Developing Sustainable Open Educational Resources for Teaching Computer Ethics and Digital Skills

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Abstract— **This research-to-practice full paper proposes a structured approach to cooperatively develop, review, and employ open educational resources (OER) for pre-service teachers focusing on computer ethics and digital competences. The rapidly progressing digital and social transformation requires students as well as teachers and staff to adapt their teaching and learning. While this holds true for the vast majority of educational contexts, (pre-service) teachers are particularly challenged into acquiring digital skills and almost at the same time passing on the respective knowledge and digital skills to their students. Understandably, pre-service teachers long for reliable, easily accessible resources that they could use in class to effectively support them in preparing their students for their future jobs and lives.**

The current paper presents the authors' student-centered approach to developing OER on computer ethics with emphasis on including students in all phases of the development and testing of the OER, sparking students to measurably advance their digital competences. To provide accessible, high-quality resources, the focus will be on presenting the student-centered quality assurance approach we introduced while testing the OER in class and improving them based on secondary-level students' feedback.

Methodologically, this paper employs the cyclic participatory research approach, which involves analyzing students' reflections and feedback, the researcher's personal observations throughout the process, the feedback of secondary-level students during the pilot testing in the classroom, as well as the perceptions of the master students implementing the OER in a lesson in class.

As a result, this study presents a set of OER developed in a student-centered manner, specifically designed to meet the needs of pre-service and early career teachers. Furthermore, the paper suggests and reflects a genuinely student-centered process of developing, evaluating, and improving OER. It aims to inspire educators, staff, educational researchers, course designers, administrators, (pre-service) teachers and interested tertiary-level students to constructively and collaboratively engage in a learner-centered development of OER and thereby support our society's learning and democratic living with the digital transformation.

Keywords—Student centered teaching, Cyclic Participatory Action Research, Open Educational Resources, Digital Competences, Computer Ethics

I. INTRODUCTION

In the rapidly evolving digital landscape of the 21st century, the pace of technological innovation is unprecedented. This causes various problems in teaching digital competences. As part of our previous research [1], a schoolbook author explained that the process of conceptualizing and eventually publishing such books takes about five years. At the current rate of technological evolution and its impact on society - think of the rise of the Internet, chat programs, social media, Web 2.0, smartphones and their proliferation among teenagers, and more recently generative AI - this procedure may be outdated. Therefore, we need constantly updated online resources, but since teachers cannot cope with the additional workload, a way to design the resources together with our teacher education students was explored.

This unstoppable progress – while exciting – presents a huge challenge for educators who are tasked with preparing students for a future where the next revolutions are hard to predict, while we are probably already unknowingly witnessing the next one. In the authors' view, as educators, we are responsible for teaching how the world is today, but also equipping students with the skills and knowledge they need to navigate the world of tomorrow.

This is where our approach of developing open educational resources (OER) with a focus on computer ethics and teaching digital skills comes into play. The need to cover a wide range of topics, such as industry 4.0, influence of social media on us, autonomous vehicles, "Fear of missing out", addiction, calls for providing teachers with high-quality and up-to-date material. This would enable them to utilize it in

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different settings, such as supplemental teaching, social subjects, and computer science. We aim to motivate and empower teachers to address current and ongoing challenges, even if these topics are outside their primary field of expertise.

However, one of the challenges in creating OER is the rapid rate of digital progression. The creation of these resources is not a one-time event but a continuing effort of refining and updating them in an iterative approach to ensure their relevance and effectiveness. Our goal is to provide well-polished, interactive, and thoroughly tested educational materials for primary and secondary level teaching in order to bridge the gap between what is happening in students' lives and what teachers were taught at university. We chose to focus on topics of computer ethics because we also wanted to impart or strengthen reflective and critical thinking in our students' minds. To create the necessary learning environment and ensure that our resources are not only informative, but also engaging, we employ a student-centered approach and tightly involve students in the OER creation process.

Research goal: Our foremost mission is to support teachers in their crucial role as educators for the future. By providing them with high-quality, up-to-date OER, we aim to make their work easier and more effective, ultimately benefiting students and society as a whole.

Target Audience: This research is intended to be of interest to educators, researchers, and teacher trainers on a university level who would like to study and/or implement a similar process in their own institution. Moreover, (pre-service) teachers in schools who want to work with children on different topics of computer ethics in a dynamic, interactive way but do not have the time to actively prepare necessary teaching materials would benefit from the OER presented.

II. Background and Pedagogical Approach

The term "digital competencies" is currently of great interest, yet there is considerable confusion about its precise meaning. Introduced in our university-wide survey, our team agreed on the following definition for our publications including this study:

'By digital competencies, we mean all the skills and abilities necessary in the digital era to participate responsibly in social and professional life, such as the informed acquisition of information and the responsible use of digital media, tools, and platforms.'

For categorizing these competencies, international frameworks were developed. They aim at defining required skills and competencies for a constructive digital learning and teaching environment: for instance, the ICT Competency Framework for Teachers" by UNESCO [2] and "The Digital Competencies Framework". For this paper we use the "DigComp 2.2" [3] by the EU Commission as our reference.

The Covid pandemic has demonstrated that educators lack the confidence to develop a number of key competencies. This was revealed to our researcher during his school visit, where he acted as an informatics teacher, mentor and colleague support. This lack of confidence was not exclusive to older educators, but also extended to younger educators, who were part of the so-called "digital natives" generation and had recently graduated from university. Given the evidence provided by several pre-studies and master's theses [4], the decision was made to investigate the University of Vienna's teacher training program with a view to enhancing its focus on digital competencies.

In 2022, an investigation into the perceived digital competencies amongst our advanced pre-teacher students revealed, amongst others, a lack of training regarding the ethical implications of technology. Most of the participants claimed a lot of the gained digital skills are self-taught, and not experienced through direct teaching. [5]

In search of best teaching practices, this study was followed up by two focus groups with students and lecturers in which we further discussed possible actions. The first author also led a series of interviews with researchers and lecturers from those subjects that our students had indicated as good examples of imparting digital skills [1]. One of our interview partners, who was also an author of schoolbooks, explained the process of writing such educational books by showing us his current project. He pointed out that the process from the start of the book until it is finally available for schools to buy usually takes five years, which is an inacceptable time period, especially for new subjects and topics. Considering the rapidly evolving technological advancements that influence our society, we need to find faster ways to provide teaching materials as well as to keep them up to date [6].

With these findings in mind, the first author designed a pilot course in which he addressed several of the mentioned points of criticism in an engaging, student-centered way. In short: students should gain digital competences, get teaching practice, try new tools, engage in a peer review process and create teaching materials with the new knowledge in mind not only for their own benefit but for everyone using the materials. He also motivated his students to try out new tools. Instead of showing the students a list of new and useful tools - supported by a study from Røkenes et al [7] - he decided to limit the number of new tools introduced to the students and focus on actively using the remaining ones from a teachers' and a learners' perspective.

In accordance with the cone of learning [8], it was a mandatory task for students not only to create materials with the new tools in mind and foster digital competences, but also to teach the lesson using these materials, followed by a discussion and peer review on the teaching experience and materials and the eventual redesign towards becoming OER.

Because a new course could address some of the students' concerns, we intended to process or findings in an efficient and scalable way, in case we were given the chance to offer the course multiple times in parallel. One of the most time-consuming tasks was checking the quality of the OER. Therefore, we investigated OER quality assurance (QA) techniques:

Related Work on QA: It was brought to our attention that young teachers often get frustrated when trying to find new materials and create their own lesson plans on recent events - either because their search was not successful, or because the quality of the found materials didn't live up to their expectations.

Several studies addressed the development of OER. In the German „Gold Standard for OER" [9], 16 authors gathered their knowledge and experience to create a compelling script which deals with the details of different medias and resources and outlines the desired standard for each of the created resources.

The Open Education Austria initiative published a "Guide for the creation of Open Educational Resources" [10] in which the authors not only provide hints for the design and creation process of the resources themselves, but also give a brief overview about the existing copyright-licenses.

Already facing a similar challenge, Zawacki-Richter and Mayrberger [11] wrote a study about QA of OER. Discussing the general meaning of "quality" in teaching materials and especially OER, they compared eight different international models of QA of OER and defined quality criteria for OER: they describe technical (usability, accessibility, re-usability), pedagogical didactical (content, learning design, assessment), and the license characteristics of the resource as a criteria, eventually calling out for a German standard of QA.

Based on the study mentioned earlier, a quality self-check was created and is available as a pdf document and a more interactive website [12]. This tool has not been introduced in the pilot course.

We critically compared the eight different mentioned QA models like "MERLOT Rubric", a huge database where quality is assured through a peer review process organized in more than 20 editorial boards, giving certain aspects of the OER star-ratings. Most other OER QA frameworks also focus on rating specific characteristics of the provided OER and these ratings were mostly done after the creation of the materials by experienced experts. But we wanted a QA process that happens in collaboration with the creators and also during the development of the materials, not just afterwards.

Collective QA Process: Eventually we created our own QA process and went for the before-mentioned student-centered approach when creating the OER featuring a peer reviewing process in the first trial, and a real-world test in the second trial. The incentive was not only the possibility of immediate action during the process, but also efficiency: instead of cross-checking the materials with all the how-tos, guidebooks and checklists on OER, we included and utilized the collective intelligence of our 25 students per course and later 28 pupils (the term we use to refer to secondary-level students) as "crowd" reviewers in addition to the researcher and teacher who worked on optimizing the materials. Because of our inclusive and student-centered approach, our students were intrinsically motivated in every step of the way, especially to share their work with others which is why the researcher mostly overviewed and guided the QA. For instance, the researcher and lecturer did not correct PowerPoint slides beforehand as this optimizing process would happen after the test-evaluations.

III. Research Approach and Methods

A. Research questions

The central focus of this research can be summed up as follows:

RQ1: In how far is a student-centered approach applicable to create OER?

RQ2: What are the advantages and risks of a student-centered approach to developing OER in the area of (computer-) ethics and digital competences?

RQ3: Which insights regarding the improvement of the quality of OER did the testing process in a real classroom setting produce?

We aimed to reach at least four goals at once with the creation of OER: a) having better teaching material for teachers and therefore reduce workload b) making the topics as interesting and enriched with digital competences as possible – we overall aimed to improve the experience for teachers and pupils alike- and c) improving the teaching and digital competences in our next generation of d) teachers as well as improving their confidence in trying out new topics and tools or creating new materials.

B. Participatory Action Research

In order to foster continuous improvement and learning of our OER, we welcomed the integrated approach of Participatory Action Research (PAR) [13] which combines research and practical action taking.

Following Susman and Evered's [14] recommendation, we adapted the process that typically consists of five cyclic phases: 1) diagnosing, 2) action planning, 3) action taking, 4) evaluating, and 5) specifying learning. In one full PAR cycle we integrated a variety of research methods implemented in the action taking phases, meaning during the creating of the materials as well as the testing in the university course and classroom.

C. "Methods Used within the Participatry Action Research Framework"

Data collection from notes and Reflection-sheets. During the first trial run, students held their lesson based on the materials they created for the chosen topic and the other students and the lecturer/researcher gave feedback. While the feedback format was always open at first, mainly investigating how the students would improve the lesson and the materials, basically to "round up the edges", the discussion was later pointed towards optimizing the materials for different audiences - for instance, with questions like "How can the materials (worksheets) be optimized so they work with younger pupils (age 10-13) as well?", "How would a performance assessment look like in this scenario?", or "Does the reflective component of the lesson go far/deep enough?" After the feedback and discussion, students were asked to provide written feedback in Reflection-sheets [15] about the lesson over the next week which usually contained a more in-depth look at those lessons, as students took time to reflect on them.

Data Analysis from Reflection-sheets: The feedback was then anonymized and sent to the students who created the materials to rework the teaching materials and the lesson planning. The students were also provided with a checklist for the content of the OER.

Data Collection from Pre/Post-Survey: The second part of "action taking" took place in an actual school where one pre-service teacher held their practice lessons with four selected OER packages, each of them in three different teaching groups (9-12 participants). Before and after each lesson, the pupils were asked to participate in a questionnaire consisting of open and closed questions, provided in a Microsoft Forms sheet. In addition to the questionnaire, the researcher and the teacher trainee took notes regarding the process and necessary changes of the materials if this lesson was held again: The questions focused on interest, knowledge about and personal opinion towards the specific topic. For example: (on a scale from 1-10) "How strong is your interest in autonomous driving?", "How would you estimate your current knowledge on autonomous driving?" and "What is

your opinion on autonomous driving?" This was followed by the open questions on the topics or the tools used for that specific topic and lesson.

The authors are happy to provide the full questionnaires upon request.

Data analysis from survey: We examined the potential increase in interest, perception of knowledge and potential change in opinion towards the topic. In addition, we analyzed the reasons for the change. In terms of the digital tools used, we investigated the pupils' tendency to reuse them in the future. We were eager to test the OER in school. Knowing that the pupils are the final audience for the resources, we hoped for a large amount of feedback, but we were also aware of the challenges because sometimes children are having troubles in expressing their opinions and thoughts. That is why in addition to the open discussion and feedback round, we created the anonymous pre- and post-surveys for each lesson, consisting of open and closed questions. Due to the small sample size we used descriptive analytics for the closed questions and searched for keywords in the open questions.

Observations: The teacher trainee who led the lessons took notes on their observations: during the selection process of the OER, during the lesson while the students worked independently, and after the lesson concerning their engagement.

OER Evaluation: For the evaluation of the materials, we decided to address usability from the pupils' perspective, accessibility as well as reusability from the teacher's perspective.

- Usability refers to the intuitive handling and design of the materials.
- Accessibility ensures the availability and usability of materials and utilized tools, regardless of any technical or individual restraints.
- The reusability of OER depends on the preparation time required for using them in the classroom as well as their usability from the teacher's perspective.

IV. Experiences and findings in light of the five phases of the Participatory action research cycle –

A. Diagnosing

Teachers who want to plan their lessons around current events or developments are often faced with the problem of reinventing the wheel as they have to create the teaching materials from scratch.

Previously, we investigated the level of integration of digital competences in our teacher education degree program and one of the results revealed that 49% of the respondents did not feel well prepared by their curriculum when it comes to fostering their future pupils' digital skills. The results called for action and during the subsequent focus group, students expressed their desire for more and better openly available resources such as videos for their studies or full lesson plans for teaching.

In brief, our findings showed that the best solution to support our students momentarily and also in the long run is to create high quality OER that are easy to use, available online and are possibly updated and reevaluated on a continuous basis.

B. Action Planning

When we designed our pilot lecture we had three main goals:

- Educate the students about the subject of Computer ethics, especially those topics that will be of interest to their students in school
- Create the first cycle of a loop that leads to better, modern teaching materials on that topic to decrease the workload of future teachers and at the same time increase their digital competences as well as their pupils'
- Reach a maximum of intrinsic motivation by designing the lecture with a student-centered approach in mind

The course consisted of 13 lessons in which the initial three gave input on lesson planning, and showed how students can benefit from different digital tools and apps for planning, preparing and teaching lessons. In coordination with the lecturer, the students tried out the tools in different settings and collected best practice examples. The students were also introduced to the wide range of topics within the subject of computer ethics, of which they chose one that will likely be of interest for or have an impact on their future clients - the pupils in school. They were then asked to find a teammate and create teaching material and prepare for a lesson of 50 minutes with the created materials. The second practical part of the course consisted of the teacher teams actually holding their lessons and afterwards being peer-reviewed on their materials and teaching. So far, this sounds like a typical seminar at our university. However:

One major critique on the previously mentioned cone of learning [8] is that being active by itself does not necessarily have beneficial effects on the learning process. Another key component is the actual engagement by the learner [16].

C. Action Taking

Adapting the student-centered teaching approach: In its first step, students of the researcher's lecture, focusing on Computer Ethics, designed teaching materials with the focus on using digital competences in the process of creating the resources, as well as using them when the lesson is held. We call them OER packages because they are connected resources – so, more than worksheets or quizzes – for certain topics. The goal here was to have complete lesson designs and their required resources. It's an idea based on a lot of teachers' frustrations: since there are no suitable materials available for certain topics, teachers and lecturers must continuously "re-invent the wheel" if they want to create new material. Our goal is to reduce that workload by eventually publishing those OER packages for everyone interested in the topics.

In the lecture, it was one of the main priorities to create an atmosphere that was later described by students as a "safe space". The lecturer tried to create this atmosphere by telling the students that he sees them on the same "level" as himself - as colleagues (since he is also a teacher), all being in the same boat. One concrete measure was the plea of the lecturer to call him by his first name and use the more informal "du" instead of the more polite "Sie" when interacting with him. This was a welcome change for most students and they happily

accepted the new terms. In addition, he tried to remove the pressure of grading by guaranteeing success in his lecture if the students manage to create useful resources. The ability to choose a topic within the wide range of the subject of computer ethics, rather than being assigned one made the process of becoming "experts" in their field much easier and interesting.

The warm, often lighthearted atmosphere was important for the lecturer, especially for the open discussions and peer review sessions following the presentations. Also, during the lecture he often put the task ahead of creating the OER for their final submission as a collective goal, where everyone wins. This was done by putting the emphasis on later benefit in their teaching career: if they all create high quality, easily usable OER and share them, it will save a lot of time later on. The students expressed their gratitude and felt they did not just work on a task they have to do in order to "earn a grade", but to them it immediately felt meaningful, unlike many tasks that are mandatory but sometimes feel pointless.

Prototype Testing: This "Prototype" of a lesson and its materials/tools were then held in the lecture and consecutively feedbacked by the lecturer and the participating students who took the role of pupils. The focus of the feedback was on: What digital skills/competences did we learn in that lesson? How can we improve the materials (especially with regards to it being also taught to a younger audience (age 10-13))? Are the tools and methods used useful/beneficial compared to traditional methods or are they ineffective?

OER Package Version 1.0: The students were then given time to rework their materials and eventually create the whole "package" and upload it to the Moodle platform of the course, including everything needed to teach this topic for a whole lesson in class – a lessons schedule, slides, worksheets, quizzes, and the tutorials for the used tools to ensure full accessibility. The students were motivated to provide well rounded materials in order to share these materials with others and get well optimized materials in return. This approach of motivating the students intrinsically proved to be very successful. However, since the students lacked the experience of actually working in a classroom, some of the resources provided were already almost perfect for using them in school right away, whilst others were a bit "rough around the edges". For clarity, we call the resulting OER Packages "Version 1.0" After one semester of the course, 10 "Resource Packages" on different topics were generated and ready to be tested in the "real world".

Fig. 1. Students built a browser-based escape room game. The player escapes by learning about the resources used (and the environmental pollution that comes with them) to build a smartphone.

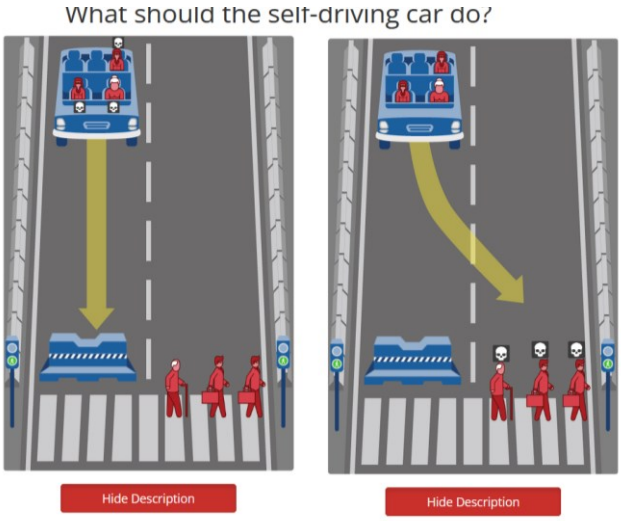

Fig. 2. In the lesson about self-driving cars, the learners have to make tough decisions when being the judge in the "Moral Machine".A browser based thinking experiment working as an evolution to the „trolley problem"

Action Taking Phase 2: Our focus was on testing the OER in school: this was done by teacher-trainees who had to practice their teaching at a secondary level school and were accompanied by the researcher and class teacher who was also their mentor. The teacher trainee chose four topics (AI, autonomous vehicles…) and held the respective lessons in three different classes. In a "Microsoft Forms" survey consisting of open and closed questions, the pupils (14 years old, secondary level education K9) were asked about their prior knowledge and opinion on the respective topics. During the lesson held by the student, the researcher/mentor took notes and at the end, the pupils filled out another form about the lesson, asking about the topic, the interest in the topic as well as their opinions towards the used tools and methods. The goal was also to see if certain skills have increased through the teaching. The noted impressions of the researcher and mentor were then discussed with the student and their own impressions about the previous lesson. For a more in-depth analysis the students are going to incorporate their experiences and research into their master's theses.

OER Selection Process and Lesson planning: The pre-service teacher acting as a researcher selected four OER lesson plans on autonomous vehicles, Teaching and learning with AI, AI & art, Fake News and Posts due to their mutual focus on AI and ethics, a present and crucial topic. Given AI's pervasive influence, especially social media, raising students' and pupils' awareness seems paramount to them. Additionally, the hands-on nature of the lessons was expected to engage and motivate students.

To assess the efficacy of the materials, the class teacher and the researcher employed a mixed methods approach. They conducted their surveys using both qualitative and quantitative questions via Microsoft Forms. Pupils completed pre- and post-lesson questionnaires to gauge changes in knowledge and opinion, tailored to each lesson's theme. The class teacher got the results with the pupils' names, facilitating the connection between pre- and post-lesson responses. However, data anonymization was carried out before sharing the results with the researcher. As an external trainee, the researcher conducted the lessons, ensuring an unbiased testing environment without any prior teacher-pupil associations. The class teacher observed the process without intervening and

served as an impartial reviewer. Thus, three distinct sources—pupil surveys, third-party observation, and self-reflection—were utilized for the assessment of the instructional materials.

Mini case studies:

Lesson 1: Autonomous Vehicles (in the following chapters: AV): The first lesson focused on autonomous vehicles. After a brief introduction by the teacher, pupils explored the "Moral Machine" tool, engaging in scenarios akin to AI decision-making in autonomous vehicles. Following this, pupils used "Answergarden" to brainstorm job redundancies in a future with more autonomous vehicles, then discussed the advantages and disadvantages of this technology. This was followed by an exercise called "expert groups" where each pupil was assigned a topic, read about it and shared their findings with the members of their group. A final Kahoot quiz assessed teamwork and knowledge acquisition. All tasks were followed by discussion on the pupils' contributions, reflections and challenges.

Lesson 2: Teaching and Learning with AI (TL-AI): The lesson TL-AI started with a brainstorming session on the board about where AI occurs in everyday life. Next, a PowerPoint presentation served as a support for the teacher's introduction to AI mechanics. The practice section involved correcting, translating and summarizing sample texts using tools such as Chat GPT, Google Translate and DeepL. Discussions followed each task to share pupils' experience. Finally, impulse questions from the materials could either be used for another plenary discussion or a survey on "Mentimeter".

Lesson 3: AI & Art (AI&A): The display of a website selling AI-generated art served as an introduction for AI&A, prompting pupils' opinion on this business model. Then, pupils used the Bing Image Creator and were asked to create their own "art" followed by a plenary discussion on their results. Next, they brainstormed the pros and cons of AI-generated art using "Answergarden". Finally, pupils were provided with a philosophical text about the impact of AI on art, which served as the lesson's conclusion, sparking further discussion.

Lesson 4: Fake Posts and News (FPN): The FPN lesson started with an engaging activity using the "Fakefinder" to distinguish real from fake news reports. Pupils then identified features of fake news and gathered them using "Mentimeter", with the teacher supplementing the list as necessary and providing additional resources. In the practical segment, pupils created their own fake posts for various social media platforms, using "Zeeob" to highlight the ease of media manipulation. The lesson concluded with a quiz to assess knowledge retention.

D. Evaluating

Reflection-sheets from students: Followed by the discussion rounds in our course-room, the students handed in more detailed, thought-through feedback. Overall, there have been 319 Reflection-sheets handed in the past two terms, resulting in 120 A4 pages of feedback. On the AV Lesson, there were 9 respondents (1 male(m), 8 female(f)), on AI&A 14 (3 male(m), 11 female(f)), TL-AI 9 (3 m, 6 f) and FP-N 9 (5 m, 4f).

While most of the students' feedback was overwhelmingly positive, there were suggestion on improving the following areas: the students loved the ethical decision making with the website "Moral Machine" and following discussion in the AV, as well as the idea of using Kahoot results to measure participation but criticized that the text was too small to read from a distance. In the TL-AI lesson, the critique was that the lesson felt like one being for teacher rather than for students or pupils. Regarding the previously mentioned tool to self-check the OER, it has been described as very helpful by the students of the third run, as it also provided a large pool on other inspiring resources as well as several templates, and a quiz about copyright.

The Survey: demographic data. For the evaluation we only considered "completed" tests from pupils, meaning those who submitted both pre- and post-tests. In total 33 pupils took part in the lesson for "AV", of which 28 (14 identified as male, 14 as female) "fully" completed the testing. In "AI&A", we got 25 complete results (14 f, 11 m), "TL-AI" – 30 tests (16 Male, 14 Female) and because it could only be taught in two instead of three groups, we only got 15 full test results from the "Fake News and Posts" lesson, of which 11 were female and 4 were male.

The data shows an increase in perceived knowledge gain in all lessons. When it comes to the interest in subjects there have also been gains in all topics besides TL-AI (Fig. 6). The result of the TL-AI lesson can be explained by the students' comment, perceiving the lesson as tailored for teachers rather than pupils.

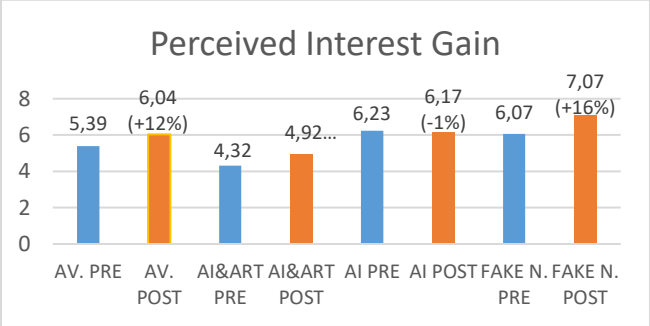

Fig. 3. Results on the question of "On a scale from 1-10, how interested are you in this topic?"

On the question of perceived knowledge, the pupils showed even larger gains:

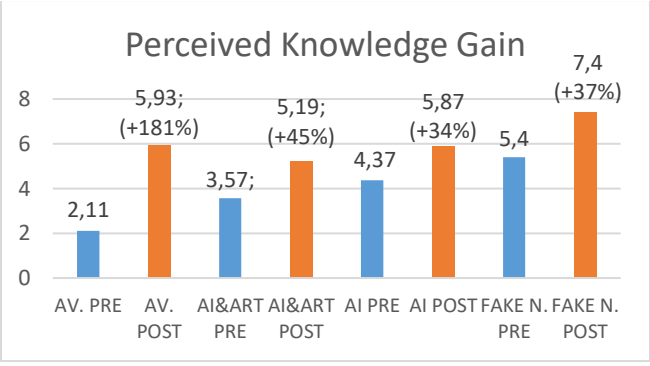

Fig. 4. Results on the question of "On a scale from 1-10, do you rate your knowledge in this topic?"

Asked on their opinions on the used digital tools, pupils particularly liked Kahoot and Answergarden, but not excessively through the whole lesson. However, none of the

pupils specifically mentioned disliking any of the applications.

Following the data, we noted some of the most crucial remarks of our teacher-trainee:

During the first lessons, it became evident that clear structure is necessary for the discussions to engage students effectively. Another important feature of their involvement was the variation of methods. For instance, the lesson on autonomous vehicles featured an excessive number of brainstorming activities using "Answergarden" which led to a decline in student interest. The possibility of inappropriate contributions is another disadvantage of anonymized brainstorming tools. Alternatively, the traditional approach on the board as it was incorporated into the "Teaching and Learning AI" lesson could be employed to retain control of contributions, but its efficacy proved to be dependent on the dynamic amongst the students. A ranking activity for the tested tools might be implemented to enhance student engagement. Practical hands-on experiences proved to be popular among students, increasing their motivation, especially in lessons where they could work creatively, such as "AI & Art" and "Fake News and Posts". Nevertheless, it is crucial to consider the potential sensitivity of the generated content as it may offend other students. A possible addition for the "AI & Art" lesson are tips for effective prompting and offering the opportunity to experiment with multiple tools for compare of different results.

OER Evaluation: As for usability, all materials were uploaded onto the school's learning platform, ensuring students' familiarity with its navigation without requiring specific knowledge or additional program installations. There was no particular focus on design, as existing freely available resources were utilized. However, the variety in methods granted effective engagement of students.

Concerning accessibility, there was a significant dependency on a stable internet connection as most concepts relied on online resources. Fortunately, this dependency was not an issue in the test school. In the event of poor connection, teachers may shift the lessons' focus on discussions on the ethical implications of AI. Occasionally, students had to create accounts with private e-mail addresses, which is problematic. To mitigate this, teachers may seek alternative resources.

From the teacher's perspective, reusability was ensured by the provision of all links and materials in a format conducive to reuse, revision, integration with other resources as well as sharing with other teachers and students. In terms of preparation, teachers only need to upload materials onto the learning platform and create quizzes.

Finally, we evaluated the gains in the students' digital competences.

Digital Competences addressed:

We used the previously mentioned DigiComp 2.2 framework to categorize the digital competences we see addressed and enhanced by the lesson held according to the related OER package.

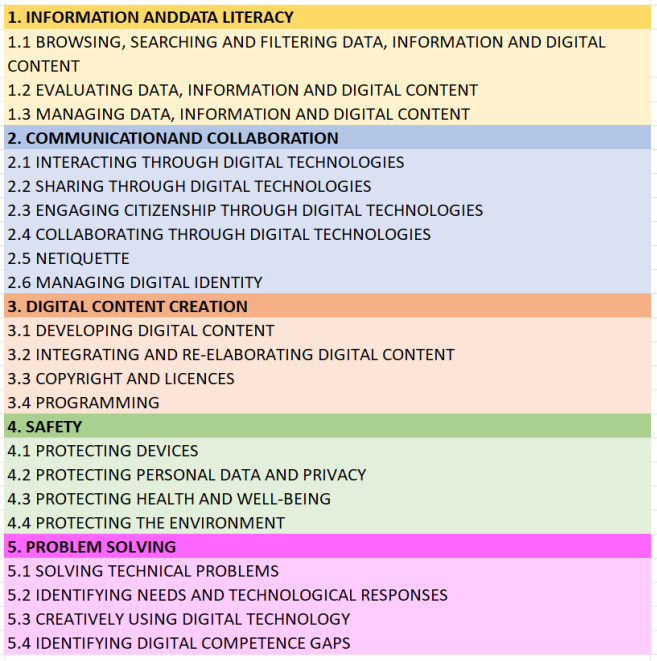

Fig. 5. Conceptual reference model of DigiComp 2.2 [3]

The first four OER, the media used for the lesson, and the digital competences (DigiCom 2.2) addressed with the OER package:

TABLE I. LIST OF LIVE-TESTED OER PACKAGES

OER/Lesson Topic	Media	DigiComp 2.2 Skills adressed
AI and Art	PPT, Bing Create/Dall-E to make the pupils explore the possibilities, Discussion, Answergarden	2.2;2.3;5.3
Fake Posts and News	Moodle Quiz, SWR Fakefinder, Mentimeter, Padlet, Mimikama, Zeoob, Socrative	1.2;2.2;2.3; 2.4
Teaching and learning with AI	Mentimeter, AI Tools (ChatGPT, DeepL Grammarly, Perplexity, Smodin), Moodle	1.3; 2.2; 2.4
Autonomous vehicles	Moral Machine, AnswerGarden, Texts and Kahoot, Moodle	1.3; 2.2; 2.4; 2.5; 5.2

Where teacher expectations fulfilled? Overall the four presented OER, yielded mostly great results in terms of practical usability even with low preparation time, therefore workload reduction for the teacher in addition addressing digital competences, using engaging methods, increasing interest in the topics and critical thinking and getting to know new digital tools – both for the teachers, and their students.

E. Specifying learning

Observing and participating in the first cycle of the Participatory Action Research process brought valuable insights. We would like to continue this path with minor alterations: As we have learned from our approach in comparison to the before mentioned alternative QA processes, our open, student-centered approach yielded very different, creative OER. But without certain criteria (ease of use, pedagogy, effectiveness…), the OERs are hard to rate through peer reviews.

V. Discussion and outlook – Transitioning to the 2nd Participatory Action Research cycle

In RQ1 we asked: In how far is a student-centered approach applicable to creating OER in class?

After the initial phase of collectively exploring the ideal lesson of the future, the students were mostly self-guided and motivated, with the lecturer changing his role to being a coach. It takes off the pressure from the lecturer to constantly transfer information towards the students and makes it feel much more like a collaboration.

RQ2: What are the advantages and risks of a student-centered approach to developing OER in the area of (computer-)ethics and digital competences?

The student-centered approach proved to be a pleasant surprise for the researcher, because it has not been tested in that scenario. The intrinsic motivation of the students resulted in a high output of quality materials and the positive atmosphere that students described as a "safe space" made the interactions fun and rewarding.

One limitation of this approach is that it may not be suitable for all individuals. It is important to create a warm, friendly, collaborative and positive atmosphere and for the lecturer to switch into another role, where he is not a frontal instructor anymore. Basically, teachers who practiced leading a class for a long time have to learn to let go of this approach. Also, it involves trust in the students, as the lessons need to be re-thought and redesigned while a great amount of work will be done by the students from a certain point on.

Yet, it is important to energize and activate the students at the beginning of a course. As for this course's third iteration, the lecturer being held back by a virus in the first three lessons resulted in reduced OER quality and fewer and shorter Reflection-sheets. However, this was corrected after using a lesson to talk about the goals of the course and to remind students, how important the Reflection-sheets are for improving the lecture as well as the OER by showing prior OER and lesson designs and how much fun and workload reduction they can bring.

RQ3: Which insights regarding the improvement of the quality of OER did the testing process in a real classroom setting produce?

Testing with the students brought a lot of constructive feedback but it also showed that they yet lack the ability to take the point of view of an actual teacher or a pupil. For instance, some assumed that the tasks were too hard for kids and others, and while the "fishbowl"-discussion method worked great in our course, the pupils in one class needed more guidance. Basically, the testing in the course was a great way to soften some rough edges of the materials and lesson designs and the pupils in class led to the final fine-tuning and showed if the creative ideas of the students worked in a real-world setting. There might be challenges concerning the technical equipment of a classroom or on the pupils' side, as the testing in the university course with everyone having a working, charged digital device and excellent Wi-Fi reception was a best-case scenario.

A. Limitations

The OER were designed by highly motivated students, yet they lacked teaching experience which resulted in varying quality of the OER packages. A second teacher who also took part in the later stages of research wanted to select the next four OER to be tested. However, the remaining six OER only partially fit his needs and quality requirements. Therefore, he selected two from the first term and is waiting for the completion of the OER from the second term.

In-Class-Testing: The reader should bear in mind that the study was only conducted in one school on one level by one (not fully trained) teacher. Additionally, the number of pupils in these particular classes was limited as they only teach computer science in small groups due to the size of the computer rooms. All the classes are taught by the same teacher in this subject which can also cause a certain bias. To overcome these limitations, the materials could be tested in different environments by different teachers. It is also possible to try an interdisciplinary approach and try the lesson plans through other subjects.

B. Further work

The next steps for the existing OER will be A) The OER which did not meet our quality expectations will be subject of the next year's course to be reviewed and redesigned. B) The OER that were successfully tested in school, will be optimized once again by the teacher who held the lessons considering the pupils' feedback and the notes. C) In addition, strict control on copyright must take place. D) After this check, the materials are ready to be published. These OER are intended to be clearly specified, making them open to translation and adaptation for learners at different levels of education and learners with special needs, e.g. by using generative AI-tools.

As for the overall course design that will ultimately lead to a substantial output of high-quality OER and more digitally literate teachers and students, we plan to continue this journey and offer more courses like the one described in this paper.

VI. Conclusion

In conclusion, the participatory action research approach as research framework can be considered a success. Not only did it yield a lot of findings from different data collection methods, but it additionally made it possible to carry out our work and produce a fair amount of new OER. The whole process of quality assurance with the participation of everyone involved was an enriching experience for the lecturers, the teachers, the students and the pupils alike. We are overall happy to have been able to address the wishes of the students, the teachers and the pupils at the same time, while simultaneously improving our university's teaching. The results of our study have demonstrated that the university should not only continue to pursue this approach but also expand upon it.

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