Rethinking Class Exercises for Teaching Database Management in the GenAI Era*

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Abstract
Generative artificial intelligence (GenAI) is reshaping pedagogical practices in higher education, especially in domains such as database management where conceptual modelling and understanding are essential. This paper proposes a shift in teaching strategies to embrace GenAI as a learning tool. We present and discuss a set of diverse exercises considering GenAI existence. We aim to foster students' critical thinking, interpretation skills, and conceptual understanding of topics such as data modeling and SQL query specification in the GenAI era. These exercises have been implemented and preliminarily used in a first-year course on Information Systems at the University of Castilla-La Mancha. Initial results suggest that they could enhance engagement and foster deeper learning. By integrating GenAI into the classroom in a thoughtful and strategic way, educators could promote understanding and prepare students for AI-augmented academic and professional environments dealing with database management.

Keywords
conceptual modelling education, database management, generative AI, pedagogical practices

1. Introduction

Teaching has become challenging nowadays due to the emergence of generative artificial intelligence (GenAI) [1]. The capabilities of GenAI tools, such as automated content generation and problem-solving, are changing how students complete their assessments [2]. Maintaining academic integrity and fostering students' original and critical thinking in environments where results are instantly accessible, demand a review of traditional teaching methods [3][4].

These challenges are also important in conceptual modelling education and in courses that involve database management, e.g., data modelling and SQL (Structured Query Language) query specification. Students are expected to learn theoretical contents and acquire practical skills related to how data is structured, stored, manipulated, and maintained. GenAI tools offer, for example, instant generation of both models and queries, reducing the analytical effort required to understand database management concepts [5]. This raises critical questions about how educators assess learning and foster authentic understanding of database management [6].

In this context, we advocate for a pedagogical shift: to assume GenAI as an integral element of contemporary learning environments and, thus, to implement methods that embrace its presence

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(and even use it) while ensuring students' knowledge acquisition. This shift implies rethinking the teaching goals and means, emphasizing the development of new critical skills, e.g., evaluating AI-generated outputs [7]. As an illustration of this shift, we present a set of diverse exercises that educators could apply for teaching database management in the GenAI era. The exercises have been put into practice with promising results in a first-year course on "*Information Systems*" of a Bilingual (in Spanish and English) Bachelor's Degree in Computer Science and Engineering at the University of Castilla-La Mancha in Albacete, Spain. Up to our knowledge, this is the first paper to propose a novel contribution to this pedagogical shift with concrete exercises for teaching database management in the GenAI era.

The paper is organised as follows. Section 2 reviews related work, Section 3 describes the exercises, Section 4 discusses them, and Section 5 summarizes our conclusions.

2. Related Work

Prior work has studied the implications of integrating GenAI on higher education. For instance, Ogunleye et al. [8] provide an overview of GenAI's role and highlight the need for robust instructional frameworks, Tillmanns et al. [9] identify critical thinking as a key issue to align GenAI with human-centred educational goals, and Dickey et al. [10] discuss the use of GenAI in programming courses, emphasizing the need of students' algorithmic reasoning.

For database management education, Bhupathi [11] explores the role of databases within GenAI workflows, underscoring how database architecture affects GenAI outputs. Ramakrishnan et al. [5] studied how GenAI tools can be embedded into database assessment exercises, highlighting shifts in students' problem-solving behaviours, engagement patterns, and understanding of queries' logic within AI-enhanced learning environments. Daun et al. [12] present how GenAI can support students in generating SQL queries and understanding schema design. Belkina et al. [13] identify use cases where GenAI facilitates the automatic generation of database exercises (e.g., query creation). Zhang [14] highlights how integrating AI tools into database classes can enhance students' understanding of SQL and foster critical thinking through assignment-specific strategies. Unlike our work, all these approaches use GenAI as an aid rather than as a trigger to reconsider how database management concepts are taught.

3. Proposal of Database Management Class Exercises

Our diverse class exercises are framed within the context of a first-year course on "*Information Systems*" of a Bachelor's Degree in Computer Science and Engineering. This course provides students with a comprehensive understanding of the strategic and operational roles of information technologies within organizations. The curriculum integrates theoretical foundations with practical methodologies for analysing, designing, and managing information systems aligned with business objectives. Emphasis is placed on topics such as types of information systems, support technologies, business requirements, data modelling and management, lifecycle models, and security. Around 50 students, including exchange ones, attend the course each year. Being a first-year course, students have no or very little knowledge about information systems in general and database management in particular.

Within this course, the exercises proposed belong to the fourth didactic unit named "*Management of Information Systems*". The unit introduces, among other topics, database management: database management systems, the relational model, how to transform UML class diagrams into relational schemas, and basic SQL queries (class diagrams are introduced in the previous unit). The exercises are conceived to be used while teaching this topic and their goal is threefold: (1) to facilitate the learning of the topic content assuming the presence of GenAI, (2) to help students to understand the use of GenAI, and (3) to raise awareness of GenAI limitations and potential issues in use. Concretely, we propose five types of exercises. We use Microsoft 365 Copilot (AI-powered assistant using GPT-4-turbo model) as our GenAI tool because students and educators have access to it with the University account.

3.1. Evaluating Copilot's Outputs

In this exercise, students must ask Copilot about conceptual and practical aspects of database management (e.g., relational modelling, SQL, or transformation of class diagrams into relational schemas) and find errors in Copilot's responses. The errors can include inaccurate query syntax, misinterpretations of relational logic, or erroneous modelling assumptions and transformations, among others. Figure 1 exemplifies how Copilots' mistakenly transforms a class diagram into a relational schema; e.g., the table *Movie* is missing in the relational schema. Rather than passively accepting generated responses, this exercise emphasizes the importance of equipping students to critically assess AI-generated output, which is an essential skill in GenAI-integrated environments.

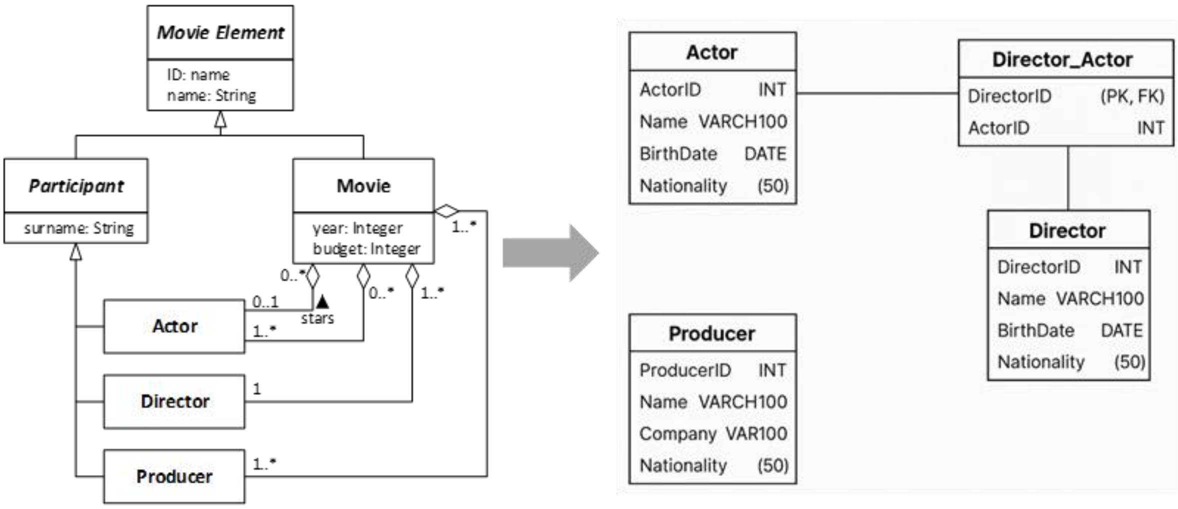


Figure 1: Example of a wrong output from Copilot

3.2. Specifying Queries From their Expected Result

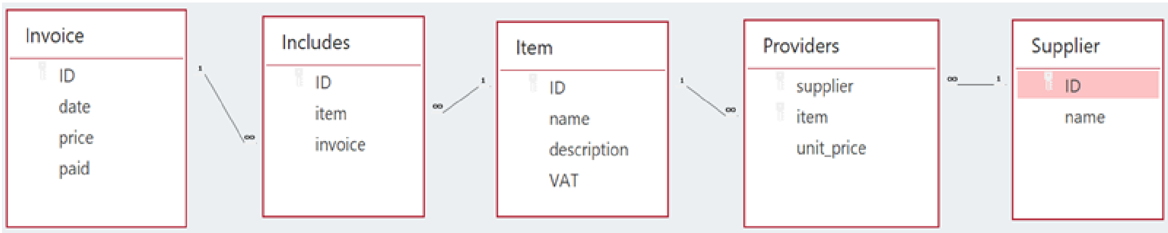
In this exercise, students are provided with (1) a relational database schema, (2) the content of its tables, and (3) the expected result from executing a particular SQL query (i.e., the resulting set of tuples). The students must reverse-engineer a SQL query that produces the expected result. The query must be general; e.g., it must not include result-specific column values in the WHERE clause. The students need to analyze the structure and content of the database, understand the expected result, and logically reconstruct a valid SQL query that matches both the schema and the output. By working this way, students actively engage in analytical reasoning and structural mapping. This can not only reinforce their comprehension of SQL and relational operations, but can also sharpen their skills in query design and debugging.

3.3. Puzzle of Queries

This exercise is designed to enhance students' understanding of SQL query structure through problem-solving. Educators define a set of SQL queries targeting a reference relational schema (e.g., Figure 2). The queries are then deliberately fragmented into smaller, logically coherent fragments (e.g., SELECT, FROM, and WHERE parts). Figure 2 shows examples of SQL queries along with their respective fragments (one query per row, one fragment per column). These fragments are printed and physically distributed among student groups. The students must then reassemble the queries by reasoning about the syntax and semantics of each fragment. Once a tentative reconstruction is completed, students could validate their assembled query by executing it on the reference database. This "puzzle-based" approach fosters analytical thinking since students can gain a clearer understanding of how query parts function together and are guided toward refining their solutions through practical verification.

3.4. Interpreting Data Models and SQL Queries

In this exercise, students receive some input related to database management (e.g., a relational schema, a transformation from a class Diagrams into a relational schema, or a set of SQL queries). Afterwards, they must answer or evaluate, respectively, a series of questions or true/false statements about the input and explain their decisions. For instance, the statement "A supplier can only provide one item" about the relational schema in Figure 2 is false. Copilot could assist students in validating statements, though its output may occasionally be inaccurate as shown in Section 3.1. This exercise is designed to strengthen students' ability to interpret and assess content, rather than simply create it. The exercise promotes reflective learning and prepares students for real-world scenarios, where verifying correctness and understanding are essential, especially in contexts involving automated generation and modelling.



SELECT ID, date	FROM Invoice	WHERE paid = FALSE	ORDER BY date ASC	
SELECT name	FROM Item	WHERE VAT = (SELECT MAX(VAT) FROM Item)		
SELECT DISTINCT S.name	FROM Supplier S, Providers P, Item It	WHERE S.ID=P.supplier AND P.item=It.ID AND It.name ="Screen"		
SELECT It.name, COUNT(*) AS N_Includes	FROM Item It, Includes Inc	WHERE Inc.item=It.ID	GROUP BY It.name	HAVING COUNT(*)>1

Figure 2: Example of a reference database and fragmented SQL queries

3.5. Identifying and Correcting Errors from a Given Input

In this exercise, educators provide students with input with deliberate errors (e.g., an SQL query with mistakes, or a relational schema with modelling inaccuracies). The students must carefully examine the input, identify the embedded errors, and propose corrected versions. This exercise emphasizes recognition and evaluative skills over creative ones. This can foster a deeper conceptual understanding and reinforces attention to details.

4. Discussion

Our experience with the proposed exercises strengthens our position: adapting teaching strategies for database management to the presence of GenAI is not only feasible but pedagogically valuable. Although some of them do not involve GenAI and could have been used before GenAI existence, they gain renewed relevance in the current educational context. Further, the exercise designs encourage students to learn database management in a critical and reflective manner. They exemplify how teaching strategies can be designed to stimulate human reasoning even in contexts where the use of GenAI is practically certain. In addition, the exercises promote high-order thinking [15], emphasizing analysis and evaluation over memorization—skills that are fundamental in current education.

Preliminary observation suggests that the types of exercises contribute to students' motivation, interest, learning, and critical thinking. Indeed, we plan to extend their use to other units of the course (e.g., about business requirements). These perceptions need to be further analysed via empirical studies, e.g., surveys.

To enhance engagement and foster collaborative learning, the exercises could be also conducted as challenge-based serious games (points, winner team, etc.). Additionally, future work could investigate whether the proposed exercises effectively foster the key competencies identified for effective data management (e.g., contextual knowledge) [16].

We acknowledge that the time allocated to each session (or to a specific topic, e.g., database management) may influence the extent to which the exercises could be used. For instance, if students ask numerous questions during a class, there may be limited time left for doing the exercises. Therefore, exercises should be understood as a flexible proposal that each educator may adapt or select based on their instructional needs, e.g., choosing those exercises to reinforce a particular concept (e.g., SQL) or those that fit better for a specific group of students.

Additionally, we want to emphasize that we do not advocate for the complete removal of “creation” exercises such as designing an entity-relation diagram from a textual description. These tasks remain valuable, e.g., in evaluations conducted without digital tools (computer with Internet connection, etc.). However, we believe that students need to learn nowadays (both in class and at home) through interpretation and correction to a larger extent, instead of ‘pure’, only creation. We have observed that most students often rely on GenAI for creation tasks. Thus, exploring alternative exercise focused on interpretation and correction is necessary to ensure conceptual and practical learning. While some exercise types, such as interpretation, were already used before GenAI, their relevance increases notably in today's context.

Finally, we are also aware that the exercises may be influenced by the GenAI tool used. For instance, Copilot leverages web searches to provide real-time assistance, whereas the latest ChatGPT version primarily relies on its trained model without direct search capabilities. Additionally, due to Copilot’s configuration, it may respond differently depending on the computer used or the record of past activity. However, we consider that both aspects are acceptable for our teaching goal of enhance student’s learning.

5. Conclusion

This paper presents a pedagogical shift that acknowledges the presence of GenAI as a component in teaching database management. Through a set of structured exercises focused on interpretation, evaluation, and correction, rather than only creation, we aim to foster students’ critical thinking and enhance their conceptual understanding in contexts where GenAI is used. Our preliminary experience suggests that our exercises can foster engagement and support deeper learning. The exercises are designed to be flexible, allowing educators to adapt them to other instructional needs and topics (e.g., requirements modelling). Ultimately, recognizing GenAI as part of the academic environment may reshape teaching methodologies and could prepare students to critically interact with GenAI tools in both academic and professional contexts. We plan to continue working this way and to empirically evaluate it in the future.

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Declaration on Generative AI

During the preparation of this work, authors use GenAI tools for grammar and spelling check, paraphrase and wording. The author(s) reviewed and edited the content as needed and take(s) full responsibility for the publication's content.

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