Database and SQL Microlearning Course

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1 Introduction

The range and complexity of competencies required for teaching in the twenty-first century are constantly evolving (Nikou, 2019). Requirements for all educators to meet technology standard is visibly increasing (Reinhardt & Elwood, 2019) as well. The digital technology development allowed for the expansion of the possibilities of e-learning. As Javorcik and Polasek (2019) found out: "The current trends and society's demands have changed the form of e-learning." One of the trends is microlearning.

This paper presents the results of the international project Work-based Learning in Future IT Professionals (Grant No. 2018-1-SK01-KA203-046382) aimed at creating comprehensive study support in the field of information systems using microlearning technology, see (web project https://fitped.eu, 2021). The following text focuses on the description of one of the created courses, namely the Database and SQL course. Three universities participated in its creation: Constantine the Philosopher University in Nitra, Slovakia, Mendel University in Brno, Czech Republic, Pedagogical University of Silesia in Katowice, Poland. The course was created in English and subsequently translated into Czech, Polish, Slovak and Spanish.

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2 Methods

Microlearning technology was used to create the course. According to Giurgiu (2017) studies indicated that a short content may increase information retention by 20%. As Gabrielli et al. (2006) state: "Microlearning activities, by definition, rely on access to learning resources which may happen at the time of breaks or gaps in learners daily work/life activities." Shatte and Teague (2020) found out in their scoping review that: "Overall, the application of microlearning to higher education has demonstrated a range of benefits for both objective and subjective student outcomes." Leong et al. (2021) concluded: "microlearning enables work-based learners to gain new knowledge or skills just in time to meet their immediate needs in this fast-changing world; in addition, microlearning can also help work-based learners to achieve a specific, actionable task." Buchem and Hamelmann (2010) state that "microlearning combines different approaches to learning. Microlearning facilitates self-directed lifelong learning, as short activities can be easily integrated into everyday activities. Small learning steps with small chunks of information can be used for learning in-between and on-demand. In this way microlearning enables individuals to stay up-to-date in today's knowledge society and offers a viable supplement to more time-consuming and formalized modes of learning, such as classroom courses or web-based trainings."

The basic principle is to use the possibilities of current personal devices, especially mobile phones or tablets for the presentation of individual parts of the curriculum. The whole teaching text corresponding to the scope of one semester of teaching is thus divided into hundreds of short parts containing both an explanation of the subject, preferably in the scope of one screen, and a verification task to verify its correct understanding. The processing time for one part should not exceed 5 minutes. The student thus has the opportunity to make optimal use of his time to study, especially if his time pool is very limited. This course was developed using the framework PRISCILLA described by Skalka and Drlík (2018) and Skalka et al. (2021).

3 Course Content

The structure of the created microlearning course corresponds to the requirements of microlearning technology and at the same time also to the requirements of subjects dealing with the field of database systems. The micro-tasks used in the course can be divided into three types:

- Contents (explanation)
- Question
  - Short answer
  - One correct

  - More correct
  - Drag&drop
  - Linear reorder
- Program (code in the given language)

The teaching of database systems and SQL is different from the teaching of procedural programming languages. The first task is to understand how the data to be worked on is related. But even earlier, it's important to understand what data is. Before the course gets to the SQL language itself, it is necessary to clarify the basic terminology and explain the principles of how to store data correctly. The first and second chapters are used for this. The whole structure of the course, as seen by the students, is shown in Fig. 1. The overview also shows the progress of the student.

The first chapter introduces the student to basic concepts such as data, attribute, domain, etc. Experiencing these concepts is important for a good understanding of the following parts of the course. Texts that explain the issue predominate here. There are 11 of them in this chapter. Whether the student has understood the content can be verified with six questions. An example of one of the questions is in the following Fig. 2.

The student has the task to assign the correct terms to the individual definitions.

The second chapter deals with data modeling. It is divided into four sections, in which the student has to understand how the data are related and ideally acquire the skill to design a data model appropriately. The issue of data modeling is very complex. There may be more suitable solutions. The course, therefore, focuses mainly on the explanation of the basic elements of data modeling such as entities, the

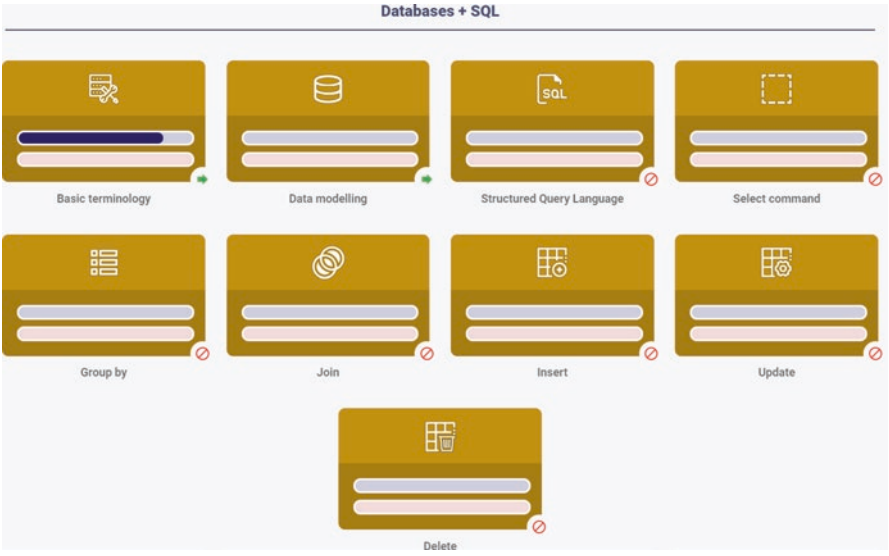

Fig. 1 Structure of the course

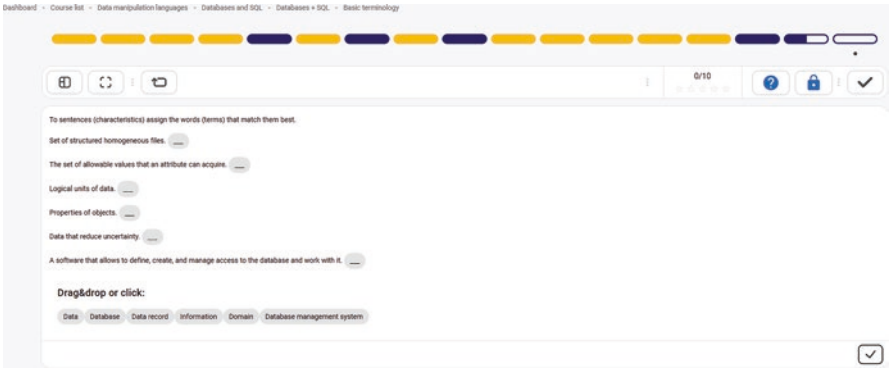

Fig. 2 Example of drag&drop question

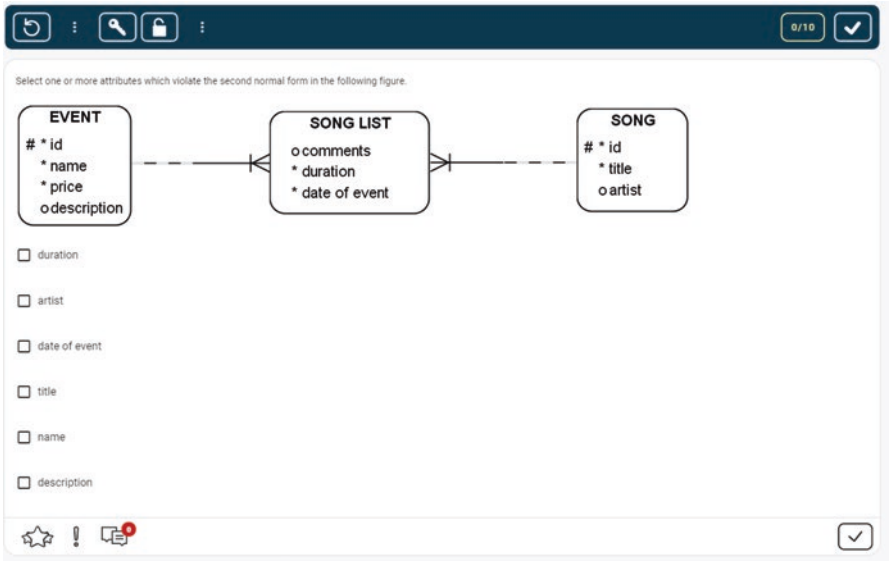

Fig. 3 Example of multiple-choice question

relationships between them, the principle of normalization, and the conversion to a physical model. From 35 short texts, the student can learn what to look out for. The texts are supplemented by 35 questions, which often point out the traditional errors that can occur during the design (example in Fig. 3).

Baker's notation was chosen to display the model. Unfortunately, it is not possible to verify more complex tasks, where the student would create something himself/herself, using microlearning. Such examples are also important for the student's explanation of what he meant and the subsequent feedback from the teacher, who

can explain what is right, what is not right, or show alternatives and, above all, explain why this is the case.

In the next chapter of the course, students will be introduced to the SQL language. The first part explains the difference compared to procedural languages and also presents the division into subsections of the language (DDL, DML, DQL, DCL). The second part of the chapter deals with the DDL language, which builds on the previous chapter of the course devoted to the design of a data model. This chapter contains a total of 19 teaching texts and 13 verification questions. You can see one of them in the following Fig. 4. The following chapters deal with DML and DQL separately.

In chapter "Learning by Designing, Imagination and Programming", students will learn how to query the relational database. It gradually reveals the secrets of the SELECT statement. Only the basics are described here, which are followed by other chapters. The fourth chapter is divided into six parts, four of which have a similar character as in the previous chapters (changing of explanations and questions), and two are set aside for writing SQL queries. Here, in contrast to the design of the data model, the correctness of the answer can be verified. As you can see in Fig. 5, it is possible to verify students' knowledge in various forms. Here, their task is to properly sort the order of the individual parts of the SELECT statement.

Figure 5 also shows the evaluation when the student correctly aligned the parts of the SELECT statement and received the full number of points for it. The following Fig. 6 shows how students will be shown a task to practice a SELECT statement.

The entire fourth chapter contains 21 explanatory texts, 14 questions, and 22 tasks for practicing the SELECT statement. The student will get acquainted with the projection, selection, sorting, and use of single-line functions.

The fourth chapter is followed by the fifth chapter. It deals with grouping in four parts. The nine texts explain the basics of grouping principles, aggregation functions, and the use of the HAVING clause. The acquired knowledge can be verified on nine questions. The last part is devoted to SELECT statements to verify skills. There are also 9. You can see an example and evaluation in Fig. 7.

The last chapter on the SELECT statement deals with joining tables. Everything important is explained in 11 texts supplemented by 8 questions and 9 examples for practice. The chapter describes the principle of an inner and outer join. It shows how to join using both the JOIN clause and the constraints in the WHERE section. Figure 8 then demonstrates one of the questions where the student's task is to correctly arrange the individual lines to achieve the desired result.

The remaining three chapters are devoted to the field of DML. Each of them deals with one of the INSERT, UPDATE, and DELETE statements. This issue is explained in 9 texts and verified on 11 questions and 50 examples. You can see one of the questions in Fig. 9.

The following Table 1 demonstrates the structure of individual chapters and the numbers of individual microtasks.

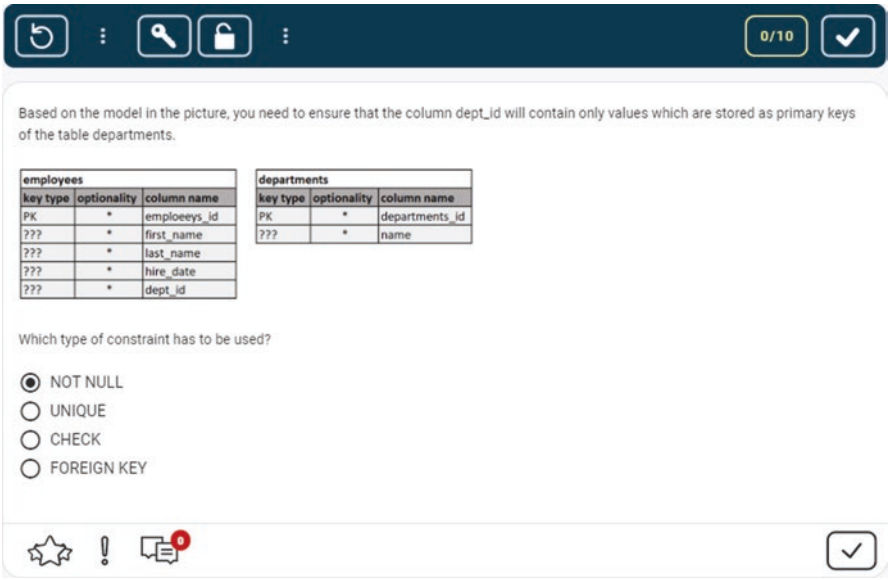

Fig. 4 Example of one-choice question

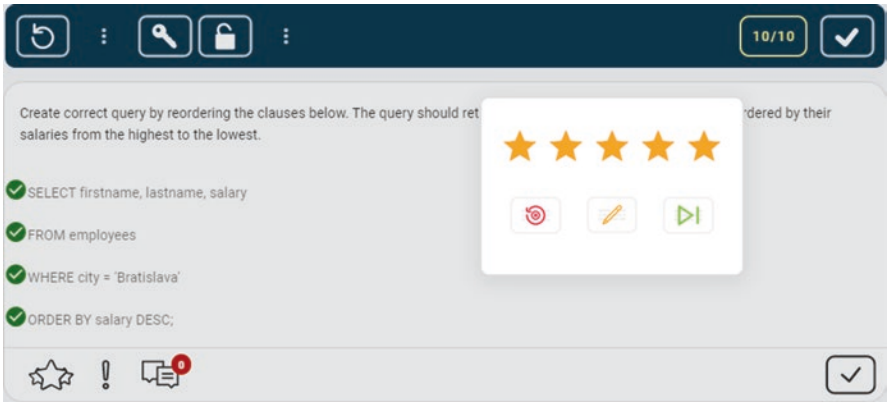

Fig. 5 Example of evaluated linear reorder question

4 Results

The created microlearning course was made available to students of Mendel University in Brno in the summer semester of the academic year 2020/2021 as one of the study materials for the study of Database Systems and Database Design. At the same time, students had at their disposal a previously created teaching text in the

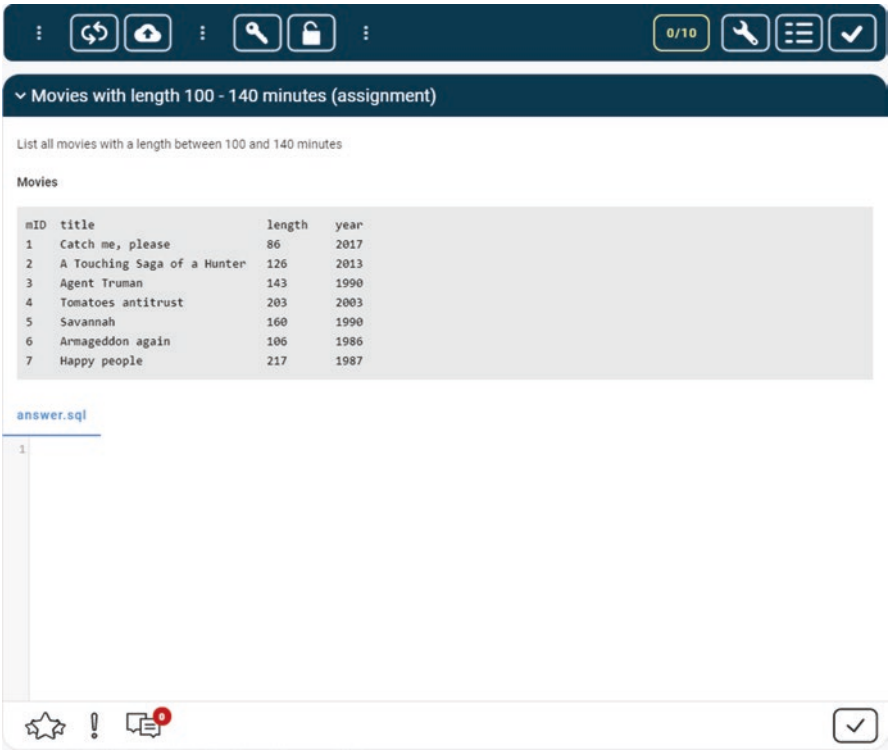

Fig. 6 Example of SQL query task

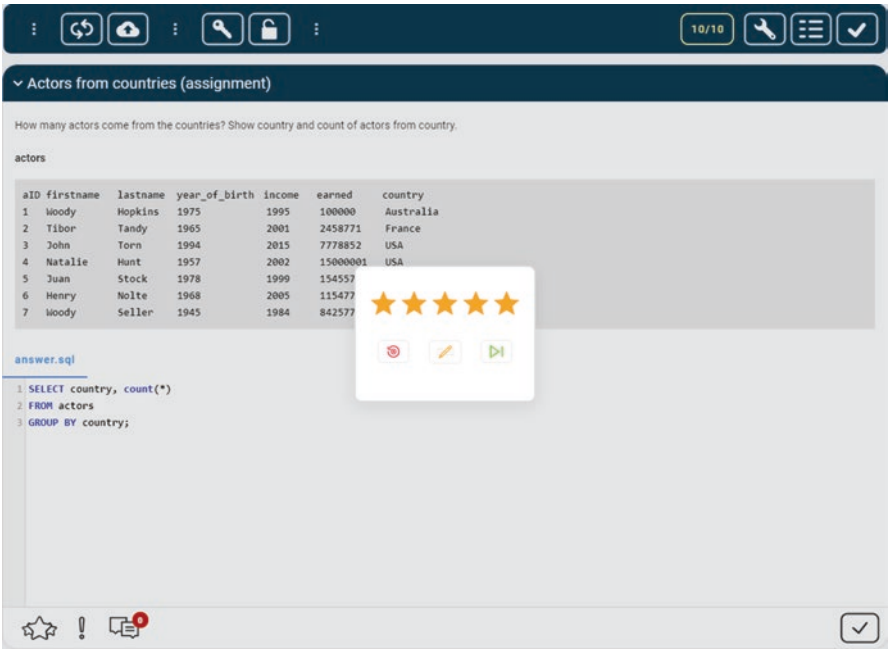

Fig. 7 Example of evaluated SQL query task

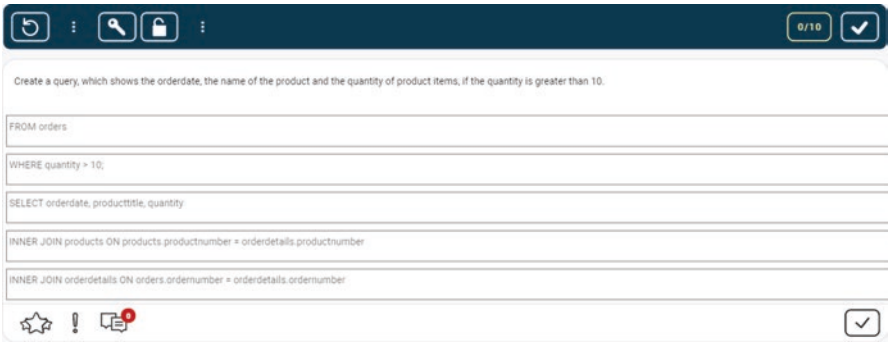

Fig. 8 Example of linear reorder question

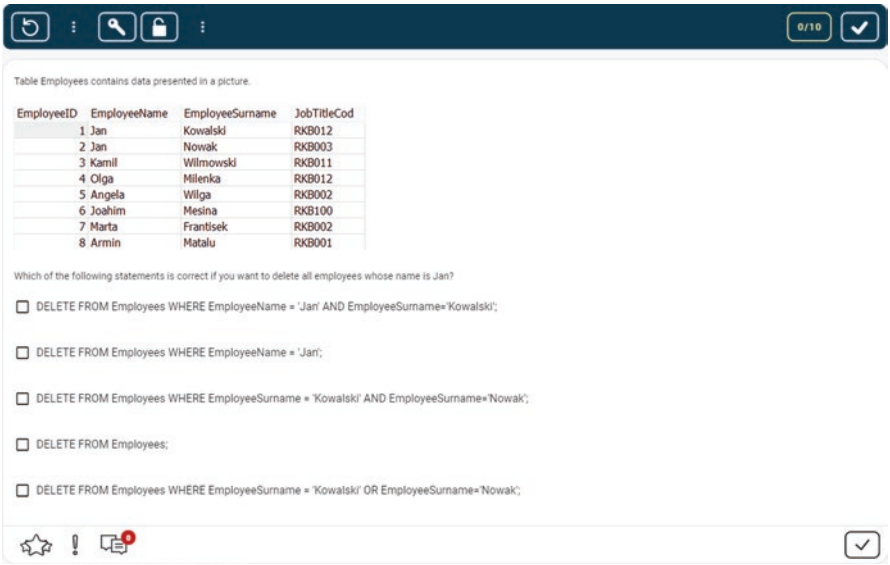

Fig. 9 Example of question

form of an e-book (Turčínek, 2018), presentations for lectures, and other literature was recommended to them. The use of materials was voluntary.

114 students started studying the course. 71 of them completed the course successfully. A questionnaire was created and completed by 50 of them. Figure 10 shows a chart showing the use of each material.

The microlearning course was used by 16% of the respondents to the questionnaire. Those who used the course rated it positively. No one indicated that it had major shortcomings (see Fig. 11).

Table 1 Structure of individual chapters

	Contents	Questions					Program	Total
		Short answer	One correct	More correct	Drag & drop	Linear reorder		
Basic terminology	**11**	**0**	**1**	**3**	**2**	**0**	**0**	**17**
Data modelling	**35**	**3**	**20**	**9**	**3**	**0**	**0**	**70**
Entities	11	0	2	4	2	0	0	19
Relationships	11	0	11	0	0	0	0	22
Normal forms	9	0	3	5	0	0	0	17
Physical model	4	3	4	0	1	0	0	12
Structured Query Language	**19**	**0**	**11**	**1**	**1**	**0**	**0**	**32**
SQL	6	0	3	1	1	0	0	11
DDL	13	0	8	0	0	0	0	21
SELECT command	**21**	**0**	**9**	**3**	**1**	**1**	**22**	**57**
Basics	4	0	2	1	0	0	0	7
ORDER BY Clause	3	0	1	0	0	1	0	5
Basics (exercises)	0	0	0	0	0	0	12	12
Functions	8	0	3	1	1	0	0	13
WHERE Clause	6	0	3	1	0	0	0	10
WHERE clause (exercises)	0	0	0	0	0	0	10	10
GROUP BY	**9**	**1**	**4**	**3**	**1**	**0**	**9**	**27**
Aggregation functions	6	0	2	3	0	0	0	11
Grouping	2	0	1	0	1	0	0	4
HAVING Clause	1	1	1	0	0	0	0	3
Procvičování	0	0	0	0	0	0	9	9
JOIN	**11**	**0**	**3**	**1**	**2**	**2**	**9**	**28**
Multi-table Queries	4	0	2	1	0	0	0	7
Simple Join Using WHERE Clause	2	0	1	0	0	1	0	4
Preferred Approaches to Join Tables based on JOIN Clause	5	0	0	0	2	1	0	8
JOIN (exercises)	0	0	0	0	0	0	9	9
INSERT	**5**	**0**	**1**	**1**	**1**	**0**	**20**	**28**
INSERT INTO statement	5	0	1	1	1	0	0	8
INSERT exercise I.	0	0	0	0	0	0	10	10
INSERT exercise II.	0	0	0	0	0	0	10	10
UPDATE	**2**	**0**	**2**	**1**	**2**	**0**	**20**	**27**
UPDATE statement	2	0	2	1	2	0	0	7
UPDATE exercise I.	0	0	0	0	0	0	10	10
UPDATE exercise II.	0	0	0	0	0	0	10	10

(continued)

Table 1 (continued)

	Contents	Questions					Program	Total
		Short answer	One correct	More correct	Drag & drop	Linear reorder		
DELETE	**2**	**0**	**1**	**2**	**0**	**0**	**10**	**15**
DELETE statement	2	0	1	2	0	0	0	5
DELETE exercises	0	0	0	0	0	0	10	10
TOTAL	**115**	**4**	**52**	**24**	**13**	**3**	**90**	**301**
		96						

When we compare the achieved results of those who used the microlearning course with those who did not use it, it turns out slightly better, as the following Table 2 demonstrates.

However, the number of students is still too small to generalize the results achieved. In order to obtain feedback from students, both a quantitative survey in the form of a questionnaire and qualitative research in the form of a guided interview were carried out. Students who used the textbook especially appreciated its concept, which they used for the appropriate timing of their preparation. One of the students, for example, stated in an interview, quoting: "I appreciated the opportunity to study individual parts of the text while traveling by bus from school to home."

5 Discussion and Conclusions

We are not aware of any other micro-learning course dealing with the area of database systems. There are some short video tutorials that can be meant as microlearning content dealing with SQL such as videos at teradata.com[1] and others. However, we didn't find any micro-learning course about database systems like ours which would have also a possibility to verify the acquired knowledge.

The fact that such courses are a novelty at Mendel University in Brno could also play a role in the small interest of students in using the microlearning course, similarly to the whole in the Czech Republic. Students are not used to them and prefer more traditional materials. It is very likely that with the occurrence of more courses, the experience with them will increase and thus their more frequent use. Those who used the course evaluated it positively.

It is not yet possible to draw conclusions regarding the acquired knowledge and skills, resp. their improvement. From the first phase of verification, we can only state that the students who chose this textbook achieved similar results as users of

[1] https://www.teradata.com/Resources?assetTypeFilter=video

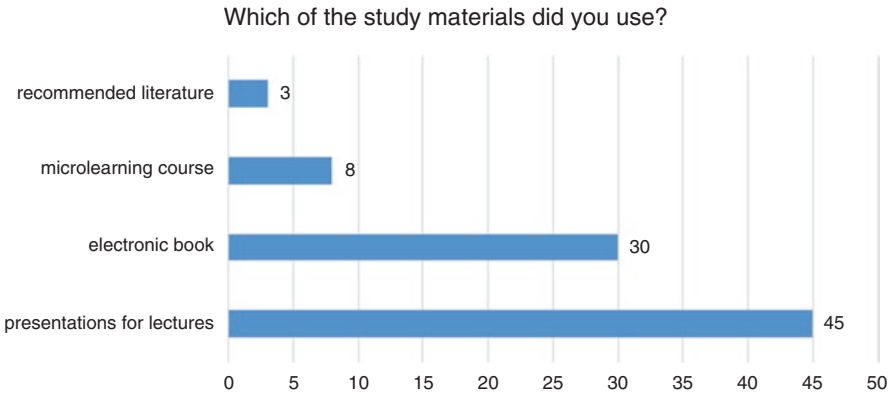

Fig. 10 Use of given materials

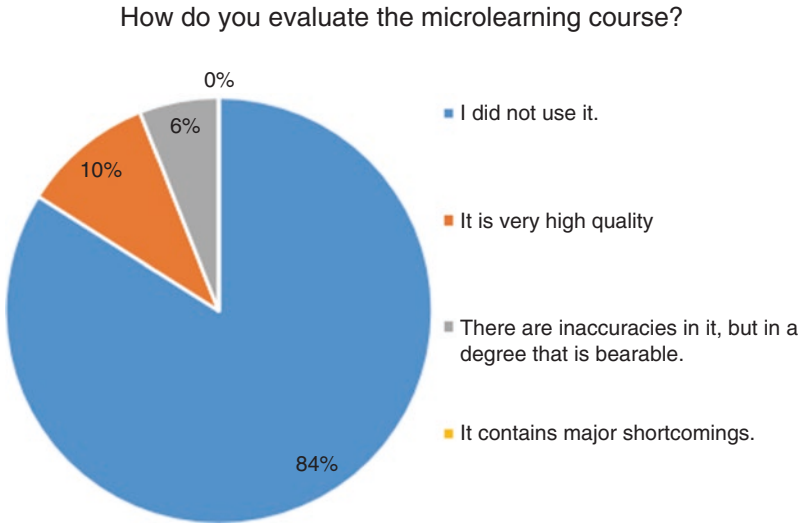

Fig. 11 Evaluation of microlearning course

Table 2 Structure of individual chapters

	A	B	C	D	E	F	Not specified	Total	Grade average
Did not use	7	4	9	13	7	2	0	42	2,2
Used	2	1	1	1	2	0	1	8	2

classical textbooks. From the teachers' point of view, we agree with Jomah et al. (2017) that micro-learning should not be used as the only tool where students need to acquire complex skills. We think that micro-learning is a suitable complement to other study materials, seminars, and lectures.

Due to the focus of the course on the basics of creating database information systems, it proves to be an interesting possibility to expand its usability for vocational education at secondary schools. Current high school students are very adept at using mobile devices in particular and can appreciate this approach.

As authors of microlearning courses in the system PRISCILLA we can state, that this system is easy to use and it is very helpful with creating microlearning courses even for learning programming languages. There are other tools such as Content Management System for Creating Microlearning Courses described by Javorcik (2021). However, we do not have any experience with other systems.

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