**IX WORKSHOP ON TEACHING MECHANICAL ENGINEERING**

**Informatics Education in permanent change:   
Example Artificial Intelligence (AI)**

***Enseñanza de la informática en un cambio permanente:   
Ejemplo Inteligencia Artificial (IA)***

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**Abstract:**

* **Problem to deal with:** Computer science education must be constantly adapted to the latest developments and trends. Current trends concern e.g. AI and machine learning, big data mining, automation and robotics, AR and VR, low-code developments for users, blockchain technology, edge computing, IoT, cloud solutions, green coding as a contribution to sustainability, safety and security especially cyber security and agile software development. Artificial intelligence in particular opens up many new possibilities (e.g. individual learning support, individual tutorial support, language support, relief from routine activities and elaborate documentation) but requires an adaptation of academic teaching and examination methods.
* **Aims:** Research questions are:

(1) What are the demands of Information and Communication Technology (ICT) trends on computer science education?

(2) How does ChatGPT change knowledge acquisition?

(3) What forms of academic training and what types and forms of examinations are appropriate in the age of ChatGPT and AI?

* **Methodology:** Literature analysis on trends in computer science, Literature analysis on the status and possible applications of AI and machine learning, Expert survey
* **Results and Discussion:** The discussion of students and university teaching staff should help to prevent conflicts and to use the new technologies adequately.
* **Conclusions:** Fields of action and measures for the adaptation and reorientation of teaching and examination forms are derived.

**Keywords:** Computer science; Artificial Intelligence; Questionnaire; Forms of examination; Robotics

***Palabras Claves:*** Informática; Inteligencia Artificial; Cuestionario; Formas de examen; Robótica

**1. Introduction**

We are currently in the age of digitalization and networking. Many new ICT solutions are emerging and pushing into application. Artificial intelligence (AI) in particular will disruptively change teaching and learning. For academic training, the question also arises as to which skills are necessary for professional activity and should be acquired in a stimulated and, if necessary, accompanied manner. AI in particular opens up many new possibilities (e.g. individual learning support, individual tutorial support, language support, relief from routine activities and elaborate documentation) but requires an adaptation of academic teaching and examination methods.

Research questions are:

(1) What are the demands of ICT trends on computer science education?

(2) How does ChatGPT change knowledge acquisition?

(3) What forms of academic training and what types and forms of examinations are appropriate in the age of ChatGPT and AI?

The authors provide a snapshot in this highly dynamic process at the time of September 2023, which, however, must be permanently updated.

**2. Methodology**

The methodology used includes the literature analysis on trends in computer science, literature analysis on the status and possible applications of AI and machine learning, and expert survey by professionals from different scientific disciplines. For the analysis of relevant aspects, ChatGPT 3.5 (OpenAI, 2023) was also used for the first time and identified as a source of knowledge.

**3. Results and Discussion**

**3.1. Result 1: Connection between ICT trends and academic education**

Table 1 collects the results to answer the question, what are the demands of ICT trends on computer science education?

Table 1. ICT Trends (Berlit & Scherf, 2018), (DHL, 2020), (Kruse, Borgelt, Braune, Mostaghim. & Steinbrecher, 2016), (Wehberg, 2019), (Glistau & Coello Machado, 2019), (Glistau, Coello Machado, & Trojahn 2022), (OpenAI, 2023) & (own elaboration, 2023)

|  |  |  |
| --- | --- | --- |
| Trend in the IT world  (Name & course characteristics) | Impact on academic education and training | |
| Form, Tools & Methods | Content |
| **AI and Machine Learning**  Highly developing field with topics such as genetic algorithms, machine learning, computer vision, speech recognition & processing, expert systems, reinforcement learning, fuzzy logic, cognitive systems and many more. | Acceptance and integra-tion of AI solutions (e.g. ChatGPT, Dall E2)  - Practical projects  - Case studies  - Students should learn to create models and solve real-world problems | AI methods  AI Examples |
| **Cybersecurity**  Threats through espionage, manipulation, extortion etc. | Practical exercises | Overview of methods of prevention and defense  Ethical hacking and network security |
| **Big Data Mining**  Increasing data volume requires efficient methods of processing.  It is necessary to evaluate situations and do forecasts. | Practical data analysis  Projects | Pattern recognition  Applications  Benefit |
| **Automation and robotics**  Current developments in robotics include: AI and Machine Learning, Autonomous Driving, Social Robots, Robots in Medicine, Cobots, Nanorobotics etc. | Robot Workshops  Robot Hackathons  Robot Clubs  Robot Project | Basic knowledge of mechanics, electronics, programming, control systems and AI  Applications |

Continuation of Table 1. ICT trends (Berlit et al., 2018), (DHL, 2020), (Kruse et al., 2016),   
(Wehberg, 2019), (Glistau et al., 2019), (Glistau, et al., 2022), (OpenAI, 2023), (own elaboration, 2023)

|  |  |  |
| --- | --- | --- |
| Trend in the IT world  (Name & course characteristics) | Impact on academic education and training | |
| Form, Tools & Methods | Content |
| **Augmented & Virtual Reality**  Extension of the real world by digital elements (AR) up to completely digital worlds (VR). | Project for creating AR and VR applications | Terms  Stage of development  Applications and tools (software and hardware) |
| **Low code development for users**  Simplify software development | Solve programming tasks as easily as possible | Methods (ChatBots, visual development environment, low code platforms) |
| **Blockchain technology**  The accounting of activities can be realized automatically by using Blockchain technology (e. g. smart contracts). | Creating smart contracts and experimenting with multiple blockchain platforms | Principle of action  Use cases (e.g. Finance, Healthcare, Logistics) |
| **Edge Computing**  Data processing is brought close to where it is needed.  Important for IoT. | Case studies,  practical exercises  Guest lectures & experts | How does edge computing work and how can it be linked?  Examples of meaningful use cases  Comparison with Cloud Computing |
| **Quantum Informatics**  Quantum computing describes the behavior of particles at the subatomic level. Promises new opportunities for solving complex problems. | Information about this trend,  If necessary, quantum mechanical experiments | **Specialty, only in development!**  Mathematical and quantum mechanical foundations |
| **Networking, Internet of Things (IoT)**  IoT connects physical and virtual devices by using information and communication technologies. The task is now to develop the Internet of services (IoS). | Developing IoT projects and working with sensors and actuators in practice | Overview of IoT technology  Example solutions  Procedure for implementation |
| **Cloud-platforms and cloud software**  Integral part of many IT infrastructures; New offered services are infrastructure (IaaS), platforms (PaaS) and software (SaaS). Memory capacity, processing power and applications are provided by internet and do not installed local. | Practical exercises are carried out on cloud platforms such as AWS, Azure or Google Cloud | Cloud Technologies  Problems of the cloud |

Continuation of Table1. ICT trends (Berlit et al., 2018), (DHL, 2020), (Kruse et al., 2016),   
(Wehberg, 2019), (Glistau et al., 2019), (Glistau, et al., 2022), (OpenAI, 2023), (own elaboration, 2023)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Trend in the IT world  (Name & course characteristics) | | | Impact on academic education and training | | | |
| Form, Tools & Methods | | | Content |
| **Green coding** as a contribution to sustainability  Aims to program in a sustainable and environmentally friendly way | | Group discussion and awareness-raising | | | Teaching methods,  e.g. Efficient algorithms and data structures, avoiding unnecessary calculations, switching to energy-saving mode, resource efficiency (efficient use, virtualization & containerization, creating awareness) | |
| **Agility**   * Agile approaches to software development * Agile Organizations * Agile project management | | Team project on a small problem to learn about the organization, approach, methods and evaluate the results | | | Comparison of classic and agile software development  Methods and rules of agile software development  Use of ChatGPT as a programming aid | |
| **Home office and remote working places**  Strong proliferation of home-based work and work that can be done from anywhere. | | Integration of home office into teaching and examination operations | | | Tools to support distributed work while ensuring security standards | |
| **Demand for digital know-how**  Require professional qualification and lifelong learning. | | Adapt the shape to the requirements and possibilities | | | Permanent definition and updating of what digital know-how means, lifelong learning vision | |
| **Digital Twins**  The virtual representation of a physical object or system is used to understand it, optimize it, predict it, control it, or repair it etc. | | Establishment of an own digital twin as a test platform | | | Setting up and structuring digital twins | |
| **Increased data protection, safety and security**  Requires critical protection of sensitive data from corruption, compromise, or loss. | Own thematic exercises to defend against threats | | | Threats  Possible courses of action  Regulate | | |
| **3D Printing**  Changes the supply chains fundamentally. The product is first created at or near the customer. | Laboratory equipment with 3D technology,  Hands-on training | | | State of 3D development  Necessary further develop-ments in the IT sector | | |
| **Benign AI-powered bots**  Integration of bots into existing programs for e.g. evaluation of data, learning in decision-making situations and visualization of options for action and effects. | Bot Lab (Design & Goals, Training Data, ML & NLP, Ethics, Monitoring & Improvement, User Experience, Security) | | | Programming and integration of bots  Examples are e.g. social media bots, chatbots, health bots | | |

These ICT trends denote topics and new solutions that must be included in academic training and subsequently transferred to application with proof of their positive effects and durability. As an academic form of training in this context, digital guest lectures by experts (developers, users, critics) who provide specialist input and discuss the topic broadly and intensively are initially suitable. A positive example of this form of training is the digital guest lecture series Logistics. (Compare (GVR, 2023)) Subsequently, proven topics should be perpetuated and suitably integrated into the training. A mix of knowledge input and practical usage experience should always be accomplished.

**3.2. Result 2: Disruptive change of education and examination by ChatGPT**

The digital world of learning prior to ChatGPT was presented, for example, in Teaching Forms of E-Learning. (Teaching, 2020). ChatGPT comes new in 2022 and is an AI-based chatbot that has been making a splash for a year now. Many students and teachers are already exploring the benefits of ChatGPT in everyday life and at university. There is a body of literature from 2022 and 2023 that addresses the opportunities, changes, and needs for action related to ChatGPT. Recommended are e.g. (Firat, M., 2023), which derives guidance for universities from literature review and interviews with 21 people.

(Willems, J. et al., 2023) proves the current limitations and flaws of ChatGPT and concludes "... it is the teacher's (privileged) responsibility to instruct students tools correctly and wisely ...". In (Nickel, J. & Ganguin, S., 2023) the view of student teachers on so-called de-bounded learning and teaching is presented and put under the heading: <Practical and overwhelming at the same time> - learning and teaching in the culture of digitality. They relate the de-limitations to the means of learning, the learning time, the place of learning, the learning space, the social form, the learning content up to the de-limitation of teaching.

Figure 1 shows important applications of the chatbot the opinion & the empirical knowledge of the authors and interviewed experts at the Otto von Guericke University Magdeburg.



Figure 1. Possible applications of ChatGPT in an academic context (Facebook, 2023) & (own elaboration, 2023)

Problems of chatbots, as of 2023, are:

* Stage of development of chatbots (incorrect answers, old answers, incomplete answers, answers with bias, i.e. with prejudices and distortions),
* Motivation to use it generate and maintain permanently,
* Digital user behavior (fast, varied, work with rewards).

Table 2 collects the results to answer the question, how does ChatGPT change knowledge acquisition.

Table 2: Comparison of the world before and with ChatGPT to illustrate the differences and possibilities   
(own elaboration, 2023)

|  |  |  |  |
| --- | --- | --- | --- |
| Old (before ChatGPT) | Possibilities  from  ChatGPT | New (with ChatGPT) | |
| Learner | Academic teacher, tutor, coach |
| * Transmission of knowledge by teachers * Reading of texts * Own research of knowledge (internet, library) | **Information & knowledge queries** | * Self-study * Exam repetition * Use as an encyclopedia * Digital fellow student | * Own continuing education * Digital "colleague“ |
| * Learning to ask accurate questions, develop questioning strategies. * Learning to distinguish contexts * Learning to question presented knowledge (control questions) * Learning to work with knowledge and add to it creatively * Learning to check and compare sources * Generating overview knowledge quickly | |
| * Homework * Vouchers * Project reports * Bachelor theses * Master theses | **Writing support** (resume, email, letters, texts and reports of any kind) | * Use when writing any type of text. * Adaptation to concrete circumstances may still be necessary | |
| * Significantly reduce the effort required to write (see left) * No to little own, understanding part * No own practice in formulating * No prolonged examination of the content | * e.g. to create assignments, teaching materials, research proposals, research reports, publications of any kind (book, paper, presentation) |
| * Own creativity, * Creativity techniques in small teams | **Brainstorming &**  **Idea generation** | * Ideas available to all * Ideas can be produced at will without  effort | |
| * Learning a foreign language * Translate yourself * Use deepl & Google | **Language translation** | * Language skills continue to lose  importance | |
| * Teaching syntax, * Programming yourself | **Programming assistance** | * Manual programming becomes less important; artificial intelligence takes over the actual programming. * If necessary, program control & evaluation * Complex, networked programs are currently still generated traditionally | |
| * Conversation and chat with real people | **Chatting**  (Communication) | * "Conversation" and chat with artificial beings | |

Continuation Table 2. Comparison of the world in front of and with ChatGPT to illustrate the differences and possibilities (own elaboration, 2023)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Old (before ChatGPT) | | Possibilities  from  ChatGPT | New (with ChatGPT) | | | |
| Learner | | | Academic teacher, tutor, coach |
| * Independent structuring of work & drafting of procedures and outline | **Outlines &**  **Procedures** | | * Automatically structure work (papers, reports, final papers, etc.) * Create procedures | | * Structure courses & research * Create procedures | |
| * Loosening up of les-sons by teaching staff | **Telling Jokes** | | * Integrate jokes and funny stories on demand | | | |
| * staff with office hours to answer customer inquiries * (lecturers, study advisors, examina-tion office) | **Customer Service & Support** (Taking orders and answering questions) | | * Change of counseling at the university * 24/7 - counseling possible | | | |
| * Required initiative and independence to repeat the learning material with or without the use of IT | **Learning support and education** (reviewing learning material) | | * Repetition and consolidation of the learning material can be done AI-supported, independently. * Explaining facts, (complex, difficult) | * Sort the teaching/learning material by: Must be taught, can be worked out on your/their own | | |
| * Writing assignments to learn how to write technical documentation * Own creativity | **Creative Writing** (poems, stories) | | * Work on the same tasks with different writing styles, also role reference possible, such as, "Formulate like a lawyer" | * Possibility of easy generation of case studies and examples | | |
| * Personal discussion with other students, friends and family | **Dialogue simulation**  (train real conversation situations, test for exams) | | * "Conversation" with the AI * Targeted use for exam preparation in conversation | * Digital "colleague“ | | |
| * Questions had to be thought up or researched by oneself * typical task of teachers for repetition and for exams (exam questions) | **Create questions and question lists** | | * Work more with questions | * Create tested question catalogs | | |
| * Generate questions for research and questions e.g. for scientific papers. * Questions and question lists can be generated easily (checking, sorting and completion may be useful) * Generate questions for interviews and questionnaires | | | |

Continuation Table 2. Comparison of the world in front of and with ChatGPT to illustrate the differences and possibilities (own elaboration, 2023)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Old (before ChatGPT) | | Possibilities  from  ChatGPT | New (with ChatGPT) | |
| Learner | Academic teacher, tutor, coach |
| * Own creativity and expression in writing interesting texts | **Content marketing** (newsletters, advertising texts) | | * One's own creativity and expression lose importance | |
| * PowerPoint presentations had to be generated by the user | **Create Presentations** | | * Slide content can be easily generated | |

These changes highlight the need for careful planning, collaboration, and ongoing evaluation to exploit the potential of AI in higher education while addressing the associated challenges.

**3.3. Result 3: Forms and content of academic training**

The forms of academic training (lecture, exercise, seminar, etc.) date back to another century. The underlying vision was determined by an academic education for a "classical" profession and its lifelong practice. However, the requirements for academic training and technical possibilities have changed fundamentally in recent years and require a reengineering of academic education and training. In the future, the new academic education and training should and will accompany the academic throughout his or her life. In this sense, it is no longer about classic professions, but essentially about skills and experiences. Many published solutions of digitalization and networking in the context under consideration are currently like small pieces of the puzzle and have initially mostly brought about small improvements to the existing actual solution, as in Kaizen. Some of the main advantages of digitalization are individualization, flexibilization, preparatory training for lifelong learning, digital interlocutors and colleagues; improved inclusion (e.g. for disabilities, lack of language skills, girls in technical professions & boys in girls' professions). In addition, there is an increase in variety among students through the use of diverse media and an increase in interactivity. Important possibilities of interactivity as a small overview are described in Tables 3   
and 4.

Table 3. Morphology for the characterization of digital forms of interaction (OpenAI, 2023) & (own elaboration, 2023)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Criterion** | **Forms** | | | | | | | |
| **Why:** | **Learn** | **Conti-nuing edu-cation** | **In-form** | **Admi-nistrate** | **Collaborate** | **Playing,**  **Enter-tainment** | **Establi-shing contacts** | **Test**  **Examine** |
| **Context:** | **Social**  (interpersonal,  e.g. between students) | | **Cultural**  dependent, e.g. on university standards | | **Business**  University administra-tion, e.g. registration for the exam | | **Without context** | |
| **What:**  Type of digital  Medium | **Read texts**  Online resour-ces,  E-books, online articles, blogs | **Texts back and forth**  Email, Chatbot  Discus-sion forums | **View picture**  Graphic,  Photos, Memes | **Picture back and forth**  Email  SMS, Whats-app Chat-bots | **Listen to Audio**  Podcast AudiobooksVoice Message, Music Stream | **Audio back and forth**  Tele-phony | **Watch Video**  Online Videos  On platform or strea-ming | **Video**  **back and forth**  Video  call  Video conferen-cing |
| **Social Networking Platforms**  Facebook, Twitter, Instagram | | **Interactive Media**  Digital simulation games, games, VR, AR | | **E-learning media**  Online Courses  Webinars | | **File**  Deploy | **Edit file** |
| **Who:**  Target group | **Private** | | **Professional-internal** | | **Professional–external** | | **Public** | |
| **With how many:**  Interaction | **Just me** Use of the Internet | | **With one person** classic chat | | **With several people**  Social media, chat group | | **With all**  Posting opinions | |
| **Own activity:** | **Low**  streaming & watching Videos | | | | **High**  Benefits of social media | | | |
| **When:** | **Real time**  Video call, chat, voting | | | | **Not in real time**  Emails, Forums | | | |
| **Wherewith:**  Technolo-gies | **Web Application**   * **Interactive Media** (Digital simula-tion games, games, VR, AR) * **E-learning media** (Online Courses, Webinars) | | | | **App** | | **Social Media Platform**  Facebook, Twitter, Instagram | |
| **Wherewith:**  Hardware | **Computer** | | **Smartphone** | | **Tablet** | | **Smart TV** | |
| **Where:** | **Internal**  Accessible only in the university network | | | | **External**  Access from the outside possible | | | |
| **Data Protection & Security:** | **Different levels of data security**  Raise awareness, read privacy policies, backup, secure Wi-Fi, beware of phishing, updates, be careful when sharing information, password or 2-factor authorization. | | | | | | | |

Table 4. Overview of important digital forms of interaction   
(Forms according to (OpenAI, 2023), (own elaboration, 2023) for characterization)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Digital Interaction**  **potentialities** | **Examples of tools** | **Brief  Characteristics** | Text., Images | Video | Audio | Virtual Meetings | Webinar | Cooperation | Forums, blogs |
| Social media | **Facebook**, Twitter,  Instagram | Interaction and communication between users via texts, images and videos |  |  |  |  |  |  |  |
| Email | **Gmail,** gmx, Outlook & Yahoo | Exchange of messages and documents via the Internet |  |  |  |  |  |  |  |
| Instant Messaging | **WhatsApp**, Telegram & Slack | Real-time communication via text, audio and video |  |  |  |  |  |  |  |
| Video-  Conferencing  tools | **Zoom**, Microsoft Teams & Google Meet | Video conferences & virtual meetings |  |  |  |  |  |  |  |
| Webinar  tools: | **GoToWebinar** & WebEx | Implementation of webinars and training courses via the Internet |  |  |  |  |  |  |  |
| Professional Networks | **LinkedIn** & Xing | Establish and maintain professional contacts |  |  |  |  |  |  |  |
| Online Forums & Community Platforms  Blogs & Blogging Platforms | **Reddit & Stack Overflow**  Blogs | Forums where users can ask questions, have discussions, and share information |  |  |  |  |  |  |  |
| Collaborative work platforms: | **Microsoft 365**, Google Workspace & Slack | Collaborate on documents, projects and tasks in real time |  |  |  |  |  |  |  |
| Social VR Platforms | **Oculus** & AltspaceVR | interact & share social experiences in a digital environment |  |  |  |  |  |  |  |
| Gamification Platforms | **Duolingo** (Language Learning), Fitbit (Health & Fitness Goals) | Game-like elements to  encourage user interaction and engagement |  |  |  |  |  |  |  |
| User inter-  Action software | **Live Chat Software** & Chatbots | to communicate with users in real time and provide support |  |  |  |  |  |  |  |

Table 5 collects the results to answer the question, what forms of academic training and what types and forms of examinations are appropriate in the age of ChatGPT and AI.

Table 5. Changing traditional forms of teaching, learning, training and evaluation   
at universities and colleges (OpenAI, 2023), (own elaboration, 2023)

|  |  |
| --- | --- |
| Traditional forms of teaching, learning,  training and evaluation | Alternatives  using digitalization |
| Traditional  face-to-face lecture  over 90 minutes | 1. **Teacher-controlled:**  * **Presence with integration of various online tools, interactive elements such as simulations, quizzes**, polls, discussion forums and peer assessments to promote learner engagement. * **Hybrid** event * **Online** event, **webinars**, and virtual seminars: Webinars are live presentations or training sessions that are broadcast online. They enable real-time interactions between the presenter and attendees, including Q&A sessions and discussions.  1. **Self-directed learning:**  * **E-learning platforms** (e.g. Moodle, Canvas, Blackboard) and directly on the Internet = provision of course content, such as: texts, tables, images, data, slides, audios, videos, questions, tasks, tests, etc. motivating elements such as gamification: (The integration of playful elements such as points, badges and competitions can increase student motivation and engagement.) * **Podcasts and video podcasts**:  Teachers can record audio or video content and deliver it as podcasts * **Video tutorials and screencasts:** Teachers can create short videos in which they explain concepts or demonstrate software. Share via YouTube or Vimeo. * **Use of AR and VR** (Students can immerse themselves in virtual environments and explore concepts digitally, realistically.) * **Learning apps and mobile platforms:** on smartphones and tablets. Examples from other disciplines include Duolingo (languages) and Khan Academy (mathematics and science) * **Adaptive learning systems:** These systems tailor the learning process to learners' individual needs and progress, providing personalized learning paths.  1. **Online discussion forums and social media:**   Encourage students to discuss and ask questions |
| Traditional  classroom exercise  over 90 minutes |
| Traditional  face-to-face seminar  over 90 minutes |
| Homework, document / project work (individual project), internship report, draft | * Combination of written elaboration and oral exam / interview |

Continued Table 5. Changes in traditional forms of teaching, learning, training and evaluation at universities and colleges (OpenAI, 2023), (own elaboration, 2023)

|  |  |
| --- | --- |
| Traditional forms of teaching, learning, training and evaluation | Alternatives using digitalization |
| Document / project work / scientific project  (team project) | * Use of digital tools * Use of tools for group work and communication |
| Strategy game | * Digital simulation game |
| Laboratory internship in presence  Experimental work | * Internship with accompanying reflection seminar (AI module) * Massive Open Online Courses (MOOCs) are free online courses available for anyone to enroll. MOOCs provide an affordable and flexible way to learn new skills, advance your career and deliver quality educational experiences at scale. |
| Guest lectures  in presence | * Guest lectures online via Zoom * Questions in the chat |
| Internship | * VR internship |
| Excursions to companies and trade fairs | * Videos and online discussions |
| Written exam under supervision with personal presence in the lecture hall (written exam) | * Still possible without digital tools * E-exam room, deliver a text in a specific time frame |
| Oral exam with 2 examiners with personal presence | * Still possible without digital tools |
| Written work (project report,  Bachelor's thesis, Master's thesis) | * Preparation with the support of digital media with indication of digital sources * Producing digital results (videos) |
| Colloquia for the presentation and scientific discussion of the results in the personal presence of all participants, presentations | * Still possible without digital tools * Enrichment with digital media |

Digitalization will make many forms of study possible in the future: Attendance as direct study (full-time study), part-time study (practice-integrating, part-time, job-integrating), simultaneous study at several locations, distance learning, international study, in addition, simple online access to lifelong continuing education must and will be created. The proportion of teacher-centered forms will decline in favor of student-centered forms.

A good example of studying at different locations is offered by the new bachelor's degree program AI Engineering. In the winter semester 2023/24, the OVGU Magdeburg will start the new bachelor's degree program AI Engineering - Artificial Intelligence in Engineering Sciences (B.Sc.) in cooperation with three other universities in the state of Saxony-Anhalt.

For the future, the bachelor's degree program in AI Engineering opens up a world of opportunities for graduates in different industries. “As an AI expert, you are driving the digital transformation in a company, implementing your own start-up projects with new technological approaches or working in research and development in an academic or industrial context: in any case, thanks to your skills and experience in the field of artificial intelligence, you will be well trained to develop innovative solutions to the technical problems of our time and master the challenges of tomorrow.” (AI engineering, 2023) & (Module handbook AI, 2023). Figure 2 visualizes the new learning with AI.

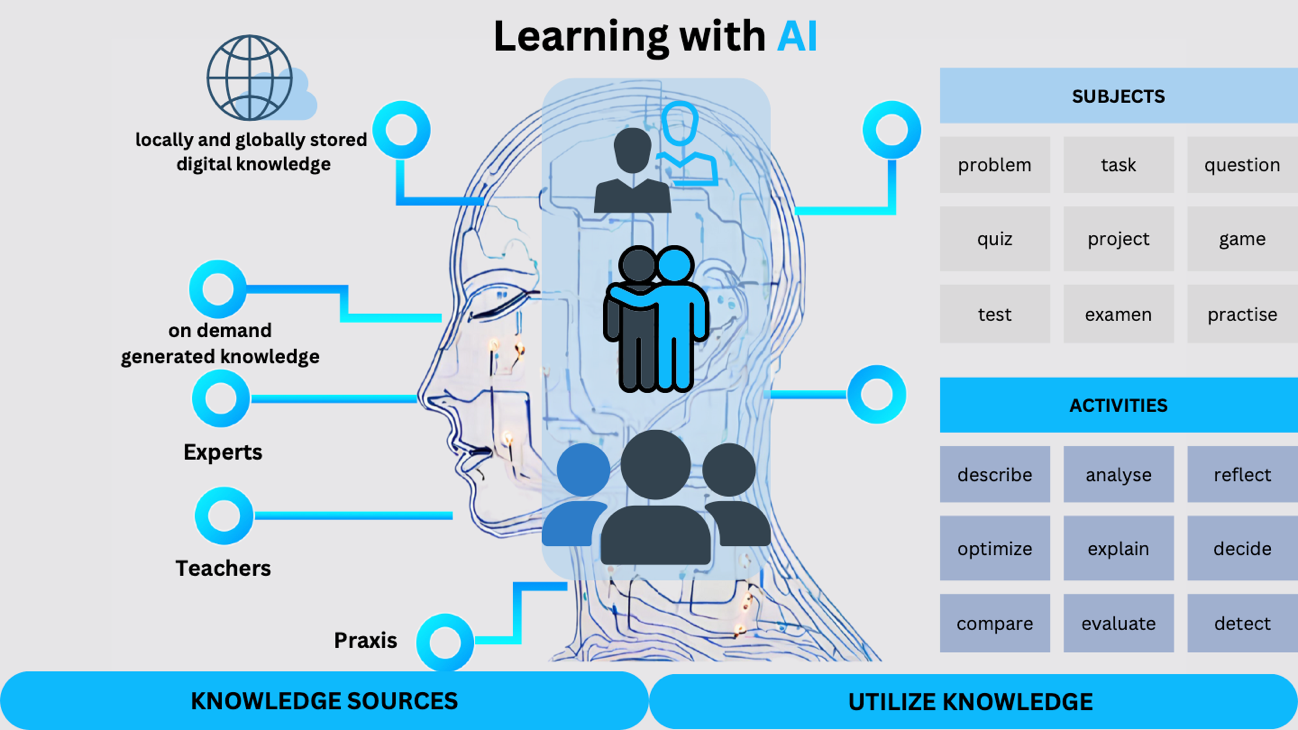


Figure 2: Change of learning with AI in an academic context (own elaboration, 2023)

**4. Conclusions**

Digitalization and networking have now reached a level of development that fundamentally changes traditional academic forms of teaching and learning and will change them even more radically. A reengineering of academic education becomes necessary.

Instead of completing academic courses face-to-face at universities and then attending further education courses if necessary, the philosophy is moving towards lifelong learning and the permanent acquisition of necessary skills. Since the world of work is very heterogeneous and individual, the necessary skills in demand will (have to) also be individual. Many issues and problems of the present are complex and can only be solved in a multidisciplinary way. Traditional thinking in terms of courses of study and modules with fixed CP seems too inflexible and does not exhaust the available possibilities.  
The authors represent the vision that the face-to-face university of the last centuries will be radically transformed. In her new role, she will become a research centre and companion of lifelong academic learning. The classic lecture in the lecture hall is an obsolete model, because basic knowledge can be provided digitally via a wide variety of media and current knowledge can be generated and used on a daily basis. With regard to academic teaching, the tasks of the scientist are shifting to creating digital teaching and learning media together with "digital colleagues". It makes sense to vote on common platforms, for example, in order to avoid pointless duplication of work. Academic teaching becomes a lifelong companion and requires research, tutorial support, coaching, and advising.

The present research results answer three questions:

(1) What are the demands of ICT trends on computer science education?

(2) How does ChatGPT change knowledge acquisition?

(3) What forms of academic training and what types and forms of examinations are appropriate in the age of ChatGPT and AI? The current status of 2023 was recorded through a literature analysis and expert discussions and an attempt was made to roughly characterize the consequences of the current situation and the development of technology and technology in the ICT sector.

These developments are changing the vision, structure, form and content of academic education. With regard to ICT trends, this was exemplified in the paper without claiming to be complete. We are looking forward to a lively scientific discussion!

**5. Bibliographic references**

AI engineering (2023). Anhalt University of Applied Sciences. <https://www.hs-anhalt.de/nc/studieren/orientierung/studienangebot/detail/ai-engineering-bachelor-of-science.html>

Berlit, M., & Scherf, J. (2018). Intralogistik 4.0. Die Top 4 Digitalisierungstrends in der Intralogistik für 2018. MM Logistik. Vogel, 10, 18.

DHL (2020). The Logistics Trend Radar. 5th Edition. DHL, <https://www.dhl.com/global-en/home/insights-and-innovation/insights/logistics-trend-radar.html>

Facebook (2023). Evaluation of a chat history of a Facebook group ChatGPT & OpenAI - German-speaking group (DACH). Public group. 6 friends. 104,482 Members

Firat, M. (2023). What ChatGPT means for universities: Perceptions of scholars and students. Journal of Applied Learning and Teaching, 6(1).

Glistau, E., & Coello Machado, N. I. (2019). Logistics 4.0 - solutions and trends. In COMEC 2019, 13 pp. Presented at COMEC2019, June 23rd-30th, 2019, Cayos de Villa Clara, Cuba.

Glistau, E., Coello Machado, N. I., & Trojahn, S. (2022). Logistics 4.0: Goals, trends and solutions. Advanced Logistic Systems - Theory and Practice, 16(1), 5–18. <https://doi.org/10.32971/als.2022.001>

GVR – Gastvortragsreihe Logistik (2023). Otto von Guericke University. <https://www.gvrlog.ovgu.de/>

Kruse, R., Borgelt, C., Braune, C., Mostaghim, S. & Steinbrecher, M. (2016). Computational Intelligence. A Methodological Introduction. London. Knight.

Nickel, J. & Ganguin, S. (2023). ‹ Praktisch und überfordernd zugleich›− Lernen und Lehren in der Kultur der Digitalität: Zur Sicht von Lehramtsstudierenden auf entgrenztes Lernen und Lehren. MedienPädagogik: Zeitschrift für Theorie und Praxis der Medienbildung, 53, 76-95.

Module Handbook AI Engineering. (2023). Anhalt University of Applied Sciences. <https://www.hs-anhalt.de/fileadmin/Dateien/Bilderpool_HSA/Courses/module_manuals/20230428_MHB_Ba_AiEng.pdf>

OpenAI. (2023). ChatGPT-3.5: A large-scale generative language model. <https://platform.openai.com/docs/guides/chat/citation>

Teaching Forms E-Learning (2020). MMB Institut. <https://www.mmb-institut.de/wp-content/uploads/mmb_Vielfalt_Lernformen_neue_Darstellung_2020.jpg>

Wehberg, G. G. (2019). Logistik 4.0–die sechs Säulen der Logistik in der Zukunft. In: Göpfert I. (eds.) Logistik der Zukunft - Logistics for the Future. Wiesbaden, Springer Gabler. pp.367-395.

Wikipedia contributors. (2023, August 2). Live coding. In Wikipedia, The Free Encyclopedia. Retrieved 09:16, September 11, 2023, from <https://en.wikipedia.org/w/index.php?title=Live_coding&oldid=1168454487>

Willems, J. (2023). ChatGPT at universities–the least of our concerns. Available at SSRN 4334162.