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Template for submission of good practices

Title of good practice	*Concise and interesting descriptive title (15 words max)*	**THOR**: Integrating Mechanical Engineering and Digital Design through Student-Driven Robotic Development in VET
Institution Name	*Name of the institution or network implementing the practice*	**School Centre Škofja Loka – Higher Vocational College** *(Šolski center Škofja Loka – Višja strokovna šola)*
Contact Person	*Name and role of the contact person*	**Igor Hanc, MSc** Head of Higher Vocational College School Centre Škofja Loka
Thematic Area	*Select one or more thematic areas*	☒ Skills ☐ Quality Assurance ☒ Research and Innovation ☐ Regional Impact ☒ Internationalisation
Summary of the good practice (max 150 words)	*A short description summarising what the practice is about and its aims.*	**THOR** is an interdisciplinary student project developed at the Higher Vocational College Škofja Loka (Slovenia) as part of the European VACIDE initiative. It involved designing and manufacturing a fully functional six-axis robotic arm by a team of students over several years. Each student was responsible for one subsystem, from CAD modeling to CNC machining and 3D printing. The project promoted cross-disciplinary collaboration, hands-on learning, and integration of subjects such as mechanical engineering, computer-aided design and

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		manufacturing, electronics, business communication, and English. The result is a working robot, a comprehensive engineering dossier (eBOM, mBOM, CAD files), and a diploma thesis documenting the entire development process. THOR now serves as a permanent educational tool, supporting the development of digital and engineering competences for Industry 4.0.
Background and Objectives	*What challenge or need did this initiative address, and what were the aims of the initiative?*	The THOR project was initiated in response to the growing demand for practical, interdisciplinary, and digitally supported learning in technical and vocational education. While theoretical knowledge was well covered in curricula, students lacked opportunities for extended hands-on work that mimics real-world engineering challenges. The aim was to create a complete, student-led development cycle—from concept to production—within an educational setting. A specific technical objective was that at least 30% of the robot's parts had to be manufactured using traditional machining or CNC technologies, encouraging deeper understanding of material behavior, tolerance management, and manufacturability. The broader goal was to develop students' competencies in areas such as mechanical design, digital fabrication, system integration, and team project management. Additionally, the project fostered the integration of complementary skills such as English communication, documentation, and collaborative problem-solving—preparing students for the complexities of modern industrial environments and the transition to Industry 4.0.
Implementation	*Please describe the*	The THOR project was implemented as part of the European initiative **VACIDE – Vocational**

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	process, stakeholders involved and how the practice was executed.	**Action Competence in Digital Environments**, and was carried out over multiple years at the Higher Vocational College Škofja Loka (Slovenia). It followed a project-based learning model in which ten students participated, each fully responsible for the design, modeling, and production of a specific robotic subsystem (e.g., base, joint modules, wrist articulation, or sensor housing). Students were mentored by faculty, but independently led all technical, documentation, and coordination tasks. The process involved CAD modeling (Creo 7.0), preparation of technical drawings, G-code programming, and 3D printing. A project requirement specified that at least 30% of all parts must be manufactured using CNC or conventional machining, while the rest were additively manufactured. A first prototype was built and evaluated. Based on the findings, a second version was developed, which simplified manufacturing, improved assembly, and enhanced mechanical reliability. The result was a functional six-axis robotic arm supported by comprehensive documentation including eBOM and mBOM. The project was developed within a broader international collaboration coordinated by VACIDE, which brought together educational and technical expertise from: • **Šolski center Škofja Loka** (Slovenia) – engineering, manufacturing and THOR project implementer • **Eurocultura** (Italy) – dissemination, intercultural support, and mobility coordination

		• **GEBIFO** (Germany) – research and analysis of digital learning competence • **VHS-Bildungswerk GmbH** (Germany) – lead institution, electronics and PLC training, pilot implementation This transnational cooperation ensured both local impact and international validation. Today, the THOR robot is used as a teaching and demonstration tool, and as a model of interdisciplinary, student-driven engineering education aligned with Industry 4.0 goals.
Results and Impact	*What were the measurable outcomes of the initiative?*	**Results and Impact** The THOR project delivered strong technical, educational, and institutional outcomes: • **Functional Robotic System**: A fully operational six-axis robotic arm was designed, produced, and assembled by students. • **Graduation Thesis**: The entire development process was documented in a diploma thesis, available for academic review and replication. • **Engineering Documentation**: A complete set of professional documentation was created, including 3D CAD models (Creo 7.0), G-code for CNC, eBOMs and mBOMs, and mechanical drawings. • **Student Competence Development**: Participants acquired hands-on expertise in CAD/CAM, CNC machining, 3D printing, system integration, team collaboration, and technical communication.

		• **Educational Integration**: The project was embedded across multiple vocational subjects (e.g., mechanical engineering, production technologies, English, business communication), promoting interdisciplinary teaching. • **Iterative Design Thinking**: A second, redesigned version of the robot demonstrated students' ability to improve real-world systems based on evaluation and feedback. • **Long-Term Teaching Tool**: THOR is now a permanent instructional tool used for training future student cohorts. • **International Collaboration**: Conducted within the framework of the European project **VACIDE**, THOR involved collaboration with partners from Slovenia, Germany, and Italy. These institutions contributed to curriculum integration, pilot testing, research coordination, and dissemination of the results across Europe. This collaboration led to wide dissemination, strengthened institutional networks, and positioned the THOR project as a replicable and scalable model of vocational innovation aligned with Industry 4.0 skills.
Lessons learned and Transferability	*What worked well? What challenges were encountered? Can this initiative be adapted to*	The THOR project demonstrated that student-led, project-based learning is highly effective for developing applied technical competences. Assigning each student full responsibility for one robot subsystem led to deep engagement, problem ownership, and collaboration across disciplines. A key success was the integration of conventional machining (CNC) with digital

	other environments?	fabrication (3D printing), which gave students practical insight into materials, tolerances, and design-for-manufacturing. The iterative development process—from a complex first prototype to a simplified second version—illustrated the value of testing, reflection, and redesign. Challenges: • The COVID-19 pandemic disrupted on-site work, forcing the team to adopt remote collaboration strategies. • Students and mentors adapted by using ICT tools such as online CAD platforms, version control systems, video conferencing, and shared cloud repositories to manage technical progress and communication. • Coordinating the integration of subsystems remotely required careful planning, digital mock-ups, and continuous communication. Despite these difficulties, the team successfully completed the project, gaining additional experience in digital project management, virtual teamwork, and problem-solving in constrained environments. Transferability: This initiative is highly transferable to other vocational and technical institutions. Its modular structure, comprehensive documentation (CAD, G-code, BOMs), and adaptability make it ideal for replication or scaling. Schools can implement the project with different tools and levels of complexity based on local needs. The use of digital tools for design, communication, and project coordination

		proved essential—not only during the pandemic but as a model for hybrid or international cooperation. The THOR project offers a robust framework for combining technical, digital, and transversal competences in applied education.

Supporting Materials	*Links to documents, websites, or pictures.*	The following materials are available to support and illustrate the THOR good practice:
		• **Graduation thesis** (in Slovenian, with technical drawings and commentary) – available upon request
		• **Engineering documentation**, including:
		  ○ 3D CAD models (Creo 7.0)
		  ○ G-code for CNC machining
		  ○ eBOM and mBOM (construction and procurement)
		  ○ Assembly instructions and exploded views
		• **Photographic documentation**: images of design, prototyping, machining, and final assembly
		• **Presentation materials**:
		  ○ A1 project poster (PDF)
		  ○ Slide deck for dissemination and internal presentation
		• **VACIDE Project Website**: https://www.vacide.eu/sl/
		→ Includes project description, methodology, partner roles, and implementation guides
		• **Digital repositories** (internal access for partners):

		◦ Source files, STL models for 3D printing ◦ Version-controlled documentation archives (Git/Drive-based) • **EURASHE Submission Document (this file)** – available for download and review Additional documentation (English summaries, translated technical sheets, or source files) can be provided upon request for replication or adaptation in other educational contexts.

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