WP5

PILOTING OF THE AISS COURSE

CONSOLIDATED REPORT

Content

SUMMARY

Objective of the AISS course:
Creation of multimedia program modules redesigned and integrated into formal and non-formal education to integrate AI approaches into the traditionally existing curricula of each university. The innovation of the results is achieved by incorporating the AI toolbox and chatbot into formal education curricula, bringing high added value for formal learners who can combine traditional learning environments with innovative tools.

The pilot of the AISS course has been carried out on the digital training platforms (such as Moodle) of each partner entity. Each university, therefore, tested the course with its students through its educational platform, integrating the chatbot corresponding to each module.

The training modules were distributed and piloted as follows:

PARTNER	COURSE	TARGET AUDIENCE: PROFILE	PARTICIPANTS
FLORIDA	Programming	Students of 2nd DAM Semi (subject "Digitalization applied to the production process (GS)")	25
KTU	Multimedia technologies	Master's students	21
BAYREUTH	Microcontrollers	Undergraduate students in Engineering and Computer Sciences, Microcontrollers subject.	24
UPJP2	Business models in digital media	University students and academic staff interested in the applications of AI in higher education.	20
		TOTAL	90

Each university adapted the dates of its piloting according to its possibilities of execution with its students, developing as follows:

PARTNER	PILOT DATES
FLORIDA	15-21 September 2025
KTU	1-30 September 2025
BAYREUTH	April-September 2025
UPJP2	June 2025

The partner KTU, as leader of work package 3 and 5 (which includes both the design of the modules and the course itself), developed a guide to be followed by the partners to implement the course, agreeing on the following steps:

- Choose one module per partner for online learning (1 module per partner).

- Duration of a module: 30-40 hours
- Select the innovation to be integrated, e.g. H5p (*H5p is a plugin that allows the teacher to create and use open-source interactive content - quizzes, presentations and interactive videos - directly in their Moodle courses, without the need for programming knowledge*).
- Prepare the chatbot to integrate it into the module (depending on the scenarios)
- Choose a platform where the modules will be redesigned.

Module Structure:

- ✓ Discussion forum/announcement of the teaching staff.
- ✓ Module Introduction: Module Objective, Duration, Learning Outcomes, Background Needed, Task Format.
- ✓ In total 4-5 lessons are planned in the module
- ✓ Homework/Hands-On Work
- ✓ Bibliographic resources used

Lesson Structure:

- ✓ Identify learning outcomes
- ✓ Add lesson in PPT format
- ✓ Add readings for the lesson
- ✓ Self-evaluation
- ✓ Assistant (Chatbot)

The pilot sessions at AISS partner universities assessed the practical applicability and added value of the main results developed under the AISS project in the context of each course, the specific objectives of which are:

- Integrate and test all AISS project outcomes, including:
  (1) the **AI-based** chatbot
  (2) the **Toolbox** for Digital Transformation
  (3) the **Compendium** of AI solutions in a real-world course environment.

- To evaluate the usability and effectiveness of these tools in supporting teaching and learning processes at grade level.

- Explore how students and faculty can use the toolbox and compendium to understand broader applications of AI in higher education beyond the realm of the chatbot.

- Collect student feedback on the relevance, accessibility, and perceived benefits of the three outcomes.

- Validate the contribution of tools to digital transformation in higher education, focusing on transparency, reliability and pedagogical impact

Brief description of the pilot session in each partner entity

FLORIDA CENTRE DE FORMACIÓ, COOP. V

The pilot carried out in Florida was organized to test, with direct users, a course of the redesigned AISS project - Programming course - that incorporates an AI virtual assistant to support students in their teaching and learning process. In the pilot, participants learned how to interact with the chatbot to access course materials, answer questions, navigate content, or provide reminders.

The pilot was carried out online through the platform (Moodle) Florida Oberta to which the students of 2nd DAM Semi (subject of "*Digitalization applied to the production process (GS)*" had access. This course focuses on the process of digital transformation focused on the productive means of today's society. It seeks strategies for modernization and implementation of new technologies to classic production methodologies. A large part of its content is the realization of machine learning prototypes, using Python language and the use of specialized AI libraries such as pythorch and tensorflow. The AISS project was considered as the ideal framework to be able to implement AI chatbot generation technologies as an example of modernization of teaching methodology in the subject.

The piloting of the results of the AISS project was integrated into the *Programming* course at Florida Universitària during the month of September 2025. Each of the 25 participants in grade 2 DAM Semi (students of the subject "*Digitalization applied to the production process (GS)*") was assigned a series of individual tasks divided into 5 didactic units focused on learning and introduction to the Python programming language. These units are based on general knowledge of software and hardware, along with decimal-to-binary transformations. Later configuring the development IDE for programming in Python by using Visual Studio Code. Next, examples of variable syntax, control structures (conditionals and loops) and data structures (lists and dictionaries) were made. Self-assessment tests were implemented for each of the syllabus. Finally, a compendium of activities and exercises (10 in total) was delivered, ordered from least to most complex as an assessable activity at the end of the course.

The students worked largely independently, receiving support through regular consultation hours, supervised by the course teacher (José Martínez Usó), as well as through the pilot AI chatbot, specifically trained on course manuals and programming guides.

In addition to the chatbot, the students were presented with two other project outcomes:

(1) the **Toolbox** for digital transformation and
(2) the **Compendium** of AI solutions for higher education.

These were used to expand knowledge about the potential applications of AI in higher education and to encourage reflection on the pedagogical and institutional context of AI-assisted learning.

The piloting was carried out in three phases:

1. Independent practical work on the Programming course, with the support of the chatbot.
2. Documentation and reporting, in which students had to reflect on their use of AI tools, including the strengths and limitations encountered.
3. Final presentations, in which each participant showed their solution, explained the implementation and answered questions to check their understanding.

The pilot session achieved its goals: students successfully tested the three project outcomes, demonstrated increased proficiency in the programming subject, and provided feedback on the usability and reliability of AI tools. Indicators such as the adoption of tools, student participation and the quality of the project's results confirmed that the pilot instruments contributed positively to both technical learning and the development of digital competence.

Several challenges and valuable lessons were identified:

- A successful integration of AI virtual tutors in web environments: Moodle, HTML was achieved, and this can be extended via API to desktop and mobile application development environments: Unity3D, Unreal Engine...

- The existence of strong competition from AI-based apps leads to the need to specialize in the training of chatbots in specific topics of the didactic units of the courses in which they are implemented.

- Human supervision will always be required to provide specific intention and theoretical basis to the content of the course, the use of AI is a very powerful tool to generate content and resolve doubts, but it does not create criteria in students unless it is directed in a specific didactic direction.

Florida Student Feedback

The overall reaction of the students to the testing of the AISS tools was positive, with most participants valuing the added value of AI-based support.

The implementation of a virtual tutor based on artificial intelligence generated a feeling of constant accompaniment in the students, which contributed to the strengthening of personalized learning and the reduction of stress levels in the face of doubts and problems that arise during the performance of the tasks assigned.

However, the wide availability of multiple online AI tools, recognized for their ease of use and popularity, meant that the adoption of personalized AI within the Moodle educational platform had a limited initial reception. The students showed a consolidated tendency towards the use of previously known external resources. In addition, the perception of "being watched" due to the teacher's access to the conversation records with the virtual tutor, generated in some students,

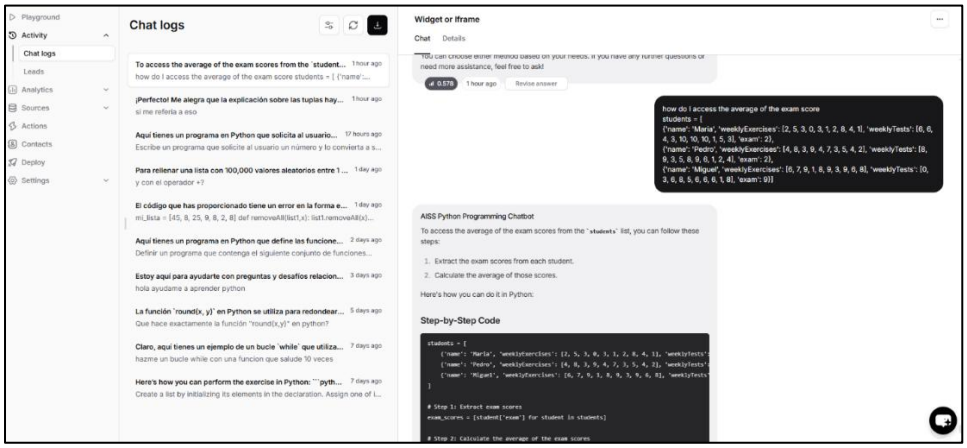
a feeling of insecurity. This situation was due to the fact that their doubts were openly exposed to artificial intelligence, even going so far as to literally copy and paste the statements of the exercises, which aroused some uncertainty about the possibility of being penalized later. In order to mitigate this situation, the use of artificial intelligence was actively promoted and, as a complementary measure, each student was asked to deliver a video summary explaining the procedures applied, the scripts developed and the way in which they had used the chatbot.

Finally, the students expressed the need to have a greater number of audiovisual materials that presented examples and exercises related to theory. This aspect shows that, despite the usefulness of being tutored virtually through artificial intelligence, the information and resources provided directly by the teacher continue to be perceived as a solid, reliable source and generator of security in the learning process. In this sense, the audiovisual material provided by teachers constitutes the main basis of knowledge, while artificial intelligence must be understood as a complementary resource that enhances this process.

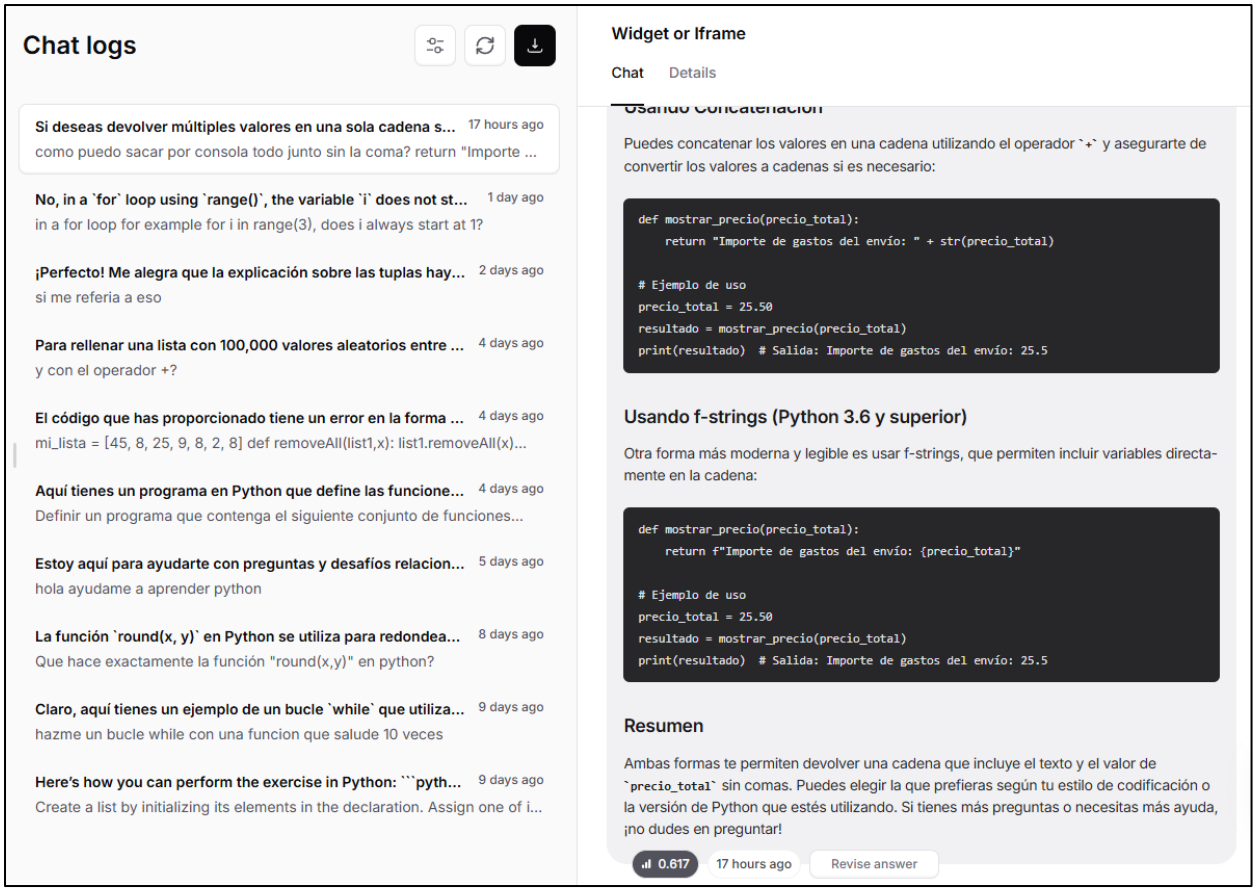
Most of the participants consider positive or very positive general aspects of the course such as the quality of the materials used, the organization of the course, its usability, content, interactivity, especially highlighting the personalization in the tutoring through AI, generating a consequent saving in time to resolve specific doubts.

Evidence

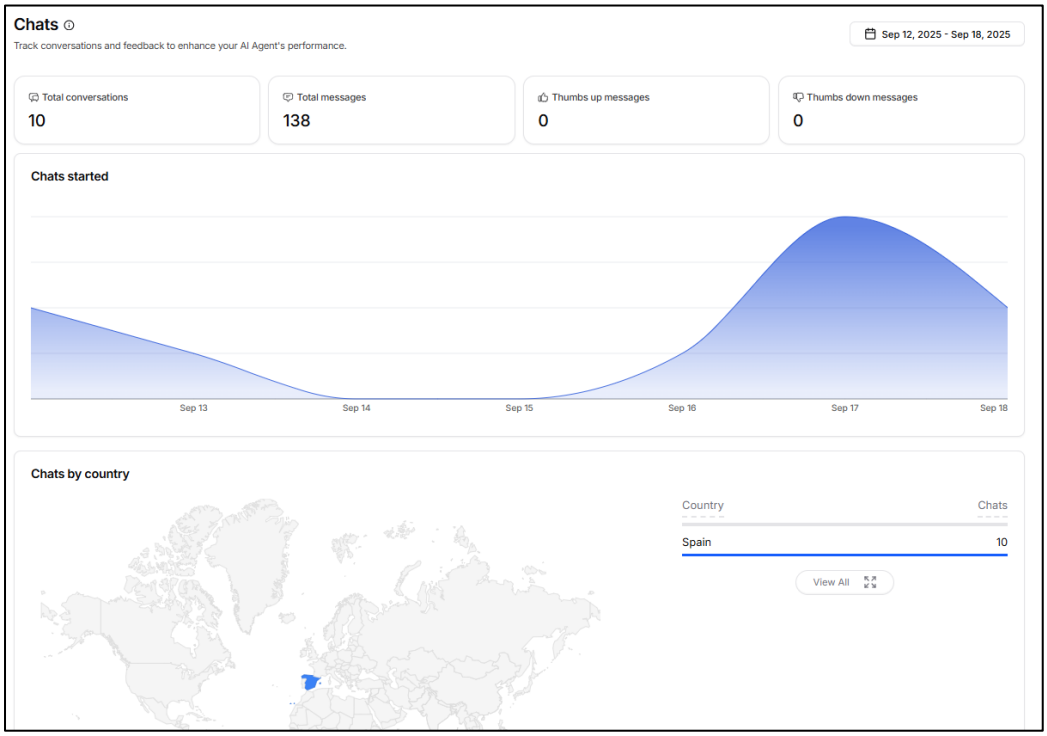
COURSE DEVELOPMENT IN FLORIDA

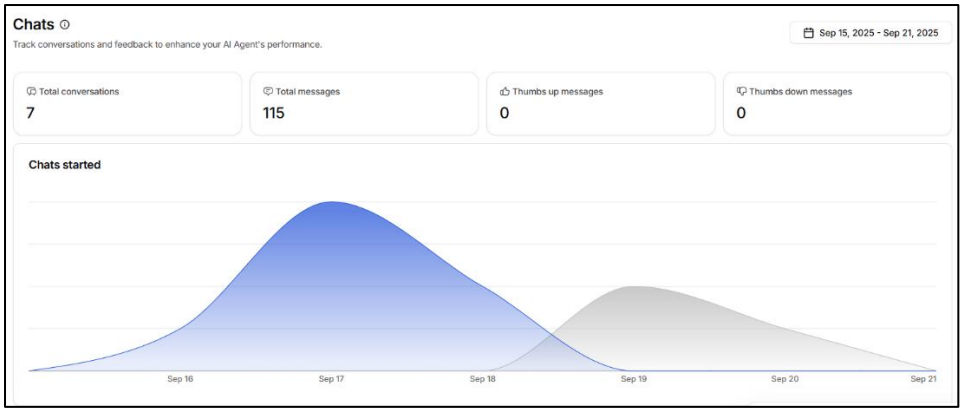


Contents of some chat logs

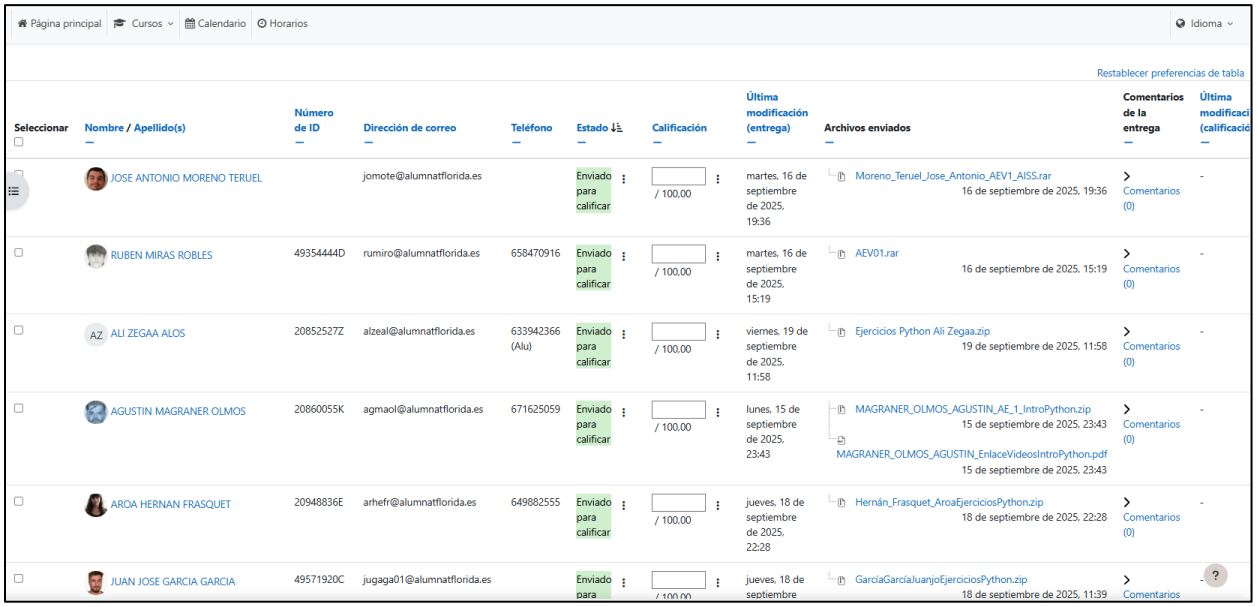


Contents of some chat logs



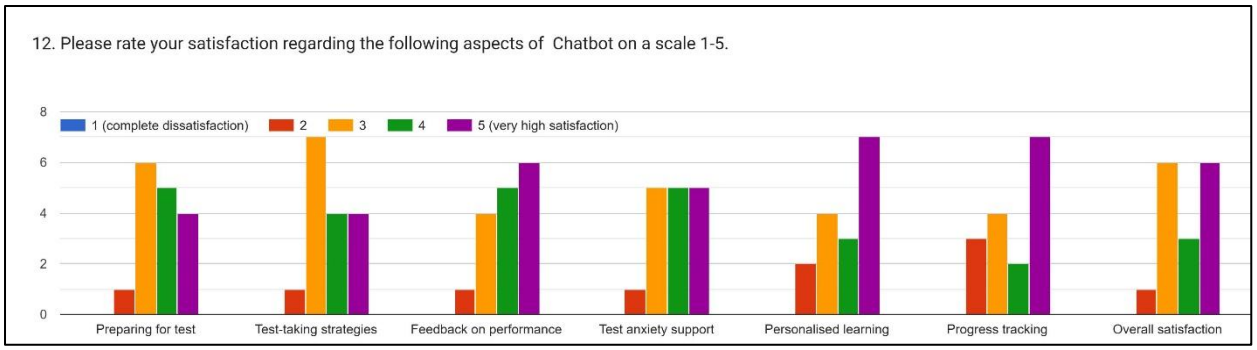


Chat Graphics

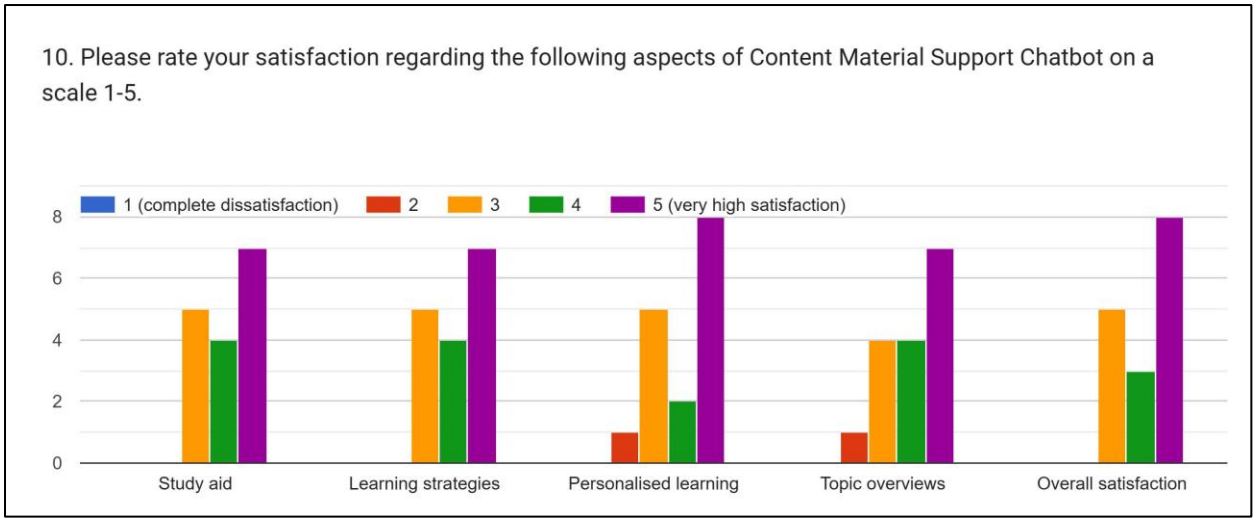


Screenshot of student deliverables

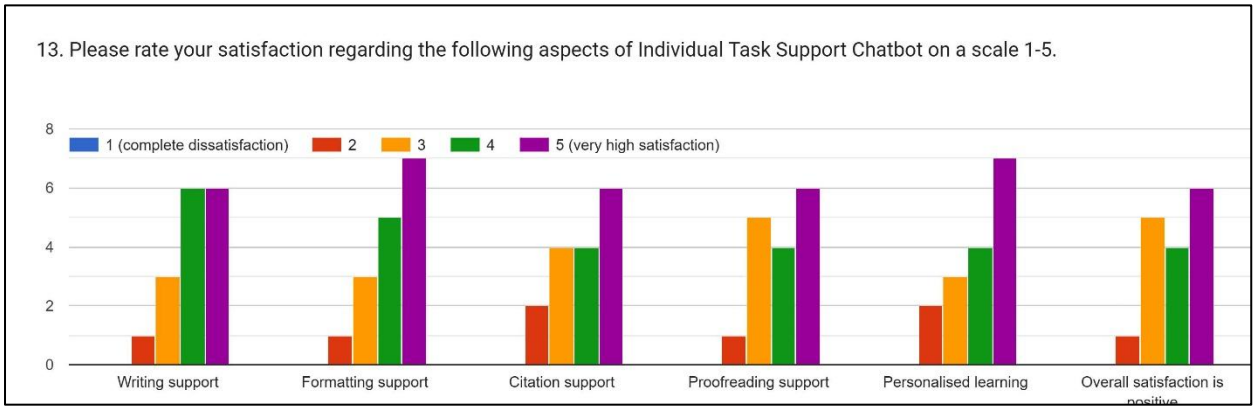
STUDENT FEEDBACK



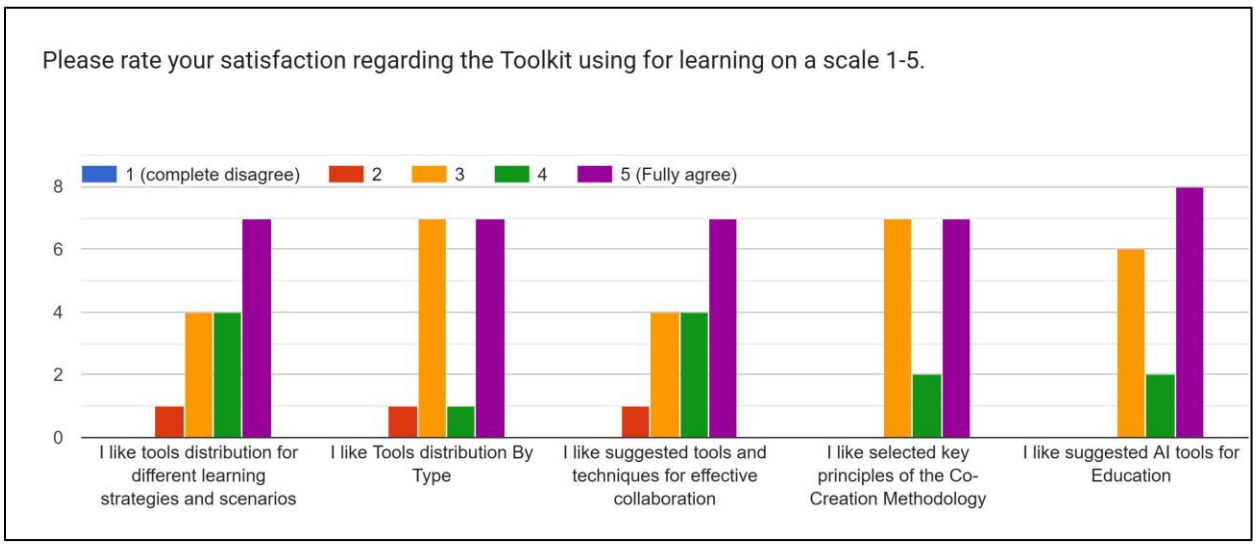
Chatbot satisfaction level



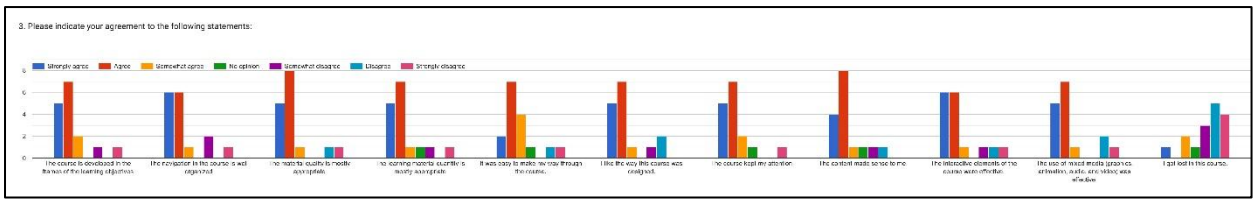
Level of satisfaction with the content of the Chatbot support material



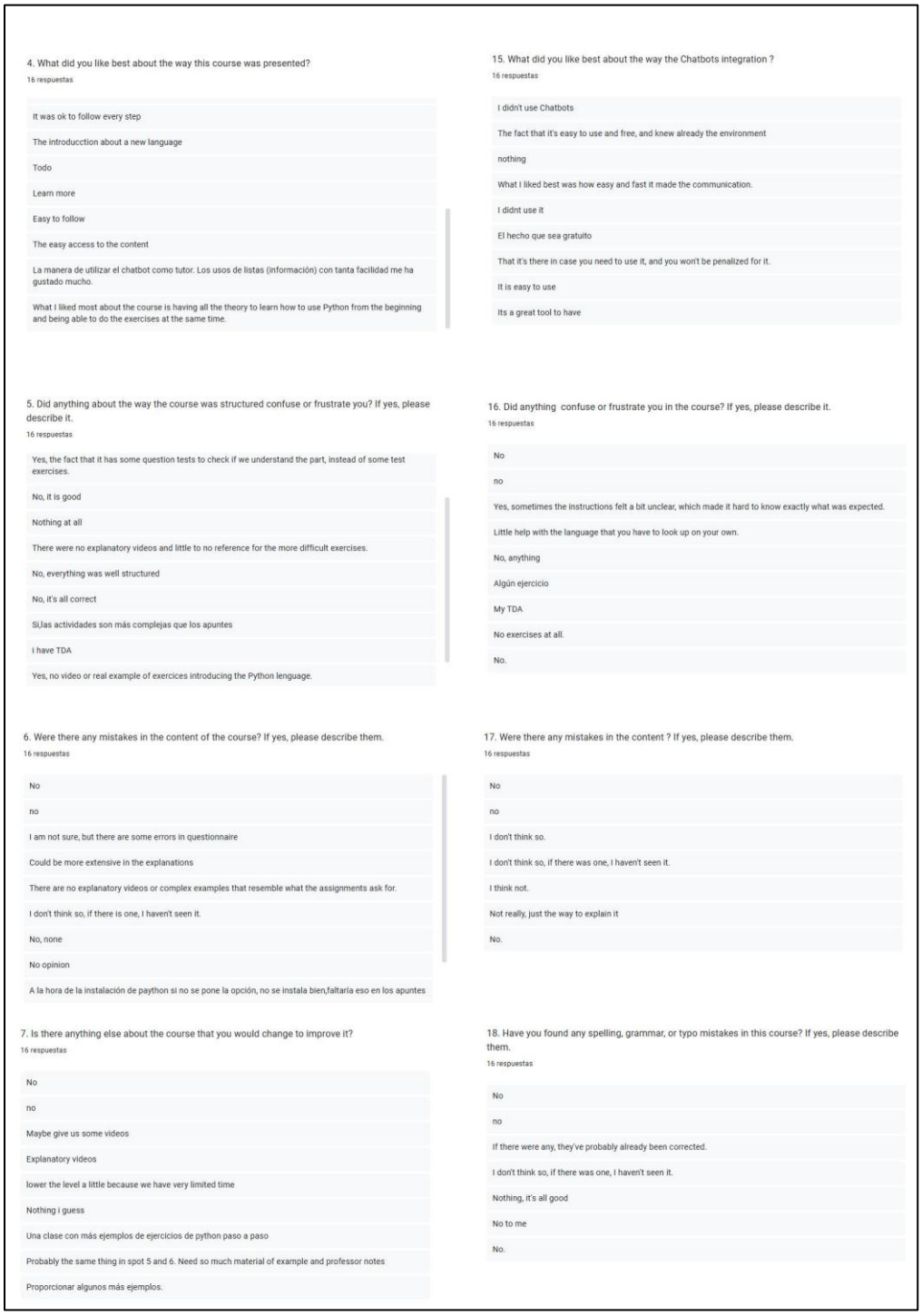
Level of satisfaction with the Individual Support Task Chatbot



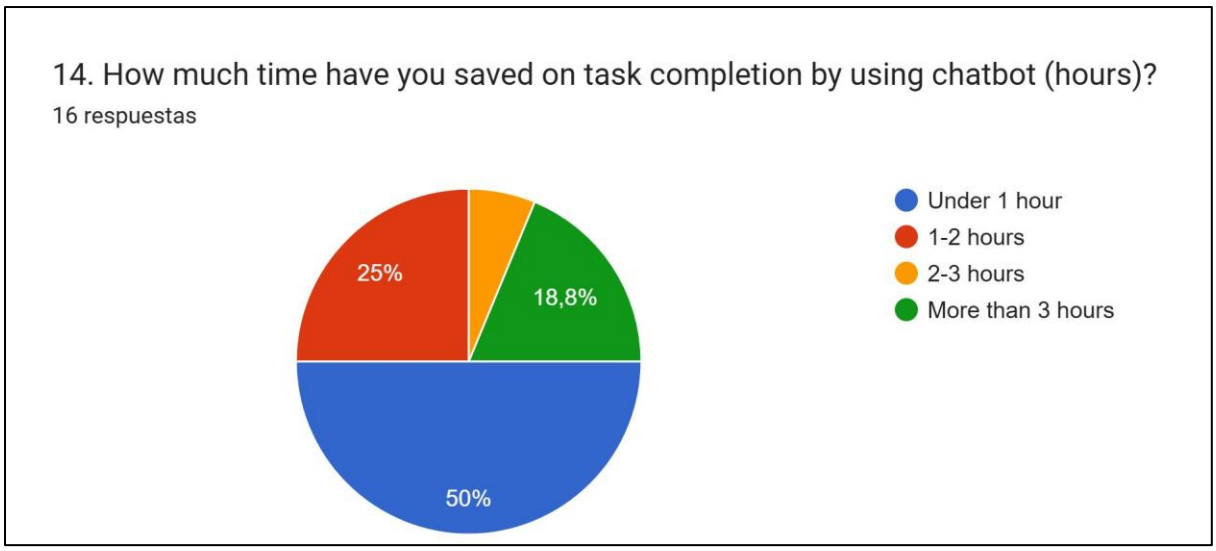
Level of satisfaction with the Toolkit



General statistics



General Questions



Time saved by using a chatbot

UNIVERSITY OF BAYREUTH

The piloting session was organized to evaluate the practical applicability and added value of the main outputs developed within the AISS project in the context of the Microcontrollers course at the University of Bayreuth. The specific objectives were to:

1. Integrate and test all project results (the AI-based chatbot, the Toolbox for Digital Transformation, and the Compendium of AI solutions) within a real course setting.
2. Assess usability and effectiveness of these tools in supporting teaching and learning processes at the bachelor's level.
3. Explore how the Toolbox and Compendium can be used by students and lecturers to understand broader applications of AI in higher education beyond the scope of the chatbot.
4. Collect student feedback on the relevance, accessibility, and perceived benefits of all three outputs.
5. Validate the contribution of the tools to digital transformation in higher education, with a focus on transparency, reliability, and pedagogical impact.

The piloting of the AISS project results was embedded into the Microcontrollers course at the University of Bayreuth during the summer semester 2025. Each of the 16 bachelor-level participants was assigned an individual task to connect a specific sensor to an STM32F4 microcontroller board and implement the programming in STM32CubeIDE. Students worked largely independently but received structured support through regular consultation hours, supervised by the course facilitator (M.Sc. Niklas Krug), as well as through the piloted AI chatbot specifically trained on course manuals, datasheets, and programming guides.

Alongside the chatbot, students were introduced to two additional project outputs: the Toolbox for Digital Transformation and the Compendium of AI Solutions for Higher Education. These were used to broaden awareness of AI's potential applications in higher education and to encourage reflection on the pedagogical and institutional context of AI-supported learning.

The organisation included three phases:

1. Independent practical work on the microcontroller project, supported by the chatbot.
2. Documentation and reporting, in which students had to reflect on their use of AI tools, including strengths and limitations encountered.
3. Final presentations, where each participant demonstrated their solution, explained the implementation, and answered questions to verify understanding.

The piloting session achieved its objectives: students successfully tested all three project results, demonstrated increased competence in microcontroller programming, and provided feedback on the usability and reliability of the AI tools. Indicators such as tool adoption, student engagement, and quality of project outcomes confirmed that the piloted instruments contributed positively to both technical learning and digital competence development.

While the piloting session achieved its main objectives, several challenges and valuable lessons were identified:

- Balancing AI support with independent learning: Some students tended to rely heavily on the chatbot for coding solutions. To ensure genuine skill acquisition, facilitators emphasized that AI tools were to be used as support, not as a substitute for problem-solving. This highlighted the importance of clear pedagogical framing when integrating AI into technical courses.
- Technical limitations of the chatbot: Although the subject-specific chatbot performed well, students reported occasional limitations when dealing with complex programming tasks or sensor-specific configurations. This confirmed the need for continuous refinement of the training data and the integration of diverse use cases.
- Engagement with the Toolbox and Compendium: Students appreciated the broader perspective offered by these resources but engaged with them at varying levels of depth. Some used them primarily for orientation, while others explored strategies and case studies in detail. This suggests that structured guidance or assignments could increase the effectiveness of such tools in future iterations.
- Assessment of learning outcomes: The combination of practical work, written documentation, and oral presentations proved effective in evaluating both technical skills and students' reflective understanding of AI tools. However, facilitators noted that explicit indicators on how students critically assess AI limitations should be strengthened in future piloting.

Overall, the piloting confirmed that integrating AI-based tools into technical courses is feasible and beneficial but requires careful instructional design, clear communication of learning objectives, and continuous monitoring of tool effectiveness.

Comments from students at the University of Bayreuth

The overall reaction of students to the pilot of the AISS tools was positive, with most appreciating the added value of AI-based support. The **course-specific chatbot** consistently stood out as a useful resource for quickly extracting relevant information from lengthy datasheets and manuals (e.g., sensor registration addresses, pin configurations, or communication protocols). Several students emphasized that it saved a lot of time by directly pointing them to essential functions and best practices, which would otherwise have required extensive manual reading.

At the same time, the students recognized the **limitations of the chatbot**, particularly in debugging tasks within STM32CubeIDE or in handling more complex hardware integrations (e.g., BSP files or display drivers). In these cases, external resources, such as online forums or general-purpose AI systems like ChatGPT, were sometimes more effective. Despite these challenges, students reported that the chatbot improved their understanding of microcontroller programming concepts (e.g., I2C communication, sensor data handling) and offered reliable guidance in many practical situations.

Some participants described combining **Copilot's specialized assistant with general AI tools** (e.g., ChatGPT) as particularly beneficial, as it provided specific, project-focused advice and broader coding support. Importantly, students did not adopt AI-generated results uncritically; They cross-referenced the suggestions with datasheets and system tests, which contributed to learning rather than simply outsourcing tasks.

Some students noted that while they didn't use the chatbot extensively, they recognized its strength in reducing lucubrations and ensuring more accurate answers compared to general AI systems. Overall, the pilot confirmed that AISS tools, especially the chatbot, were **well received, sped up the development process, and improved the quality of code and documentation**, while encouraging the thoughtful use of AI in technical education.

Students and faculty valued the **AI Digital Transformation Toolbox** as a structured and accessible resource that provided a broad overview of strategies, tools, and methods for integrating AI into higher education. Its modular design and clear categorization (e.g., virtual assistants, adaptive learning platforms, AI-powered assessment tools) were perceived as particularly useful for orienting oneself in the fast-growing field of AI in education. Participants emphasized that the toolbox helped them understand not only how AI can support individual courses, but also how it can contribute to broader institutional transformation processes.

The **Compendium of AI Solutions for Higher Education** was positively received as a reference collection of case studies and best practices. The students appreciated the concrete examples, which illustrated real-world applications of AI in teaching, assessment and research support. Participants noted that it complemented the more practice-oriented chatbot tool by offering a broader perspective on the ethical, methodological, and organizational dimensions of the use of AI in higher education.

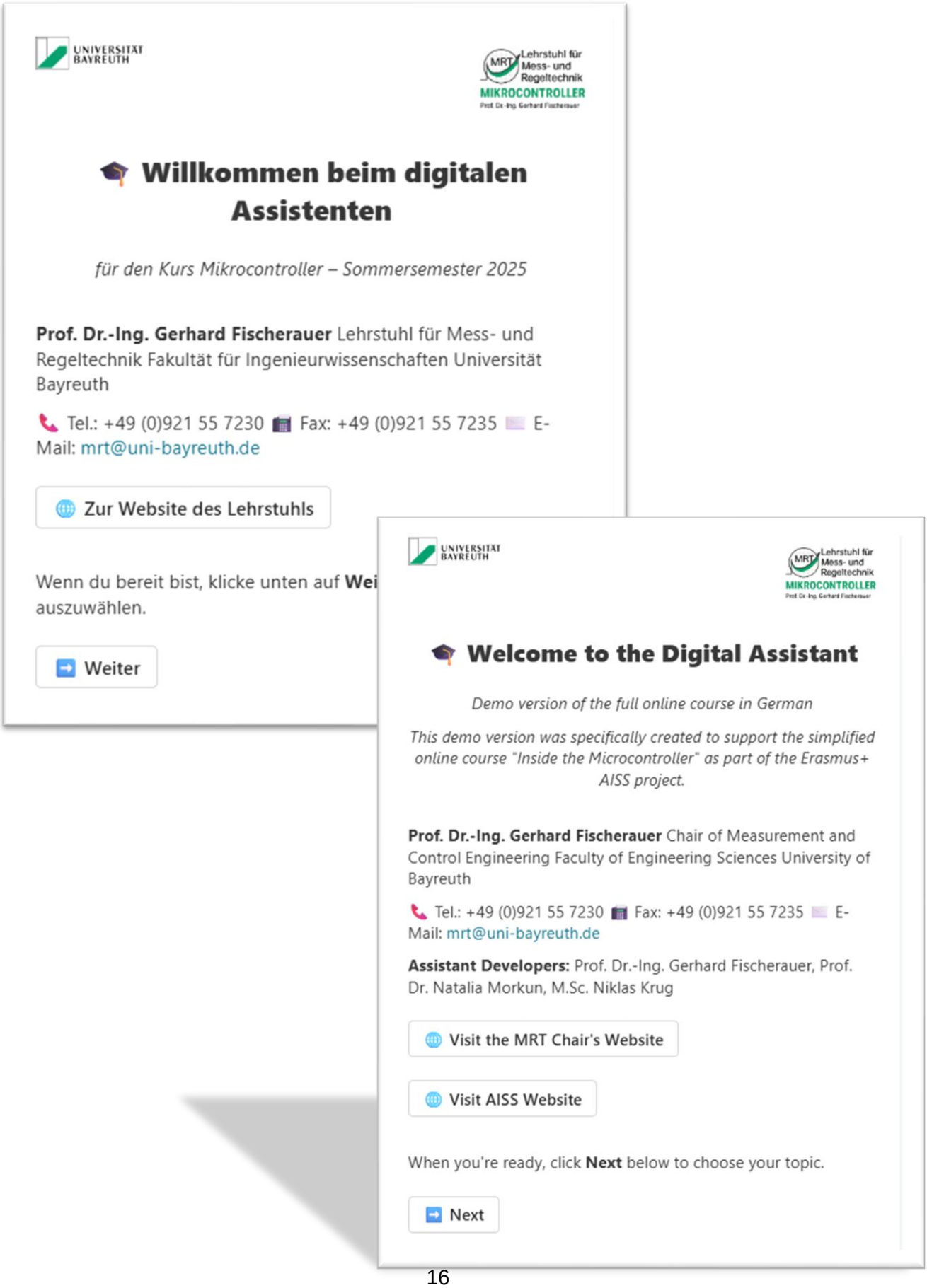
Table 1. Student comments: strengths and limitations

Aspect	Positive feedback (strengths)	Challenges/Limitations
Access to information	Helped quickly extract key details from datasheets (e.g., sensor logs, pin settings)	Precise instructions for CubeIDE configuration (IOC files) could not always be given
Code generation and support	Provided useful code snippets, best practices, and efficiency improvements	Sometimes overly cautious, suggesting unnecessary complexity or generic solutions
Learning Support	Improved understanding of microcontroller concepts (e.g., I2C communication, interrupts, sensor data handling)	Limited debugging support, online forums are often more effective
Reliability vs. General AI	More focused and less prone to "hallucinations" than ChatGPT	More limited scope: Had problems with integrating complex libraries (e.g. BSP files, display drivers)
Workflow Impact	Accelerated development, improved documentation, and code readability	Small/impractical interface and limited usability of the Copilot chatbot UI
Overall user experience	It served as a useful "assistant" and even as a "programming partner" for reflection and debugging	Some students used it only occasionally, preferring manual reading of fact sheets

Evidence

The pilot session and related outreach activities were documented and communicated through various channels to ensure visibility and reach:

- **Photos and screenshots:** Visual documentation was collected during the piloting of the *Microcontrollers* course and dissemination seminar, which served as direct evidence of student participation and testing of the tools.
- **Dissemination seminar (23 July 2025, University of Bayreuth):** The event brought together professors, students and technical staff to present and discuss the results of the AISS project. Presentations by Prof. Dr.-Ing. Gerhard Fischerauer, Prof. Dr. Natalia Morkun and M.Sc. Niklas Krug highlighted the methodological and pedagogical results. Participants received university teaching certificates and Erasmus+.


UNIVERSITÄT BAYREUTH
Lehrstuhl für Mess- und Regeltechnik
MIKROCONTROLLER
Willkommen beim digitalen Assistenten
für den Kurs Mikrocontroller – Sommersemester 2025
Prof. Dr.-Ing. Gerhard Fischerauer Lehrstuhl für Mess- und Regeltechnik Fakultät für Ingenieurwissenschaften Universität Bayreuth
Tel.: +49 (0)921 55 7230 Fax: +49 (0)921 55 7235 E-Mail: mrt@uni-bayreuth.de
Zur Website des Lehrstuhls
Weiter
UNIVERSITÄT BAYREUTH
Lehrstuhl für Mess- und Regeltechnik
MIKROCONTROLLER
Welcome to the Digital Assistant
Demo version of the full online course in German
This demo version was specifically created to support the simplified online course "Inside the Microcontroller" as part of the Erasmus+ AISS project.
Prof. Dr.-Ing. Gerhard Fischerauer Chair of Measurement and Control Engineering Faculty of Engineering Sciences University of Bayreuth
Tel.: +49 (0)921 55 7230 Fax: +49 (0)921 55 7235 E-Mail: mrt@uni-bayreuth.de
Assistant Developers: Prof. Dr.-Ing. Gerhard Fischerauer, Prof. Dr. Natalia Morkun, M.Sc. Niklas Krug
Visit the MRT Chair's Website
Visit AISS Website
When you're ready, click Next below to choose your topic.
Next

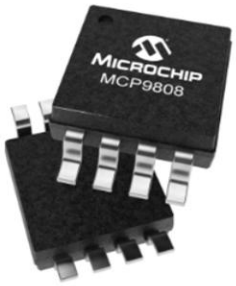
Wobei brauchst du Unterstützung?

- Organisatorische Informationen
- Theoretische Inhalte
- Individuelles Projekt
- Technische Unterstützung des Kurses
- Arbeit beenden & Feedback geben

MCP9808 – Digitaler Temperatursensor

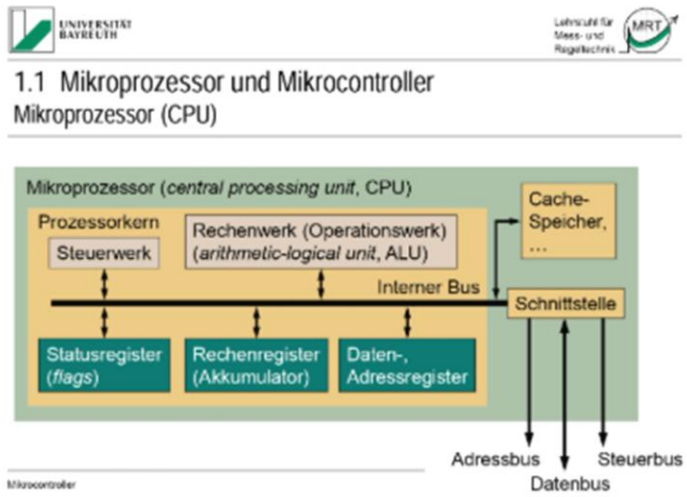
Der MCP9808 ist ein hochpräziser Temperatursensor mit digitaler I²C-Ausgabe, ideal für Anwendungen mit hohen Anforderungen an Genauigkeit und Energieeffizienz.

Messbereich:	-40 °C bis +125 °C
Genauigkeit:	±0,5 °C (max.) von -20 °C bis +100 °C
Auflösung:	0,0625 °C (wählbar)
Versorgungsspannung:	2,7 V – 5,5 V
Stromverbrauch:	200 µA (typ.) im Betrieb
Schnittstelle:	I²C / SMBus (400 kHz)



- Mehr Informationen
- Kalibrierung & Fehleranalyse
- Anwendungsbeispiele
- FAQ – Häufig gestellte Fragen

Präsentation – Slide 1/9



- ▶ Nächster Slide
- Zurück zur Lektion

Technische Unterstützung zum individuellen Projekt

Wähle den technischen Bereich, zu dem du Informationen oder Hilfe brauchst:

- Cortex-M4 Prozessor
- STM32F412 Mikrocontroller
- Sensoren & Schnittstellen
- Programmierung (STM32CubeIDE)
- Zurück zum Hauptmenü

STM32F412 Mikrocontroller

Die STM32F412 MCUs sind Einstiegsmodelle der leistungsstarken STM32F4-Serie. Sie bieten ein hervorragendes Verhältnis zwischen Rechenleistung und Energieeffizienz – dank Cortex-M4 Core (mit FPU) bei 100 MHz.

Technische Highlights: • 100 MHz Cortex-M4 + FPU • 125 DMIPS / 339 CoreMark (Flash) • 0-Wait-State dank ART Accelerator • BAM-Modus: Datenübertragung bei minimalem Stromverbrauch • Stromaufnahme: 112 µA/MHz (Run), 18 µA (Stop)

Speicher & Integration: • Flash: 512–1024 KB • SRAM: bis zu 256 KB • 48–144 Pins, sehr kompakte Packages • 14 Timer, 12-bit ADC (2.4 MSPS), True RNG

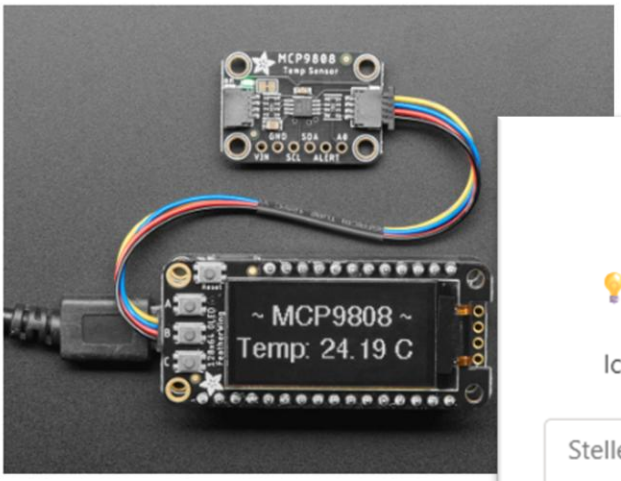
Schnittstellen: • 4x USART (bis 12.5 Mbit/s) • 5x SPI / I^2S (bis 50 Mbit/s) • 4x I^2C, 2x CAN, USB 2.0 OTG FS • SDIO, Audio über I^2S, PDM, Sigma-Delta Filter

Produktseite bei STMicroelectronics

Frage zum STM32F412 stellen

Tragbare Geräte: Ermöglicht energieeffiziente Temperaturüberwachung in batteriebetriebenen Geräten.

Smart Home & IoT: Nutzung als Temperatursensor in intelligenten Thermostaten oder Klimasteuerungen.



▶ Video ansehen

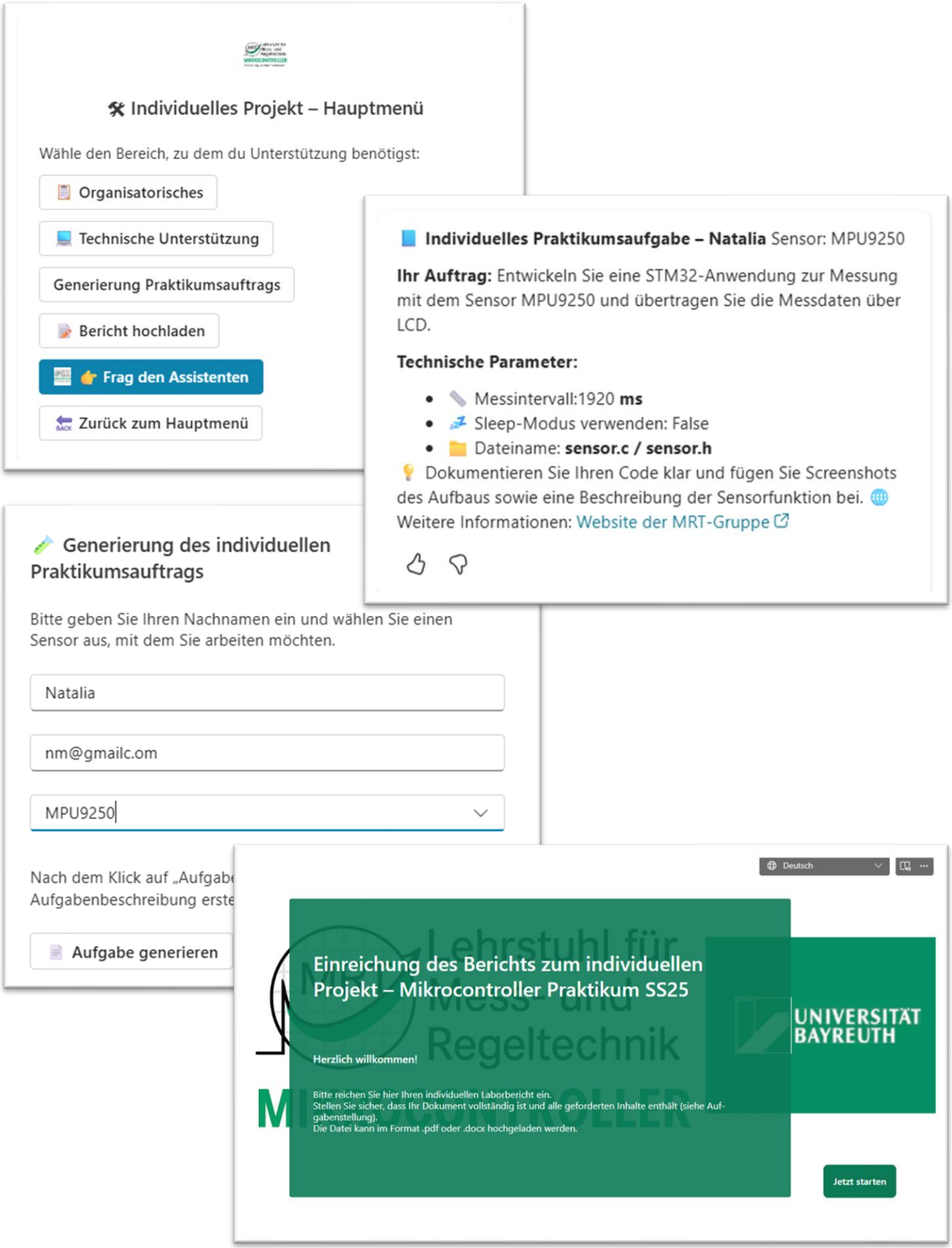
Zurück zum MCP9808

Hast du Fragen zum Cortex-M4 processor?

Ich helfe dir gerne weiter! Formuliere deine Frage unten:

Stelle deine Frage hier...

Frage an den Assistenten stellen


🛠 Individuelles Projekt – Hauptmenü
Wähle den Bereich, zu dem du Unterstützung benötigst:
Organisatorisches
Technische Unterstützung
Generierung Praktikumsauftrags
Bericht hochladen
👉 Frag den Assistenten
Zurück zum Hauptmenü
Individuelles Praktikumsaufgabe – Natalia Sensor: MPU9250
Ihr Auftrag: Entwickeln Sie eine STM32-Anwendung zur Messung mit dem Sensor MPU9250 und übertragen Sie die Messdaten über LCD.
Technische Parameter:
Messintervall:1920 ms
Sleep-Modus verwenden: False
Dateiname: sensor.c / sensor.h
Dokumentieren Sie Ihren Code klar und fügen Sie Screenshots des Aufbaus sowie eine Beschreibung der Sensorfunktion bei.
Weitere Informationen: Website der MRT-Gruppe
Generierung des individuellen Praktikumsauftrags
Bitte geben Sie Ihren Nachnamen ein und wählen Sie einen Sensor aus, mit dem Sie arbeiten möchten.
Natalia
nm@gmailc.om
MPU9250
Nach dem Klick auf „Aufgabe
Aufgabenbeschreibung erste
Aufgabe generieren
Deutsch
Einreichung des Berichts zum individuellen Projekt – Mikrocontroller Praktikum SS25
Herzlich willkommen!
Bitte reichen Sie hier Ihren individuellen Laborbericht ein.
Stellen Sie sicher, dass Ihr Dokument vollständig ist und alle geforderten Inhalte enthält (siehe Aufgabenstellung).
Die Datei kann im Format .pdf oder .docx hochgeladen werden.
Lehrstuhl für Mess- und Regeltechnik
UNIVERSITÄT BAYREUTH
Jetzt starten

Co-funded by the European Union

UNIVERSITÄT BAYREUTH

AISS
ARTIFICIAL INTELLIGENCE FOR STUDIES AND SUPPORT IN HIGHER EDUCATION

Unit 1: Inside the Microcontroller

Foundations of Embedded Systems

University of Bayreuth, Germany

Gerhard Fischerauer, Natalia Morkun, Niklas Krug

Tel.: +49 (0)921 55 7230 Fax: +49 (0)921 55 7235
E-Mail: mrt@uni-bayreuth.de

"Co-financed by the European Union. The opinions and views expressed are those of the author(s) and do not necessarily reflect t Spanish Service for the Internationalization of Education (SEPIE). Neither the European Union nor the awarding authority can be held res

Co-funded by the European Union

UNIVER BAYREU

Aim of the unit

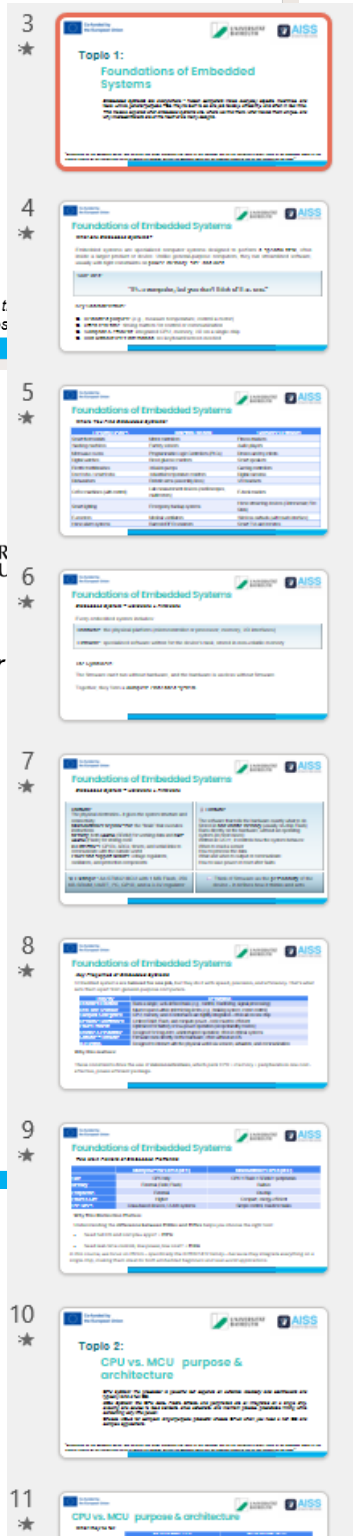
Give learners a big-picture understanding of what MCUs are, how they differ and where they are used.

Topics

1. Foundations of Embedded Systems
2. CPU vs. MCU purpose & architecture
3. Memory & I/O at a glance (Flash, SRAM, GPIO, timers, ADC/DAC)
4. Peripherals: GPIO, Timers, ADC/DAC, Comms
5. MCUs in the Real World: Applications & Trade-offs

Learning outcomes of the unit

- ✓ Define what an embedded system is and list its key characteristics
- ✓ Distinguish microprocessors from microcontrollers in plain language.
- ✓ Read a simple MCU block diagram and name its core parts.
- ✓ Explain what common peripherals do (GPIO, timer, ADC, UART).
- ✓ Identify real-world MCU application areas and key constraints



Co-funded by the European Union

UNIVERSITÄT BAYREUTH

AISS ARTIFICIAL INTELLIGENCE FOR STUDIES AND SUPPORT IN HIGHER EDUCATION

Unit 2: Inside the Microcontroller

Cortex-M4 Processor Fundamentals

University of Bayreuth, Germany

Gerhard Fischerauer, Natalia Morkun, Niklas Krug

Tel.: +49 (0)921 55 7230 Fax: +49 (0)921 55 7235
E-Mail: mrt@uni-bayreuth.de

"Co-financed by the European Union. The opinions and views expressed are those of the author(s) and do not necessarily re
Spanish Service for the Internationalization of Education (SEPIE). Neither the European Union nor the awarding authority can be he

Co-funded by the European Union

UNIV BAYI

Aim of the unit

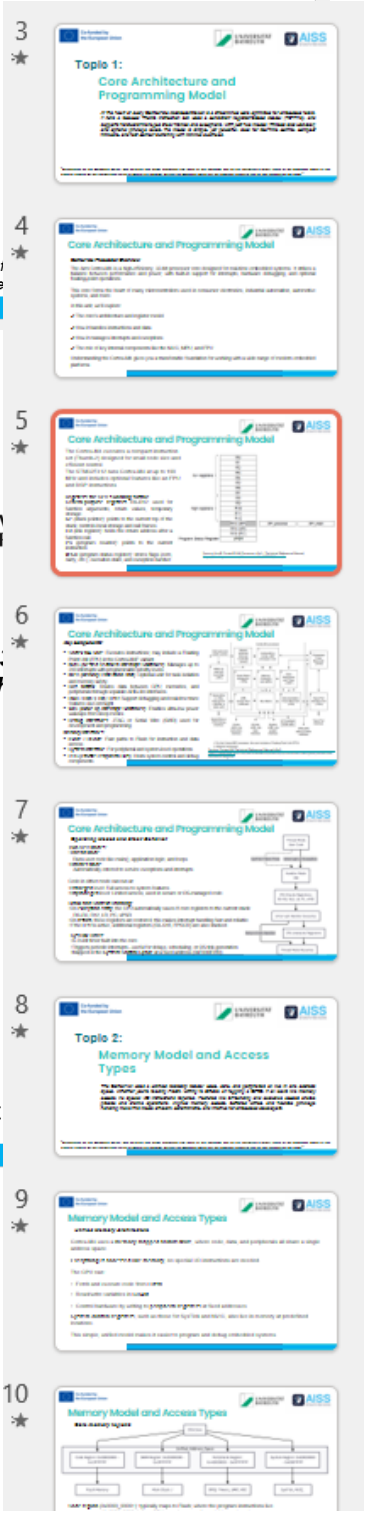
To introduce the architecture, core behavior, and programming model processor, laying the groundwork for understanding and using modern effectively. This unit helps learners build a strong conceptual model of th workings before moving on to specific hardware (STM32F412).

Topics

1. Core Architecture and Programming Model
2. Memory Model and Access Types
3. Exception and Interrupt Handling
4. Floating-Point Unit and CMSIS

Learning outcomes of the unit

- ✓ Describe the key components and registers of the Cortex-M4 core.
- ✓ Explain the processor's memory model and its interaction with peripherals.
- ✓ Understand exception types and how the processor handles interrupts.
- ✓ Utilize the floating-point unit and CMSIS interface in simple programs.
- ✓ Interpret core behavior in debugging scenarios (e.g., stack frames, interrupt



Co-funded by the European Union

UNIVERSITÄT BAYREUTH

AISS ARTIFICIAL INTELLIGENCE FOR STUDIES AND SUPPORT IN HIGHER EDUCATION

Unit 3: Inside the Microcontroller

STM32F412 Microcontroller in Practice

University of Bayreuth, Germany

Gerhard Fischerauer, Natalia Morkun, Niklas Krug

Tel.: +49 (0)921 55 7230 Fax: +49 (0)921 55 7235
E-Mail: mrt@uni-bayreuth.de

"Co-financed by the European Union. The opinions and views expressed are those of the author(s) and do not necessarily reflect those of th Spanish Service for the Internationalization of Education (SEPIE). Neither the European Union nor the awarding authority can be held responsible fo

Co-funded by the European Union

UNIVERSITÄT BAYREUTH

Aim of the unit

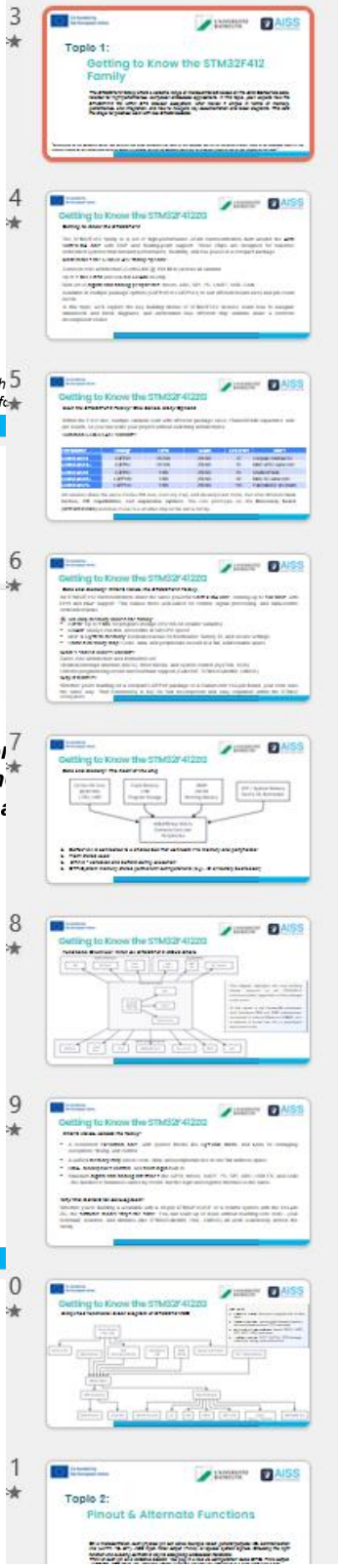
This unit introduces learners to hands-on development with STM32 microcontroller on the STM32F412 family. It connects theory with practical skills: understanding th pinout and peripherals, navigating STM32 development tools, and building simple a

Topics

1. Getting to Know the STM32F412 Family
2. Pinout & Alternate Functions
3. STM32 Development: From Idea to Execution
4. Safety & Lab Etiquette

Learning outcomes of the unit

- ✓ Interpret STM32F412 datasheet and pinout information
- ✓ Use STM32CubeMX to configure peripherals and generate code
- ✓ Build, flash, and debug simple embedded applications with STM32CubeIDE
- ✓ Describe the alternate function model and how peripherals connect to pins
- ✓ Follow safe lab and prototyping practices in real hardware work



Co-funded by the European Union

UNIVERSITÄT BAYREUTH

AISS

About this Course

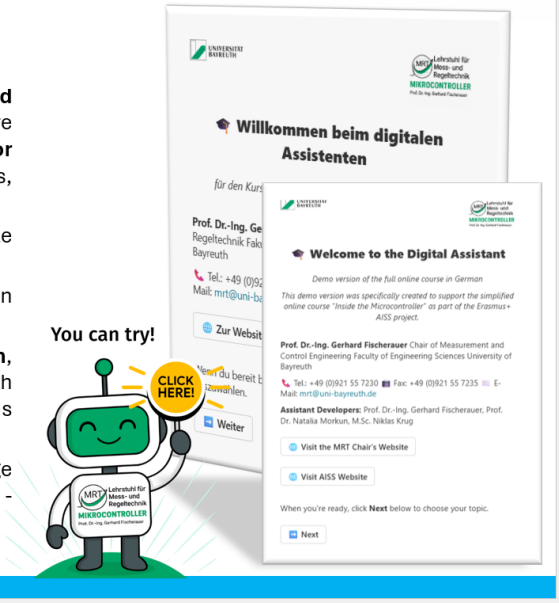
This course was developed with the support of **AI-powered assistance (ChatGPT)** to help curate, summarize, and structure technical content based on **official Arm Cortex®-M4 Processor and STM32 documentation**, including datasheets, user manuals, and Arm architectural references.

The goal was to create a clear, beginner-friendly learning path while staying faithful to verified sources.

All technical descriptions, diagrams, and workflows were based on materials published by **STMicroelectronics** and **Arm Ltd**.

A original version of this course is being developed in **German**, supported by a dedicated **AI assistant** to help learners interact with materials, answer questions, and explore embedded systems concepts on demand.

This project also demonstrates how instructors can use large language models to co-design meaningful educational content - from theory snapshots to interactive labs.



Co-funded by the European Union

UNIVERSITÄT BAYREUTH

AISS

Thank you for attention

Universität Bayreuth, Germany

Gerhard Fischerauer, Natalia Morkun, Niklas Krug

Tel.: +49 (0)921 55 7230 Fax: +49 (0)921 55 7235
E-Mail: mrt@uni-bayreuth.de

https://www.mrt.uni-bayreuth.de/de/index.html

- **Online Broadcasting:**
    - Advertisement and news article on the **institute's website -** https://www.mrt.uni-bayreuth.de/de/index.html, https://www.mrt.uni-bayreuth.de/de/news/2025/Seminar-zur-Unterstuetzung-der-Hochschullehre-durch-KI/index.html.
    - Anuncio en el portal web **ProfiLehrePlus: Hochschullehre Bayern** (ProfessionalEducationPlus: Higher Education Bavaria) - https://profilehreplus.de/seminare/unterstuetzung-der-hochschullehre-durch-ki-ergebnisse-und-handlungsempfehlungen-aus-einem-erasmus-projekt.
    - Noticia en el **portal de eventos regionales de Alta Franconia -**. https://region-bayreuth.de/veranstaltung/unterstuetzung-hochschullehre-kuenstliche-intelligenz-bayreuth-95447-hawn8u.
    - A **video ad with an AI-generated avatar** created on the HeyGen https://app.heygen.com/videos/6c09850439c34a60829a2342008bfdce platform.
    - A **social media post on the AISS Facebook page**, increasing reach beyond academic networks: https://www.facebook.com/share/p/19r99wpsaR/.

Together, these outreach efforts provided visibility both within the University of Bayreuth and in regional, national and international networks, ensuring that the results of the pilot and the results of the project reached various stakeholders in higher education.

Annex 1

Collecting feedback from students at the University of Bayreuth

Student 1

In this project, the use of chatbots was specifically supported, in particular by a Microsoft Copilot-based assistant (9) developed specifically for the module, which specialized in content on the dashboards used, software, sensors and module content. In addition, ChatGPT was used for code reviews and targeted improvements.

The module's own wizard helped me above all to quickly understand the gesture sensor used and its connection. However, due to the practical limitations of its interface (small and unwieldy window and rather cumbersome operation through buttons), I switched the rest of the work mainly to ChatGPT. There I received useful recommendations on the architecture and structure of the code, on increasing efficiency and problem solving, and I did it in a contextual way, i.e. taking into account the existing modules and the project in general.

All suggestions were not accepted blindly, but were verified on the basis of the information in the data sheet and tests in the system. Overall, the combination of specialized Copilot Assistant and ChatGPT has significantly improved the documentation, readability, and maintainability of the code and accelerated the development process.

Student 2

The chatbot was a great help in quickly extracting important information from long and confusing data sheets. For example, what information is located in which sensor registration directions.

It was also able to help with code generation to some extent. Since I'm not very familiar with C syntax and microcontroller-specific function names, I would have had to read the documentation without the chatbot to find out what functions are available to me. The chatbot was able to immediately tell me useful functions and also apply them directly to my code. The chatbot always uses best practices. If you want to do it differently, point out potential problems, but you can't say if these problems would occur in this case. It seems to be a bit too cautious, in my experience, primitive code usually works as well.

When asked about the necessary configurations in the CubeIDE and IOC file, the chatbot could only list which values need to be set, but not specifically where and how these configurations can be made. This also leads to the fact that the generated code does not work, as it was partly not possible for me to obtain the necessary interfaces through the IOC. In order to control the screen, I had to copy the code and header files from a working example and integrate them into my project with great difficulty.

Student 3

During the project, I tested different chatbots for support. I used the course's internal chatbot several times, but I didn't really get along with it.

In the end, I mostly used ChatGPT and made the STM32F4 discovery board manual and MMA8451 datasheet available in the chat. This allowed me to ask specifically how certain interfaces can be controlled or what functions the libraries of the STM32F412G offer.

As already mentioned, chatbots were more of a hindrance than a help for me in integrating the BSP into my project, as some of the files were probably combined into the stm32412g_discovery.h/.c. Therefore, the structure of the BSP differed significantly from that on which OpenAI's GPT-4o model was trained.

Despite these issues, it was helpful to have a conversation partner with whom I could brainstorm issues during implementation. Sometimes really helpful tips came up, and sometimes the chat just served as a "programming duck." It helped me catch bugs on my own by accurately explaining to ChatGPT how my current code works.

In addition, I also used ChatGPT at the end to review this report and minimize spelling and grammatical errors. It's important for me to emphasize: I wrote the report itself entirely myself: the chatbot only served as a better autocorrect so that there are no misunderstandings when reading, otherwise my spelling and comma placement are really inaccurate.

Student 4

Overall, the chatbot was used between 6 and 7 times. This was particularly useful for tasks for which you would have to search the datasheet without a chatbot. For example, for questions such as:

"How's the pin... labeling on the circuit board of the STM32F4?"

"Which register on the sensor represents the acceleration in Z?"

"Which pins need to be set to High/Low for the sensor direction... Is it?"

The chatbot was also helpful in learning how the configuration logs worked for sensor accuracy.

Logically, the chatbot had difficulty debugging STM32CubeIDE.

In some cases, better solutions were found in online forums. This is understandable, as this wasn't necessarily the chatbot's focus.

Student 5

The chatbot has been used as a complement to the information in the exercises when important information could not be found in the datasheets, or additional explanation was needed for better understanding. For example, to repeat the basics of I2C communication and the HAL functions required for it, or to set up kill pins. Problems arose when asked about the control of the built-in display: Firstly, it was described that bitmaps should be sent directly to the screen via the interface, which seemed odd due to the complexity. It has therefore only become clear through further investigation that the so-called "BSP" is responsible for the simple control of the display. After the chatbot was subsequently confronted with the use of the BSP, a helpful manual was published.3 So, if you summarize individual searches, the chatbot was used three times.

Student 6

On the one hand, the provided AI chatbot was used to properly combine and store the raw sensor data with the question "How can the raw temperature and humidity values be stored in a uint32_t each of the 6 bytes read from the sensor?" The attached output was well suited to understanding the storage scheme of the measurement data used by the sensor.

On the other hand, the chatbot recommended the use of the corresponding ASCII code to display a "°" symbol on the screen, although this symbol is not stored in the symbol database used, so this variant was not usable. Another suggestion as an alternative to using the predefined symbol was to create your own bitmap and then draw this symbol using an associated function, but this would have taken relatively time. The third suggestion was actually used to mimic the symbol "°" through a superscript "or". In response to the question "How can I set the lowercase or superscript when using the BSP driver to control the display?", useful code was generated, which was further tailored for the specific application.

Student 7

The chatbot provided was only used for initial orientation. It is very useful to extract information from manuals and datasheets, but it can also be found quickly in the datasheet. For my part, working directly with a data sheet and manual had become a habit while working. However, I can confirm that the course chatbot is less prone to hallucinations. I couldn't perceive the classic ChatGPT answer, which corrects a really correct statement and arrives at the same result, here with some questions about bit switching. Due to low usage, the limits of the chatbot were not explored, although these are due to limited input data in C programming, screen control, and the like. However, I cannot testify to this myself.

JOHN PAUL II PONTIFICAL UNIVERSITY (UPJP2)

The main objective of the piloting session was to test and evaluate the AISS learning materials and tools within the Digital Media course framework. The session was organised around short presentations, demonstrations, and interactive practice with AI-powered tools.
Participants were introduced to:

- the project activities and results (WP2, WP3, WP4, WP5)
- AI-powered virtual assistants
- tools supporting educators and students
- multimedia course modules
- practical strategies for implementing AI in higher education.

The objectives of the session were met, as participants successfully engaged with the tools and explored their potential in academic contexts. Indicators such as active participation, questions raised, and willingness to test the system confirmed the relevance and effectiveness of the piloted materials.

UPJP2 Student Feedback

Participants reacted positively to the session and expressed appreciation for the opportunity to experiment with AISS solutions in practice. The evaluations highlighted:

- high interest in the practical applications of AI in teaching and learning
- a strong appreciation of the interactive and user-friendly format
- requests for further demonstrations and extended training opportunities.

Overall, the feedback confirmed that the AISS approach is perceived as useful, innovative, and relevant to the needs of both students and educators.

Evidence

KAUNAS UNIVERSITY OF TECHNOLOGY – KTU-

The KTU pilot was based on the Multimedia Technologies for Education course and was carried out on the university's Moodle platform: https://open.ktu.edu/course/view.php?id=353

The pilot session aimed to help teachers understand the basics of multimedia tools, apply artificial intelligence for content design and analyse technologies for inclusive education. The 40-hour course was organized into three modules:

- The first introduced fundamental multimedia concepts, showing how text, images, audio, and video can support student engagement.
- The second focused on AI applications, giving participants the opportunity to design learning materials using modern tools.
- The third explored inclusive education, with case studies and evaluation frameworks to assess accessibility and effectiveness.

The activities combined lectures, demonstrations, workshops and group discussions, ensuring a balance between theory and practice. Success was measured through practical assignments, thoughtful posts, and a final project in which teachers created multimedia learning objects. The objectives were fully achieved, as participants gained both the knowledge and skills to design engaging, technology-driven, and inclusive learning experiences that can be applied in modern classrooms.

KTU Student Feedback

During the pilot session, participants showed a very positive reaction to using the Artificial Intelligence Support System (AISS). Most of the teachers valued the hands-on experience very positively, as it allowed them to experiment with tools they had only heard of before. They found

the system to be easy to use, engaging, and supportive in making complex processes such as content design more accessible. According to the feedback gathered through evaluations and reflections, most agreed that the objectives of the course were successfully achieved. Participants reported that they clearly understood the basics of multimedia technologies and how different formats such as text, video, or interactive elements can be integrated to enhance teaching. They particularly valued the opportunity to apply AI tools for content design, as it gave them practical skills to create inclusive and interactive learning resources.

Several participants mentioned that they felt more confident using AI for lesson preparation and adapting content to various learning needs. Another key finding was increased awareness of inclusion: participants were able to analyze existing technologies and critically evaluate their effectiveness for students with disabilities. They highlighted the importance of accessibility features, such as subtitles, screen readers, or sign language avatars, and expressed their willingness to implement these practices in their teaching. Overall, the feedback from the group of students was very encouraging, indicating that the pilot session not only met its objectives, but also motivated teachers to continue exploring innovative and inclusive approaches in education.

Evidence

22 participants found

First name: All A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Last name: All A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

First name / Last name	Email address	Roles
Asta Aksinavičienė	a.aksinaviciene@gmail.com	Student
Jurgis Andziulis	jurgis.andziulis@ktu.edu	Student
Domas Baltrušaitis	domas.baltrusaitis@ktu.edu	Student
Paulius Bartasevičius	paulius.bartasevicius@ktu.edu	Student
Ana Basiukaitienė	ana.basiukaitiene@ktu.edu	Student
Gabija Eicheltaitė	gabija.eicheltaite@ktu.edu	Student
Jolanta Grigaliūnienė	jolanta.grigaliuniene@ktu.edu	Student
Daina Gudonienė	daina.gudoniene@ktu.lt	Teacher
Rimantas Intas	it@smk.lt	Student
Marius Jankauskas	marius.jankauskas@ktu.edu	Student
Dainius Juškys	dainius.juskys@ktu.edu	Student
Vytautas Krivelis	krivelis.v@gmail.com	Student
Justas Lisajus	justas.lisajus@ktu.edu	Student
Aurimas Matelis	aurimas.matelis@ktu.edu	Student
Karolis Mockaitis	karolis.mockaitis@ktu.edu	Student
Roberta Paulauskaitė	roberta.paulauskaite@ktu.edu	Student
Simona Skarboe	simona.petrauskaite@ktu.edu	Student
Gytis Šneideraitis	gytis.sneideraitis@ktu.edu	Student
Miglė Štabokaitė	migle.stabokaite@ktu.lt	Student
Dovydas Stumbra	dovydas.stumbra@ktu.edu	Student
Julius Vaičiulis	julius.vaiciulis@ktu.edu	Student
Ingrida Vilavičienė	i.ivanauskaite@ktu.edu	Student