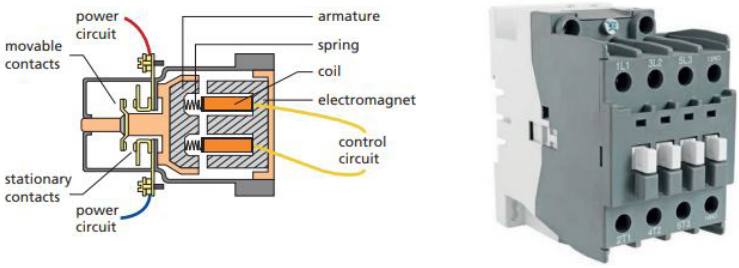
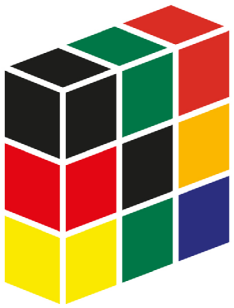


Figure 8 Construction of a contactor and example of a contactor (Extracted from Fritz et al, 2020: 65)



TRAINME 2

Modular training and further education of South African TVET-lecturers in mechanical and electrical engineering

This course book has been developed within the bilateral programme TRAINME 2 in order to promote in-service lecturers' Technological Pedagogical Content Knowledge (TPACK). The programme has been designed by the Inter-Company Training Center in Easter Bavaria (ÜBZO) and University of Stuttgart, Department of Vocational Education focused on Teaching Technology (BPT) on behalf of the German Federal Ministry of Education and Research and DLR in cooperation with the South African Department of Higher Education (DHET).