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Comparing AI-Generated and Teacher-Generated Lessons in moodle

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ABSTRACT

This study examines the pedagogical quality and student acceptance of AI-generated lesson materials produced by Moodle's integrated AI tool. It compares an AI-generated moodle course with a teacher-generated course on the same computer science topic, using the Technological Pedagogical Content Knowledge (TPACK) framework to evaluate the AI-generated lesson against the teacher-generated one. The main research question asks to what extent AI-generated lesson texts differ from teacher-generated lesson materials in their integration of technological, pedagogical, and content knowledge. A comparative qualitative content analysis based on Mayring's deductive–inductive approach was applied as the methodology. CK, PK, and TK served as deductive main categories, while subcategories were developed from students' open-ended questionnaire responses. The study involved 14 students, including 10 primary participants and 4 supplementary validation participants; a second teacher reviewed the questionnaire and analytical categories. The findings show that students perceived the AI-generated lessons as concise, clear, logically structured, and useful for revision or examination preparation. However, they considered teacher-generated materials more detailed, context-sensitive, and suitable for first-time learning. In the pedagogical dimension, AI-generated materials lacked sufficient scaffolding, practical examples, and real-world relevance. In the content dimension, they were accurate but superficial rather than in-depth. In the technological dimension, AI-generated images were often blurry, unreadable, and misleading, reducing students' trust in the materials. The study concludes that Moodle-integrated AI can support teachers in creating summaries, revision materials, and initial lesson drafts, but does not yet replace teachers' expertise in pedagogical design, subject depth, contextual adaptation, and reliable multimedia development.

KEYWORDS AI in education, moodle AI tool, TPACK

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Introduction

Artificial intelligence (AI) and Massive Open Online Courses (MOOCs) are increasingly reshaping the international educational landscape. As noted by Reich and Ruipérez-Valiente (2019), MOOCs enable universities, schools, companies, and public institutions to offer digital learning opportunities to large numbers of learners regardless of their location. They have expanded access to lectures, assessments, resources, and learning communities beyond traditional face-to-face classrooms. However, the authors emphasize that access alone does not automatically ensure educational quality or successful learning outcomes [1]. According to Kasneci et al. (2023) Generative AI tools have further increased the relevance of AI for online learning. Platforms such as ChatGPT, Google Gemini, Claude, and LMS-integrated AI tools can generate texts, questions, feedback, and images. In Moodle-based courses, such tools can support the creation and revision of learning material directly within the course environment. This may help teachers develop content more efficiently, especially in large-scale online courses [2]. As highlighted by Zawacki-Richter et al. (2019), these opportunities and challenges become particularly significant when AI is

embedded directly in a learning management system (LMS) such as Moodle. In this context, AI-generated material becomes part of a structured course that includes learning objectives, resources, exercises, assessments, and communication. Therefore, the key question is not only whether AI can generate a text or image, but also whether its output supports the instructional purpose of the course. AI-generated materials should be accurate, understandable, accessible, relevant to the curriculum, and appropriate for learners' prior knowledge and learning needs [3]. To address these requirements systematically, the next section discusses the methodological aspects of digital learning through the Technological Pedagogical Content Knowledge (TPACK) framework. This framework provides a suitable basis for evaluating how AI-generated materials can be integrated effectively into Moodle-based learning environments.

TPACK Framework

To evaluate whether these requirements are fulfilled, the Technological Pedagogical Content Knowledge (TPACK) framework provides an appropriate theoretical perspective. Building on Lee Shulman's earlier model of pedagogical content knowledge (PCK), Mishra and Koehler (2006) developed the TPACK framework, arguing that meaningful technology integration requires a situated and context-sensitive knowledge base rather than technical skill alone. Since its introduction, TPACK has become one of the most influential frameworks for analyzing technology-enhanced teaching and for evaluating the quality of digital lesson design [4]. Regarding AI-generated learning materials, content knowledge is particularly important for assessing the quality and instructional suitability of the output. As noted by Shulman (1986), content knowledge concerns the correctness, depth, and organization of subject matter. Accordingly, AI-generated lessons should be evaluated according to whether they provide sufficient technical detail, clear explanations, relevant examples, and logically connected concepts [5].

Research Gap

According to Le Tan et al. (2025), the use of artificial intelligence (AI) in education is expanding rapidly, ranging from intelligent tutoring systems and adaptive learning systems to generative tools that support teachers and students. Their systematic review indicates that AI can facilitate personalization and learning analytics; however, it also highlights the need for further research on pedagogical quality and ethical use in authentic educational settings [6]. As reported by Zhu et al. (2026), teachers recognize the potential of AI tools in education but remain cautious about issues of control, responsibility, and alignment with their own didactic beliefs. Their findings suggest that acceptance of AI-generated materials depends strongly on perceived didactic fit, transparency, and teachers' ability to adapt and critically evaluate AI-generated outputs [7]. Similarly, as noted by Stadler et al. (2020), research on AI in education has often focused on adaptive learning, automated assessment, and stand-alone tutoring systems. In contrast, the integration of AI into mainstream learning management systems (LMSs), such as Moodle, has received comparatively limited detailed attention [8]. As Zawacki-Richter et al. (2019) noted, AI applications in education include intelligent tutoring systems, learning analytics, adaptive learning systems, and generative AI tools. These applications can support teachers in preparing instructional materials Nevertheless, research indicates that the use of AI in higher education has often focused more on technological possibilities than on teachers' pedagogical roles and classroom-related needs [3]. Finally, as demonstrated by Koraishi and Karatepe (2025), AI-generated materials can effectively summarize and restate key points but tend to underperform in areas requiring nuanced pedagogical judgement. These areas include the formulation of clear learning objectives and the adaptation of content to actual classroom conditions [9].Taken together, these findings reveal a research gap concerning the pedagogical quality, instructional design, and acceptance of AI-generated materials created directly within LMS environments such as Moodle.

The Aim of the Study

The identified research gap gives rise to three interrelated needs:

Need to characterize didactic quality differences: As highlighted by Henderson et al. (2025), studies comparing generative AI outputs with teacher-generated inputs demonstrate that, although AI can provide rapid and extensive feedback or content, its outputs are often perceived as less context-sensitive, less reliable, and less closely aligned with course-specific learning objectives. Teacher-generated materials, by contrast, typically reflect a deeper understanding of curriculum requirements, students' backgrounds, and classroom culture. These factors influence the selection, organization, and sequencing of lesson content [10].

Need to measure teacher perceptions and acceptance: Research by Fan et al. (2025) suggests that teachers' beliefs, values, and perceived self-efficacy strongly influence whether and how they adopt AI tools in their teaching practices. Research on AI literacy and competence frameworks further indicates that acceptance is shaped by perceived usefulness, perceived ease of use, ethical concerns, and consistency with professional identity. Therefore, teachers may be more likely to accept AI-generated content when it supports, rather than undermines, their didactic autonomy [11]. Although teachers' beliefs, values, perceived self-efficacy, and professional autonomy may influence their adoption of AI tools in teaching practices, teacher acceptance is not the focus of the present study. Instead, this study concentrates on students' perceptions and acceptance of AI-generated lesson content in Moodle. Need for validated instruments and comparative methodology: As noted by Barcelona and Dela Cruz (2025), research on the

development and validation of scales for AI-related constructs in education emphasizes the importance of rigorous instrument development. This process combines qualitative exploration with psychometric testing to ensure instrument reliability and validity [12].

Based on the findings of these studies, the present research is motivated to conduct a systematic comparison between AI-generated and teacher-generated lessons addressing the same topic within a Moodle-based course. Specifically, the study seeks to analyze differences in didactic structure and instructional methods, assess the perceived pedagogical and methodological quality of AI-generated lesson materials, and investigate teachers' and students' acceptance of AI-produced resources. Accordingly, the aim of this study is to analyze differences in the didactic structure and instructional methods of AI-generated and teacher-generated lesson materials. Furthermore, it aims to assess the perceived pedagogical and methodological quality of AI-generated materials and investigate teachers' and students' acceptance of these AI-produced resources

Research Questions

Based on the identified research gap and research needs, the following research questions were developed. The main research question is grounded in the Technological Pedagogical Content Knowledge (TPACK) framework. As argued by Ning et al. (2024), effective technology-integrated teaching does not result from treating technological, pedagogical, and content knowledge as separate competencies. Rather, it depends on the dynamic interaction among these domains and on an understanding of how they intersect within a specific teaching and learning context. This perspective is particularly relevant to the use of AI-generated lesson materials in Moodle, as their educational quality depends not only on the technology used but also on how appropriately content, pedagogy, and technology are integrated [13].

Research Question: To what extent do AI-generated lesson texts produced by Moodle's integrated AI tool differ from teacher-generated lesson texts in their integration of technological, pedagogical, and content knowledge (TPACK), and how do students perceive and accept these AI-generated materials?

This research question therefore examines whether AI-generated lesson material demonstrate an appropriate integration of the three central TPACK domains—technological knowledge, pedagogical knowledge, and content knowledge—in comparison with teacher-generated texts. It further investigates students' perceptions and acceptance of these AI-generated materials within the Moodle-based learning environment.

Research Question a: What qualitative differences exist between AI-generated and teacher-generated lesson materials in how they integrate content knowledge, pedagogical knowledge, and technological knowledge, as conceptualized by the TPACK framework?

Research Question b: How do students evaluate the pedagogical adequacy and usability of AI-generated lesson material in Moodle, particularly regarding their perceived integration of content, pedagogy, and technology?

Research Question C: which TPACK-related factors do students associate with their acceptance of AI-generated material?

The research questions are addressed through a comparative qualitative content analysis based on Mayring's deductive–inductive approach. The three core domains of the TPACK framework—content knowledge, pedagogical knowledge, and technological knowledge—serve as the deductive main categories. Additional subcategories are developed inductively through the comparison of AI-generated and teacher-generated course materials, as well as through the analysis of students' responses to open-ended questionnaire questions. This approach combines a theory-driven analysis of the lesson materials with insights derived from students' actual learning experiences.

Relevant Literature

The Technological Pedagogical Content Knowledge (TPACK) framework provides the theoretical foundation for examining effective technology integration in teaching. In the present study, it is used to compare AI-generated and teacher-generated moodle lesson texts. Rather than evaluating AI-generated material only in terms of its technical production, the framework makes it possible to examine whether the material integrates accurate subject content, suitable pedagogical strategies, and appropriate technological features in a coherent manner. Valtonen et al. (2023) conceptualize TPACK as the interaction of technological, pedagogical, and content knowledge, rather than the isolated application of technological skills. This framework is relevant to the present study because the educational quality of AI-generated moodle lesson texts depends not only on their technical generation, but also on their capacity to support learning and represent disciplinary content accurately [14]. Ali and Hawk (2024) emphasize that TPACK is context-dependent because teachers' instructional decisions must account for learners' needs, disciplinary requirements, available technologies, and institutional conditions. Their mixed-method study further indicates that teachers' knowledge of students' cultural backgrounds is associated with their perceptions of TPACK, highlighting the importance of learner context in technology-supported instructional design [15]. Engin et al. (2023) demonstrate that the development of TPACK requires more than familiarity with digital tools. Lesson planning, microteaching, reflection, and the revision of technology-enhanced learning activities can support teachers in connecting technological choices with pedagogical and subject-specific decisions [16].

The following figure illustrates the TPACK framework, which describes the integration of teachers' technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK).

Koehler and Mishra (2009) describe TPACK as the meaningful integration of technological, pedagogical, and content knowledge within a specific teaching context. In this study, these three domains provide the analytical basis for comparing AI-generated and teacher-generated moodle lesson texts: pedagogical knowledge is used to assess explanations, examples, scaffolding, and learner support; content knowledge is used to examine accuracy, depth, and subject-specific relevance; and technological knowledge is used to evaluate the suitability and reliability of Moodle-integrated AI functions and generated outputs [17].

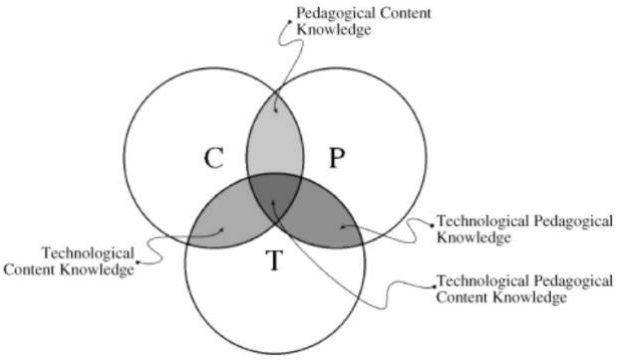


Fig. 1 Technological Pedagogical Content Knowledge (Koehler & Mishra, 2009; Source: Koehler & Mishra, 2008)

Pedagogical Knowledge

Valtonen et al. (2023) show that teachers' technological, pedagogical, and content-related knowledge may develop at different rates. This finding indicates that the ability to use a digital tool does not automatically ensure the pedagogical capacity to structure learning, provide scaffolding, or support meaningful student engagement. For the present study, pedagogical knowledge is therefore relevant for assessing whether AI-generated moodle lesson texts offer clear explanations, appropriate learning sequences, concrete examples, and adequate support for learners [14]. Abouelenein and Selim (2024) found that digital interventions such as interviews, reflective reports, and video simulations can support the development of pre-service teachers' TPACK. Their findings suggest that the pedagogical value of technology depends on teachers' ability to reflect on, evaluate, and adapt instructional decisions to learners' needs. This is relevant to AI-generated moodle materials because teachers must evaluate and revise AI-generated texts when explanations, examples, or scaffolding are insufficient [18]. Mekheimer (2025) argues that effective technology integration in higher education requires the combined consideration of technological knowledge, pedagogical knowledge, and content knowledge. Pedagogical knowledge is particularly important because it guides the selection of teaching strategies, learning activities, feedback methods, and assessment practices that make technology-supported learning meaningful [19]. Simon et al. (2025) highlight that learning-management-system use in higher education should be evaluated in relation to teachers' and students' educational experiences. moodle functions should therefore be selected and organised to support pedagogical purposes, such as interaction, task completion, feedback, and learner progress, rather than being used solely because they are technically available [20]. Koraishi and Karatepe (2025) compare AI-generated and teacher-generated summaries, providing a closely related basis for the present study. Their comparison shows that the quality of AI-generated educational text should not be evaluated only in terms of efficient content generation or broad coverage; it should also be assessed in relation to pedagogical depth, contextual relevance, and suitability for learners. The present study extends this comparison by examining AI-generated and teacher-generated moodle lesson texts rather than summaries alone [9]. Henderson et al. (2025) compare generative-AI and teacher feedback from students' perspectives, focusing on usefulness and trustworthiness. Their study is relevant because it demonstrates that students' evaluations of AI-generated material may depend not only on whether the content is available or useful, but also on whether it is perceived as trustworthy, contextually appropriate, and educationally supportive. The present study expands this perspective from feedback to moodle lesson texts embedded in a course environment [10].

Content Knowledge

Velander et al. (2024) reports that teachers' AI-related content knowledge may be affected by misconceptions and incomplete understanding, particularly when knowledge is acquired through informal or incidental learning. Their findings emphasize the importance of accurate subject knowledge when teachers introduce complex digital and AI-related topics in educational settings. In the present study, content knowledge is therefore used to assess whether AI-generated moodle lesson texts provide accurate, sufficiently detailed, and relevant subject content [21]. Mailizar et al. (2026) found that generative AI can support the development of mathematics teachers' TPACK, particularly in relation to pedagogical strategies. However, their findings also indicate that teachers require adequate subject knowledge to evaluate, adapt, and use AI-generated resources appropriately in their lessons. This supports the assumption that teacher expertise remains necessary to review the accuracy, depth, and educational appropriateness of AI-generated moodle lesson texts [22]. Amiruddin et al. (2026) emphasize that technology-integrated teaching competence requires subject-specific approaches. Content knowledge should therefore not be understood as general factual information alone; rather, it must be connected to the concepts, practices, and epistemological characteristics of the relevant discipline. This perspective guides the present study's assessment of whether AI-generated moodle lesson

texts provide content that is appropriate for the specific course context [23]. Koraishi and Karatepe (2025) demonstrate the importance of examining AI-generated texts in relation to teacher-generated material. Their comparison of summaries suggests that factual coverage alone is not sufficient for educational quality; the depth, contextualization, and relevance of the content must also be considered. This supports the present study's focus on students' perceptions of conceptual depth, technical detail, and the need for additional teacher-generated explanations in moodle lesson texts [9].

Technological Knowledge

Aji et al. (2026) link teachers' readiness for AI integration to AI-specific TPACK and attitudes towards AI. Their findings suggest that technological knowledge includes understanding AI tools' functions, limitations, and appropriate educational applications, as well as the ability to evaluate whether their outputs are suitable for teaching and learning. In the present study, this dimension is relevant for examining the quality and educational suitability of AI-generated moodle lesson texts and visual materials [24]. Joshi (2026) uses the Intelligent-TPACK framework to highlight the relationship between AI knowledge, pedagogical strategies, and ethical decision-making in university teaching. This perspective indicates that technological knowledge in AI-supported learning involves not only operational competence but also critical awareness of responsible use, ethical implications, and the limitations of AI-generated outputs [25]. Ergo et al. (2026) identify institutional and professional factors that influence the implementation of TPACK in teacher-education institutions. Their findings suggest that technological knowledge develops more effectively when educators have access to relevant technologies, structured support, and opportunities to apply digital tools in authentic teaching contexts. This is relevant to Moodle-based AI integration because the availability of AI functions alone does not ensure meaningful learning; teachers must also be able to configure, evaluate, and integrate them appropriately into course design [26]. Henderson et al. (2025) show that the evaluation of AI-generated educational support should include students' perceptions of trustworthiness as well as usefulness. Their comparison of AI and teacher feedback indicates that technological quality is not limited to speed or availability, but also includes the reliability, transparency, and contextual appropriateness of AI-generated outputs. This perspective is applied in the present study when evaluating students' perceptions of Moodle-integrated AI-generated materials [10].

AI in Education

Artificial intelligence (AI) is increasingly shaping educational practice through adaptive learning systems, intelligent tutoring, chatbots, learning analytics, automated assessment, and generative tools. These applications can personalize learning, support learner engagement, and assist teachers with instructional tasks and the creation of teaching materials [27] [6]. In LMS environments such as Moodle, AI functions can provide more interactive and adaptive support for students and instructors. Generative AI may also reduce teachers' planning workload by helping them create lesson plans, examples, and resources. Nevertheless, teachers remain concerned about ethical issues, loss of control, and whether AI-generated content reflects appropriate pedagogical reasoning and curricular objectives [28] [29]. Therefore, AI-supported educational tools should be evaluated not only for technical accuracy but also for their didactic quality, alignment with learning outcomes, integration into instructional workflows, and support for teacher agency. Although research has extensively examined adaptive systems and stand-alone AI applications, comparatively little is known about AI text-generation modules embedded in mainstream LMSs and their use in everyday course development [8][30]. TPACK offers an established framework for analyzing the integration of technology, pedagogy, and content in lesson design [4].

Research Methodology

This study adopts Philipp Mayring's approach to qualitative content analysis as its methodological foundation. Mayring's qualitative content analysis is a rule-guided, systematic procedure in which text material is examined through clearly defined units of analysis, and categories are developed either inductively from the data or deductively from existing theory, then applied using explicit coding rules to ensure transparency and reliability [31]. According to Barcelona et al. (2025), in the context of Moodle's AI integration, there is a need for a research design that uses systematic content analysis to compare AI- and teacher-generated texts, combined with a validated questionnaire or mixed-methods protocol to measure teachers' acceptance and didactic evaluations [12]. Figure 2 illustrates the steps of Mayring's qualitative content analysis.

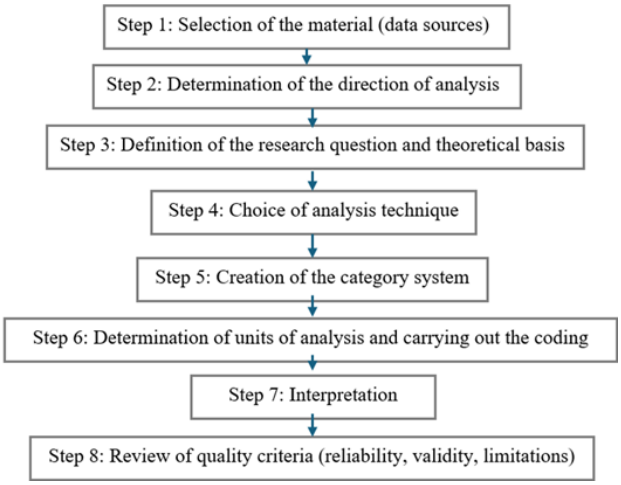


Fig. 2 Steps of qualitative content analysis, adapted from Mayring (2019)

The following subsections describe the study in terms of Mayring's eight procedural steps:

Data Sources:

From moodle version 4.5 onward, administrators can integrate AI services, such as OpenAI in moodle. Figure 3 shows an AI-generated course created by the author in Moodle. The empirical material comprised two versions of a computer science course implemented in moodle at SRH Neckargemünd, Germany in June 2026. The first version was AI-generated: all textual content, images, and exercises were created using Moodle's integrated AI tool. The second version was teacher-generated and developed by a single instructor, drawing on her subject knowledge, existing teaching materials, and self-designed exercises.

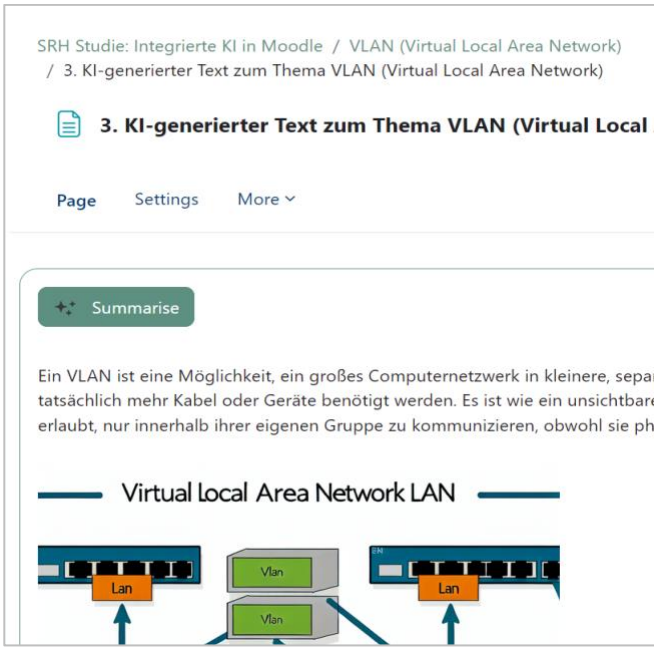


Fig. 3 AI-generated course created by the author in moodle

Both course versions were completed by 10 students (8 male and 2 female). After completing the courses, the students filled in a questionnaire evaluating the didactic quality, trustworthiness, and acceptance of the materials. To examine the consistency of responses across a different instructional context, the same questionnaire was also administered to an additional class of four students taught by a different teacher. The questionnaire consisted of three sections, each containing four open-ended questions. It was designed to address the research question by exploring students' experiences of AI-supported learning materials, their perceptions of the didactic quality of AI-generated content, and their comparisons between AI-generated and teacher-generated materials.

- Section 1: Learning Experience with the AI-Supported Course: This section explored students' overall experiences with the AI-supported moodle course. Participants were asked to describe their general impressions of the course, identify the aspects they found most helpful for learning, and indicate whether any AI-generated content was confusing or unclear. The section also examined whether the structure and organization of the AI-generated lessons supported or hindered their understanding.
- Section 2: Perceived Didactic Quality**:** This section investigated students' perceptions of the didactic quality of the AI-generated materials. Participants were asked to assess how effectively the materials explained the selected topic, such as switching, and whether the lessons included clear learning objectives. They were also asked how clearly these objectives were communicated or recognizable. In addition, participants evaluated whether the content followed a logical instructional sequence and identified any elements they believed were missing from a learning perspective.
- Section 3: Comparison with Teacher-Generated Materials: This section compared the AI-generated materials with teacher-generated lessons. Participants were asked to evaluate the two types of material, particularly in terms of clarity, depth, and structure. They were also asked which type of material supported their learning more effectively and why. Finally, participants were invited to identify situations in which they would prefer AI-generated materials and situations in which they would prefer teacher-generated materials.

Data Analysis: Link the TPACK framework to the Category System

The study applies comparative qualitative content analysis in a mixed deductive–inductive design. The direction of analysis is content structuring: predefined main categories derived from theory (TPACK) structure the material, while subcategories are refined inductively from students' questionnaire responses. A mixed-methods design was chosen because it combines theoretical grounding with attention to students' actual learning experiences. A purely deductive approach would only assess whether the lessons formally address the three domains of TPACK, without capturing how students perceived and experienced the materials. In contrast, a purely inductive approach could reduce the connection to established theory and limit comparability with previous TPACK research. Therefore, the deductive stage uses the established TPACK categories as a framework for coding, while the inductive stage further refines these categories based on students' perceptions of clarity, trust, and acceptance. In line with the TPACK framework, three main deductive categories were defined for the content analysis: Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK). After coding the lesson texts and analyzing the students' questionnaire

responses, several inductive subcategories emerged, which can be systematically assigned to these three domains.

First, the use of deductive main categories (CK, PK, TK) is theoretically justified, as these dimensions are well-established components of the TPACK model and provide appropriate analytical lens for examining technology-enhanced teaching. Applying these predefined categories ensures theoretical alignment and construct validity, as the analysis directly reflects the conceptual framework underpinning the study.

Three deductive main categories were defined:

- Pedagogical Knowledge (PK)
- Content Knowledge (CK)
- Technological Knowledge (TK)

Second, the development of inductive subcategories from the empirical material allows for a data-driven refinement of these broad domains. By deriving subcategories from students' questionnaire responses and lesson analyses, the study captures nuanced perceptions that may not be fully anticipated by the theoretical model. This enhances the content validity and sensitivity of the analysis, as participants' perspectives are systematically integrated rather than forced into rigid predefined structures.

Within these, inductive subcategories were developed from the empirical material:

PK subcategories:

- Perceived clarity, brevity, and accessibility of texts
- Deficits in depth, examples, and scaffolding
- Recognition of basic learning objectives
- Importance of examples, use-cases, and real-world anchoring

CK subcategories:

- Perception of superficiality and missing technical detail
- AI as concise summary vs. teacher as in-depth explainer

TK subcategories:

- Visual (in)effectiveness and quality of AI-generated images
- Deficient visualization and multimodality
- Perceived limitations of the specific Moodle-integrated AI model
- Differences in clarity, multimodality, and adaptivity

These subcategories reflect students' nuanced perceptions and allow the TPACK framework to be empirically examined and, where necessary, adjusted in light of actual learner evaluations.

Category System

According to Byrne (2022), a deductive research approach is a theory-driven, "top-down" method in which the researcher derives propositions or hypotheses from an established theoretical framework. In contrast, an inductive research approach is a data-driven, "bottom-up" method in which researchers derive codes and categories from participants' accounts [32]. In this research, the deductive categories were guided by the TPACK framework, while each category consisted of inductively derived subcategories that emerged from students' questionnaire responses.

Deductive Main Category 1: Pedagogical Knowledge:

Deductive Category 1 consists of four inductive subcategories:

Inductive Subcategory 1: Perceived clarity, brevity, and accessibility of texts: Several students described the AI-generated texts as clear, concise, structured, and accessible. The material was perceived as suitable for obtaining a basic overview and, in some cases, for learners with little prior knowledge. Students also appreciated the logical organization of the content and the possibility of learning at their own pace.

Inductive Subcategory 2: Deficits in depth, examples, and scaffolding: Although students valued the concise presentation, many considered the AI-generated materials too superficial for comprehensive learning. They reported missing concrete examples, step-by-step explanations, detailed guidance, and sufficient depth. Therefore, the materials were perceived as more appropriate for revision or introductory orientation than as a complete resource for students who were new to the topic.

Inductive Subcategory 3: Recognition of basic learning objectives and logical sequencing: Students identified basic learning objectives in the AI-generated lessons, including an introduction to switching, VLANs, and MAC address tables. The sequence of the content was generally perceived as logical, typically moving from basic definitions to explanations, visualizations, and examples. However, some students believed that the limited scope of the materials prevented the learning objectives from being fully developed.

Inductive Subcategory 4: Importance of examples, use-cases, and real-world anchoring: Students repeatedly emphasized the instructional value of concrete examples, everyday applications, and metaphors. Examples were considered important because they enabled learners to connect abstract technical concepts with practical situations. However, students also noted that examples were insufficiently detailed or inconsistently provided in the AI-generated materials.

Deductive Main Category 2: Content Knowledge:

Deductive category 2 consists of two inductive subcategories:

Inductive Subcategory 1: Perception of superficiality and missing technical detail: Students frequently perceived the AI-generated content as factually basic but insufficiently detailed. They particularly criticized the absence of technical processes, detailed explanations, and procedural descriptions necessary for a full understanding of switching and VLANs. The materials were therefore considered inadequate as a stand-alone learning source for complex technical topics.

Inductive Subcategory 2: AI as a concise summary versus the teacher as an in-depth explainer: Students commonly differentiated between the functions of AI-generated and teacher-generated learning materials. AI-generated material was perceived as concise, structured, and useful for revision, preparation, or gaining a quick overview. Teacher-generated content was perceived as more detailed, more informative, more adaptable to learners' prior knowledge, and more appropriate for developing a deeper conceptual understanding.

Deductive Main Category 3: Technological Knowledge:

Deductive category 3 consists of four inductive subcategories:

Inductive Subcategory 1: Visual effectiveness and quality of AI-generated images: The visual quality of the AI-generated images was a major concern for students. Images were frequently described as blurred, unreadable, misleading, or technically incorrect. Rather than supporting understanding, the visuals often cause confusion, particularly in relation to the MAC address table and VLAN diagrams.

Inductive Subcategory 2: Deficient visualization and multimodality: Students considered visualization essential for understanding technical processes. They perceived the AI-generated materials as lacking coherent visual support, while teacher-generated videos were seen as more effective because they integrated animations, readable graphics, spoken explanations, and step-by-step demonstrations.

Inductive Subcategory 3: Perceived limitations of the specific Moodle-integrated AI model: Several students differentiated between their evaluation of the particular Moodle-integrated AI tool and their views on AI more generally. They attributed many shortcomings—especially poor images, limited content, and low trust—to the perceived outdatedness or technical limitations of the specific system used in the study rather than to all current AI technologies.

Inductive Subcategory 4: Differences in clarity, multimodality, and adaptivity: Students perceived differences between AI-generated and teacher-generated materials regarding clarity, multimedia design, and responsiveness to individual learner needs. Although AI-generated materials were described as structured and efficient, teacher-generated videos were generally seen as clearer, more visually coherent, more detailed, and better adapted to learners' needs. Students also recognized the potential of interactive AI to provide individualized learning support when learners can ask follow-up questions.

Review of quality criteria (reliability, validity, limitations)

According to Klock et al. (2021), the quality criteria of empirical research refer to three core standards—objectivity, reliability, and validity—used to evaluate the rigor of a research instrument. Objectivity means that the results are independent of the researcher and is achieved through objectivity in implementation, evaluation, and interpretation. Reliability refers to the consistency or precision of measurement: an instrument is reliable if it produces the same results under the same conditions, regardless of what it measures. Validity concerns whether an instrument actually measures what it claims to measure and includes content, criterion-related, and construct validity [33]. To enhance the reliability and validity of the instrument, the same course was implemented in an additional class consisting of four students and conducted by a different teacher. The same questionnaire was administered in this setting to examine whether the results remained consistent across different participants and instructional contexts.

Reliability: In the study, the similar response patterns in the main study and the additional class provide preliminary evidence of consistency across groups: both groups showed conditional acceptance and similar concerns about depth, examples, scaffolding, and teacher support.

Validity: The results support validity because the instrument differentiated meaningful aspects of students' perceptions of AI-generated moodle materials: pedagogical adequacy, content depth and accuracy, technological quality, usability, and acceptance. These categories align with the intended TPACK-related dimensions, suggesting that the instrument captured the construct under investigation.

Objectivity: Objectivity was supported using clearly defined categories and systematic coding rules; however, it would be strengthened by independent second-coder review or an inter-coder agreement assessment.

Findings

Quantitative Result

Overall Student Perception of AI-Generated moodle Materials:

In the main study, the sample consisted of N=10 students. An additional class of N=4 students, taught by

a different teacher, participated to provide additional evidence regarding the reliability and validity of the instrument. Figure 4 shows that most students in the main study (n=6) and in the additional class (n=3) accepted the AI-generated moodle materials only conditionally. They considered the materials useful for gaining a basic overview, reviewing key concepts, or supplementing other learning resources, but not as a complete substitute for teacher-generated instruction. A further n=3 students in the main study and n=1 student in the additional class evaluated the materials mainly positively. In contrast, n=1 student in the main study expressed predominantly critical or low acceptance.

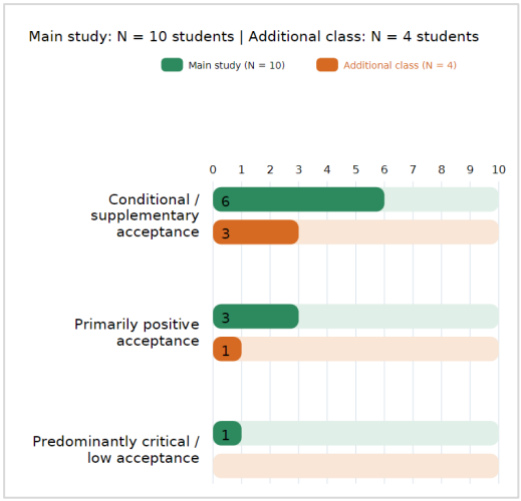


Fig. 4 Overall Student Perception of AI-Generated moodle Materials

Dominant Perceived Difference Between AI- and Teacher-Generated Materials

Figure 5 indicates that n= 6 students in the main study and n=2 students in the additional class perceived teacher-generated materials as superior in terms of conceptual depth, concrete examples, and visual support. A further n=3 students in the main study and n=2 students in the additional class viewed AI-generated and teacher-generated materials as complementary. They considered AI-generated materials useful for revision, whereas teacher-generated materials were preferred for initial learning and deeper understanding. Only n=1 student in the main study preferred the AI-generated material, although this student also acknowledged that the teacher-generated materials provided greater depth.

Pedagogical Adequacy and Usability of AI-Generated moodle Lessons:

Figure 6 shows that n=6 students in the main study and n=2 students in the additional class regarded the AI-generated moodle lessons as useful mainly for introductory orientation, review, or basic concepts. A further n=3 students in the main study and n=2 students in the additional class found the lessons generally clear and usable but identified limitations, including insufficient examples, scaffolding, technical detail, or visual explanations. One student in the main study n=1 considered the materials insufficient for independent learning or for learners with limited prior knowledge. No student in the additional class expressed this view.

Overall, these findings suggest qualitative differences in the integration of the TPACK framework.

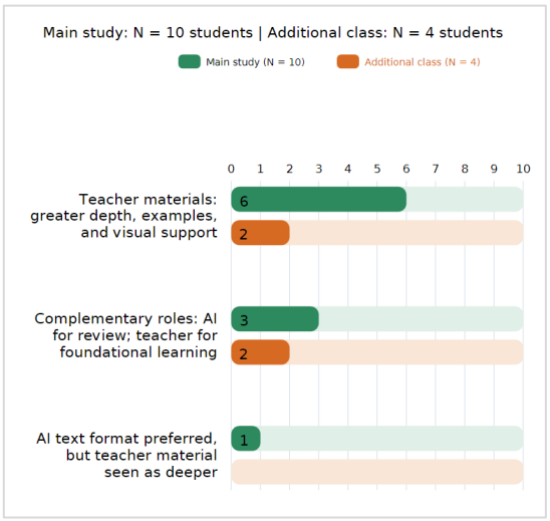


Fig. 5. Dominant Perceived Difference Between AI- and Teacher-Generated Materials

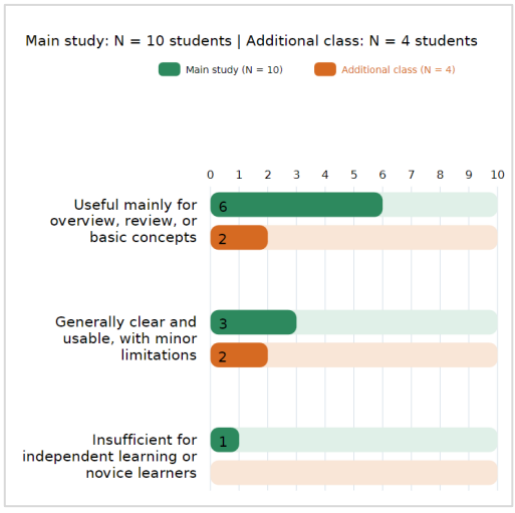


Fig. 6 Pedagogical Adequacy and Usability of AI-Generated moodle Lessons

Dominant TPACK-Related Factor Shaping Acceptance

Figure 7 shows that pedagogical factors were most frequently associated with students' acceptance of AI-generated materials, identified by five students in the main study N=10 and all four students in the additional class N=4. These factors included adequate depth, concrete examples, scaffolding, and teacher support. Technological factors were important for four students in the main study, particularly readable and accurate visualisations, the quality of the Moodle-integrated AI model, and opportunities for interaction. No technological factors were identified by students in the

additional class. Content-related factors—such as accuracy, technical detail, and the need to verify information—were identified by one student in the main study and by no students in the additional class. Overall, acceptance appears to depend primarily on the pedagogical and, particularly in the main study, technological quality of AI-generated lesson materials rather than on content-related issues alone. Because the study used a small qualitative sample (N=10; additional class: N=4), these factors should be described as associated with acceptance rather than as statistically tested predictors.

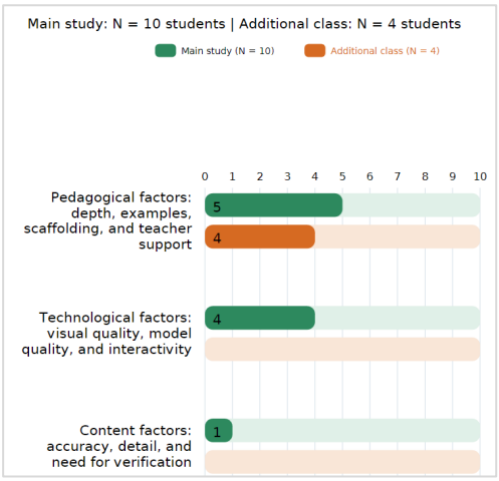


Fig. 7 Dominant TPACK-Related Factor Shaping Acceptance

A. *Qualitative Result*

In "**pedagogical knowledge**" Students generally perceived the AI-supported lessons as clear, short, and well structured. One student stated that *"the clear and precise structure supports my learning"*. Another student observed that the text began with "a general definition" and then gradually moved into more detail, which made the topic understandable even for learners with little prior knowledge. However, several students criticized the limited depth, examples, and scaffolding. One student described the AI materials as "more like a somewhat more detailed definition". Another student stated that "more concrete examples" were needed, especially to understand how a switch works in practice. One student also missed the teacher's *"facial expressions and gestures to support the teacher"*. Thus, the AI lessons were mainly perceived as useful for an initial overview or revision, rather than for comprehensive first-time learning.

In "**Content knowledge**" Students mostly considered the AI-generated materials to be concise summaries of the main points. One student stated that AI content was *"a summary of the most important points"*. Another explained that the materials offered *"a rough insight"* into Switching and VLANs but did not provide enough information to fully understand the topics without prior knowledge. Several students stated that technical details were missing. One student criticized the lack of *"detailed step-by-step processes",* for example regarding broadcast behavior. Another student noted that the teacher video clearly showed *"how a switch builds the MAC address table and how packets travel from A to B"*. In contrast, the AI material was perceived as more suitable for reviewing content, gaining a quick overview, or preparing for examinations. One student stated: *"for exam preparation, I prefer AI content"*.

In "**Technological knowledge**" the most frequent criticism concerned the AI-generated images. Students described them as *"blurry"*, *"not readable"*, and *"misleading"*. One student stated that the MAC address table contained *"unreadable, hallucinated characters"*. Students compared the visual problems with the teacher-generated videos. One student stated that the videos offered "*much more depth, clarity, and error-free animations*". Another student explained that the combination of clear pictures, videos, animations, and an explanatory voice created *"a very good learning structure"*. Consequently, students' trust in the AI-generated content was limited. One student stated: *"I do not trust AI content without reservations"* and explained that AI-generated information should be checked against reliable sources.

The findings support the argument of Ning et al. (2024) that effective technology-integrated teaching results from the dynamic interaction of technological, pedagogical, and content knowledge within a specific learning context [13].

Although students evaluated the AI lessons as clear and well structured, the limited depth of content, lack of concrete examples, and poor quality of the AI-generated images reduced their learning value. This shows that pedagogical clarity alone cannot compensate for insufficient content detail or technically weak visualizations. Similarly, accurate content alone is not enough when it is not supported by suitable explanations, examples, and reliable technological tools. Therefore, the findings confirm the central assumption of the TPACK framework: meaningful AI-supported learning requires the integrated application of Pedagogical Knowledge, Content Knowledge, and Technological Knowledge rather than the separate consideration of these domains.

Discussion

Pedagogical Knowledge

The present findings show that students generally perceived the AI-generated moodle lessons as clear, concise, and logically structured. However, they also considered the materials insufficiently detailed for comprehensive first-time learning, particularly because concrete examples, step-by-step explanations, and scaffolding were often missing. Therefore, students primarily viewed the AI-generated content as useful for introductory orientation, revision, or supplementary learning rather than as a replacement for teacher-generated instruction. As highlighted by Qian (2025), research on pedagogical applications of generative AI identifies both instructional opportunities and

pedagogical challenges. The review shows that the educational value of generative AI depends on how it is integrated into teaching and learning, rather than on the mere availability of the technology [34]. This supports the present finding that clear and concise AI-generated texts are not automatically sufficient for meaningful learning when they do not include adequate explanation, task design, examples, and learner support. As explained by Walter (2024), effective AI-supported learning requires pedagogical scaffolding, including clear instructions, prompts, feedback, reflection, modelling, and direct support from teachers. This is consistent with students' comments in the present study, which emphasized the need for more practical examples, guided explanations, and teacher support [35]. The findings therefore suggest that AI-generated moodle texts should be pedagogically revised by teachers before being used with learners who have limited prior knowledge.

Content Knowledge

Regarding Content Knowledge, students perceived the AI-generated materials as concise summaries that communicated basic concepts of switching, VLANs, and MAC address tables. Nevertheless, several students reported that the texts did not provide sufficient technical detail, procedural explanation, or subject-specific depth. They especially missed explanations of technical processes, such as how switches create MAC address tables or how packets and broadcasts are handled. Teacher-generated videos were perceived as more useful because they provided detailed explanations and demonstrated these processes step by step. As reported by Albadarin et al. (2024), empirical research on ChatGPT in education shows that learners may find AI-generated answers helpful for explanations, summaries, and personalized learning support. However, the review also identifies concerns related to inaccurate, misleading, or insufficiently satisfactory responses [36]. This supports the present finding that AI-generated text can provide a useful overview but requires critical evaluation when learners need accurate and detailed subject knowledge.

As found by Luo et al. (2025), instructional designers use generative AI for tasks such as brainstorming, creating learning resources, and streamlining design processes, but they also report concerns about inaccurate, biased, and low-quality outputs. The study stresses that AI-generated learning materials require critical review and revision to ensure that they are accurate and aligned with learning objectives. This corresponds with the current study, where students perceived teacher-generated materials as more detailed, reliable, and appropriate for developing a deeper understanding of technical networking concepts [37].

Technological Knowledge

The technological findings demonstrate that the quality of the Moodle-integrated AI tool strongly influenced students' evaluations. The most common criticism concerned AI-generated images that were blurry, unreadable, misleading, or technically incorrect. By comparison, teacher-generated videos were perceived as more effective because they combined readable graphics, animations, spoken explanation, and step-by-step demonstrations. These results indicate that technological knowledge includes not only knowing how to use AI tools, but also evaluating whether their outputs are reliable, understandable, and appropriate for the specific learning topic. As demonstrated by Cooper and Tang (2024), AI-generated educational imagery must be critically evaluated because it may contain visual inaccuracies and can fail to represent scientific concepts appropriately. Their study of generative-AI imagery in science education highlights that teachers need to assess visual outputs before using them in instruction [38]. This supports the present finding that poor-quality AI-generated diagrams, such as unclear MAC address tables and misleading VLAN visualizations, can hinder rather than support students' understanding. As observed by Baidoo-Anu et al. (2024), higher-education students recognize potential learning benefits of generative AI but also report concerns related to excessive reliance, academic risks, and insufficient training for safe and effective use. The authors argue that institutions should provide clear guidance and strategies for responsible AI use [39]. This aligns with the present study, in which students expressed limited trust in AI-generated content and stressed the need to verify AI output against reliable sources.

In summary, the results indicate that AI-generated moodle materials can support learning when used for short explanations, initial orientation, and revision. However, their value was reduced when pedagogical scaffolding was limited, technical content lacked depth, or AI-generated visuals were inaccurate and difficult to understand. Based on the findings of Qian (2025), Albadarin et al. (2024), and Cooper and Tang (2024), AI should not be treated as an autonomous substitute for teacher-designed instruction. Instead, teachers should use AI-generated moodle content as a draft or supplementary resource that requires pedagogical adaptation, subject-matter verification, and technological quality control. This interpretation supports the central assumption of TPACK: meaningful AI-supported learning depends on the integrated application of Pedagogical Knowledge, Content Knowledge, and Technological Knowledge [36].

Implications

The central implication of this study is that AI-generated lessons in moodle are promising as concise supplementary materials, but they do not yet achieve the full integration of pedagogical, content, and technological knowledge that characterizes high-quality, teacher-designed lessons. Therefore, AI should complement rather than replace human instructional design. In teaching practice, instructors can use AI-generated materials for revision, quick overviews, exam preparation, brief summaries, or alternative explanations; however, teacher-designed lessons

should remain the core resource, particularly for first-time learning and complex topics. Teachers should also critically evaluate AI-generated visuals and replace inaccurate or misleading images where necessary. From a theoretical perspective, the findings indicate that current AI-generated lessons only partially fulfil TPACK expectations, particularly regarding content depth and technological quality. Future research should examine AI–teacher co-design approaches, include larger and more diverse student samples, and investigate improved AI integration in LMS environments to determine how AI can better support full TPACK integration in everyday teaching practice.

Limitations and Future direction

This study has several limitations that should be considered when interpreting its findings. First, the sample size was small, consisting of 10 students and 4 additional students involved in the reliability check. Consequently, the findings cannot be statistically generalized to a wider student population. Future research should involve a substantially larger sample across multiple classes to enable more robust statistical analysis and improve the generalizability of the results. Second, the study was conducted at a single institution and within one geographical location. Educational practices, students' backgrounds, technological infrastructure, and institutional policies may differ across regions and countries. Therefore, the findings may not be transferable to other geographical, cultural, or institutional contexts. Future studies should replicate research across institutions in different regions or countries to examine whether similar patterns emerge. Third, the participants were drawn from only one academic discipline and one specific course context, namely computer science. Students from other degree programs may have different learning needs, levels of prior knowledge, attitudes towards AI-generated materials, and expectations of teacher-generated content. Future research should include students from diverse disciplines, such as business, education, engineering, social sciences, and humanities, as well as different course levels. Finally, the teacher-generated lesson was designed by one instructor and may reflect that instructor's individual teaching style, pedagogical knowledge, experience, and familiarity with the subject. Thus, the observed differences between teacher-generated and AI-generated content may partly be attributable to individual instructor characteristics rather than to teacher-generated content in general. Future studies should involve several instructors who independently develop lessons for the same topic, allowing comparisons across teaching styles and improving the representativeness of the teacher-generated materials.

Conclusions

This study found that AI-generated moodle lesson materials were mainly accepted as supplementary resources rather than as a replacement for teacher-generated instruction. Students considered the AI-generated texts useful for short overviews, revision, and examination preparation, but they preferred teacher-generated materials for first-time learning and complex technical topics. Although the AI lessons were perceived as clear, concise, and well structured, students identified limitations in pedagogical support, content depth, practical examples, and visual quality. Unclear or inaccurate AI-generated images reduced students' understanding and trust in the materials. Overall, the findings support the TPACK framework by showing that effective AI-supported learning requires the integrated consideration of Pedagogical Knowledge, Content Knowledge, and Technological Knowledge. AI-generated moodle materials should therefore be reviewed and improved by teachers before use. Teachers should verify content accuracy, add examples and scaffolding, adapt the materials to learners' needs, and replace low-quality visuals. AI can support instructional design, but teacher expertise

remains essential for ensuring meaningful and reliable learning experiences.

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