

Learning SQL by practising on popular movie databases through an online platform

KIRÁLY Sándor, BALLA Tamás, KIRÁLY Roland

Abstract. The new Hungarian *National Base Curriculum* (NAT2020), unlike the previous NAT2012, makes knowledge of the SQL language mandatory for students in the advanced final examination, which poses new challenges for both students and their teachers. An educational portal, sqlsuli.hu, has been developed and launched in order to help students to learn SQL (*Structure Query Language*). The framework of this online learning platform has an extensive grader tool that helps students test their SQL commands without intervention from a teacher, thus providing a flexible learning experience. The created sample databases are based on *Harry Potter* and *Star Wars* data, which is expected to increase students' engagement and motivation for learning. The developed LMS (*Learning Management System*) offers the authors the ability to improve the courses based on the solved problems and the comments on the forums. The course is available in Hungarian language.

Keywords: SQL, Learning Management System, final examination, online platform

1. Introduction

SQL is a standard language for accessing and manipulating relational databases. For a software developer, the knowledge of SQL is as important as a high level programming language. According to the previous NAT (NAT2012) guidelines, graduate (final examination) students in computer sciences were not required to know SQL, since they were allowed to use Microsoft Access at both intermediate and advanced levels and its tool of QBE (*Query-By-Example*) grid. According to the new NAT (NAT2020), at the intermediate level, there is no database management in the practical exam, but at the advanced level, the QBE grid cannot be used, the final exam measures the practical use of the SQL language (especially the *select* statement).

Learning a programming language may be more difficult than learning SQL statements, meanwhile acquiring knowledge of SQL for students under the age of 18 is also time-consuming and not as easy as one might think. This is partly due to the nature of SQL, and the fact that it is fundamentally different from the other skills secondary school students learn during their course of study [15]. Several researchers have been involved in teaching SQL: Al-Shuaily and Renaud proposed applying SQL patterns [2], Mitrovic developed a *Knowledge-Based Teaching System* for SQL [9], Quer et. al developed a software tool, LearnSQL (*Learning Environment for Automatic Rating of Notions of SQL*), that allows the automatic and efficient e-learning and e-assessment of relational database skills [14]. Garner and Mariani developed a graphical user interface centred around the textual translation of a query which has the potential to improve the way in which users gain an understanding of SQL [6].

Although books and notes in Hungarian and online courses in English are available, it seems insufficient for most secondary school students. Educational games such as *SQL Island* or *SQL Murder Mystery* are also available [17],[18]. Portals such as Udemy.com, CodeAcademy, or tutorials on W3Schools or Tutorialspoint that teach SQL in an interactive way in English might be useful. In Hungary, this type of portal is not available, apart from our sqlsuli.hu portal, which was developed for people under the age of 18.

On our website, students can learn how to apply different SQL statements such as *Select*, *Update*, *Delete*, etc. The curriculum focuses on the *Select* statement since students primarily have to know how to apply this one in the final examination. Through 24 chapters, students can learn to use *Select* statement, beyond basic use, through *Join* statements to the nested *Select* statements. The statements

of DDL (*Data Definition Language*) and DML (*Data Manipulation Language*) are also introduced to the users of the portal. DML statements (*Update*, *Delete from*, *Insert into* and *Insert into with Select*) are presented through four chapters with practice exercises. In a chapter, DDL statements (*Create table* and *Alter table*) are also presented with a practical exercise.

Although data modelling is not one of the requirements of the final examination in computer science, we explain to our students how the *Harry Potter* and *Star Wars* databases have been developed. Deletion and modification anomalies, as well as normal forms, are presented in the curriculum.

2. Learning and practising on this site

There are three attractive videos on the main page to make our site more engaging and one of them always appears randomly. After login, students can read a short description of SQL then they need to choose whether they wish to learn database planning or SQL. The material to be learned can be found on the left side of the screen. The exercise linked to the current topic is on the right side.

Students are asked to write the correct SQL statement in the panel on the right side. After the coding is completed, clicking on the *Send (Elküld)* button uploads the solution. If it is correct the next exercise that belongs to this unit appears, but if it is the last exercise, the next unit will be displayed. If the statement is not correct a warning message will be displayed. By clicking on *Help (Segítség)* button, the program displays a part of the solution for the student to be able to correct the mistake. If the student fails an exercise they can move on to another unit and come back later to try again. Students' attempts are stored in a database so teachers can help them with the solution.

Figure 1: Learning and practicing on this site

The goal is to learn SQL statements (commands) first and then apply them in order to be able to solve database exercises. The curriculum mainly focuses on the *select* statement thus it explains its functions through twenty-five units. It is the most frequently used SQL statement and at the final exam in computer science, students need to apply mainly this one for solving different database tasks.

A consecutive sequence of lessons forms a chapter. We distinguish three types of lessons: **curriculum with assignments, independent assignments, and independent curriculum.** Independent teaching materials may contain blocks of text, audio-visual elements to support the learning process, and games may also be included here. Most of the lessons contain short tasks, in which case, in addition to the curriculum, a set of tasks appears on the right side to help students master the specific part of the lesson (see Figure 1). Most lessons contain more than two exercises. In these lessons, the structure and the content of the used tables are presented in the text.

After completing the required 24 lessons on *select* statement, students can get many interesting facts about *Hogwarts* and the *Galaxy*. After completing the required 24 lessons on select statement, students can get many interesting facts about Hogwarts and the Galaxy by solving exercises. For example, after submitting the correct statement, the name of the subject for which Hogwarts students were punished most frequently is displayed (see Figure 2). In these tasks, the tables that were used in the previous lessons are applied and all the information (the name of the tables, the exact name of the fields, the field names for setting the relationships between tables) for completing the exercises are available in the text of the task.

Melyik tárgyból büntették a legtöbbet a diákokat?



Melyik tárgyból büntették a diákokat a legtöbbször? A tantárgy neve jelenjen meg!

Emékeztetőül a táblák nevei: **buntesek, tantargyak**

A szükséges mezők nevei: **tantargyak.tantargy, tantargyak.id, buntesek.tantargyid**

Add meg a megoldást adó SQL utasítást!

A megoldás megadása

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

Select tantargyak.tantargy From tantargyak INNER JOIN buntesek ON tantargyak.id=buntesek.tantargyid Group By tant

Megoldás elküldése

A beküldött megoldás által visszaszolgált sorok: 1

A visszaszolgált eredmény(ek):

tantargy
bájjítlan

Figure 2: Independent assignment

To transfer the new knowledge the Harry Potter database is used, the tasks that check understanding also use this database. The Star War database is used to deepen the new knowledge students have learned.

The portal contains a Forum for users to communicate with each other on a variety of subjects and to share their experience gained during coding, or they can collaborate with each other [1],[8]. By reading this forum, teachers can help students and improve the system.

3. The developed Learning Management System

The website has been written in PHP5 according to the MVC pattern. The curriculum, the SQL statements of the solutions of the exercises, the users' data and their actions are stored in a MySQL database. Currently, there are two types of users who can access the system; students and the administrator. Students can reach only the curriculum while the administrator has full access to both the materials and the users' data. Basically, after some modification, the LMS of kodolosuli.hu portal is used [12].

3.1. The admin interface

Users logged in as administrators can create new topics, new curriculums and new exercises or edit the previous ones and change the order of the units presented to students. It is possible to see the students' solutions, and this way the difficulty level of the exercises and the mistakes can be analysed as well. To check the students' progress, administrators have to choose the user's name then the name of the chapter (see Figure 3).

Felhasználók ⇒ [ksanyiteszt](#) ⇒ [SQL](#) ⇒ [A SELECT utasítás](#)

Feldolgozott fejezetek

Sorszám	Fejezet címe	Kész	Részletek
1	SELECT FROM	✓	Részletek
2	Csak bizonyos rekordok	✓	Részletek
3	WHERE és a logika	✓	Részletek
4	Még mindig WHERE, de most a Csillagok háborúja adatbázissal	✓	Részletek
5	A sorrend is számít	✓	Részletek
6	A Like használata	✗	Részletek
7	Like példák a Csillagok háborújában	✓	Részletek
8	Számított mezők és az aggregáló függvények	✗	Részletek
9	Csoportosítás	✗	Részletek
10	Jedik száma	✗	Részletek

Figure 3: Keeping track of users' progress

Our system also records how many times a unit was opened and how often a student tried to solve an exercise. It logs all the actions users perform so the publication of the achievements becomes easier, and it helps the developers improve the curriculum (see Figure 4).

Felhasználók ⇒ [Könyvtész](#) ⇒ SQL ⇒ [A SELECT utasítás](#) ⇒ Csak bizonyos rekordok

Idő	Feladat szövege	Feladat megoldása	Hallgatói megoldás	Helyes?
2022-02-27 10:34:46	<i>Idősebbek</i> Válogasd ki a diákok (ékezet nélkül, kisbetűkkel) táblából azokat a rekordokat, ahol az életkor mező értéke 14-nél több. Minden oszlop jelenjen meg! (A végén legyen pontosvessző!) Figyelj arra, hogy a feladatokban (itt és most is) a táblanevek és a mezőnevek is kisbetűvel kezdődnek! Es persze nincs ékezet!	SELECT * FROM diakok WHERE életkor>14;	select * from diakok where életkor>14	
2022-08-18 09:41:27	<i>Idősebbek</i> Válogasd ki a diákok (ékezet nélkül, kisbetűkkel) táblából azokat a rekordokat, ahol az életkor mező értéke 14-nél több. Minden oszlop jelenjen meg! (A végén legyen pontosvessző!) Figyelj arra, hogy a	SELECT * FROM diakok WHERE életkor>14;	select életkor from diakok where életkor>14;	

Figure 4: The log of a user's actions in a unit

3.2. The grader

The most important part of the system besides the curriculum is the grader. During the creation of a task, it is compulsory to define not only the text of the task, but the name of the database (*harry_potter* or *star_wars*) the task applies and the SQL statement representing the solution. After saving the task, the system checks the correctness of the SQL statement. If the MySQL engine fails to execute, the LMS returns the error message received from the engine.

When students upload their solutions by clicking on the *Send (Elküld)* button, first, the LMS passes the SQL statement to the MySQL engine to execute it. If it fails, the LMS sends back an error message to the user. If it is successful, the SQL statement representing the official solution will be executed as well. Then our LMS compares the results returned by the two SQL statements. If they are the same, the uploaded solution is considered correct. For these databases, users only have the right to *SELECT* which means they can read rows from the tables of the databases.

In the case of DML and DDL statements, a temporary database is used. When the user needs to create a table to solve an exercise, the *CREATE TABLE* statement will be replaced with *CREATE TEMPORARY TABLE* statement, thus, the new table is visible only within the current session, and is dropped automatically when the session is closed. In the case of *INSERT*, *DELETE* and *UPDATE*, our LMS makes the MySQL engine create the proper temporary table for the statement then the user's statement will be executed by the MySQL engine.

4. The curriculum

In an online environment, students' performance can be influenced by many factors that stem from students' individual characteristics and habits. These include the ability of students to maintain their intrinsic motivation to learn and their attention [3],[5],[10]. It is also feasible to influence these factors in an online environment since we have the opportunity to increase engagement, which can be defined as a student's cognitive process, active and emotional participation in the learning process [4],[13],[16]. All three factors of commitment (cognitive, behavioural and emotional) can be increased if the text of the curriculum is not only professionally correct, but also has a good style and personal tone [7]. The thought-provoking effect of the text can be facilitated by the inclusion of good metaphors, interesting examples, sometimes astonishing and provocative recordings, questions, contradictions, surprising and in many cases humorous twists [10],[11]. In *sqlsuli.hu*, directive e-learning is preferred since the material of this site is supposed to be new for the participants.

The text of our curriculum contains imaginary dialogues between the authors of the curriculum and the student, provocative questions and comments, and also interesting examples. The modified quotes from *Star Wars* and *Harry Potter*, such as "There are always two of the *Sith*, now the tasks too" or "Curiosity is not a sin but we should exercise caution with our curiosity but not in this portal" accompany the entire curriculum. We have inserted emoticons and pictures related to the movie in each unit. Videos have been created for a better understanding of *inner join* clause.

As it has been already mentioned, after students completed the units of the *select* statement chapter thus they are familiar with this statement they can gain interesting information about the *Wizard World* and the *Galaxy* by solving difficult exercises. These independent assignments specify the task and, in most cases, they contain the solution as an image. For example, "Who are the students who shopped at *Borgin & Burkes*". The solution is three Hogwarts students whose blurred faces can be seen in the assignment. If students enter the correct, statement they get the three names (see Figure 5).

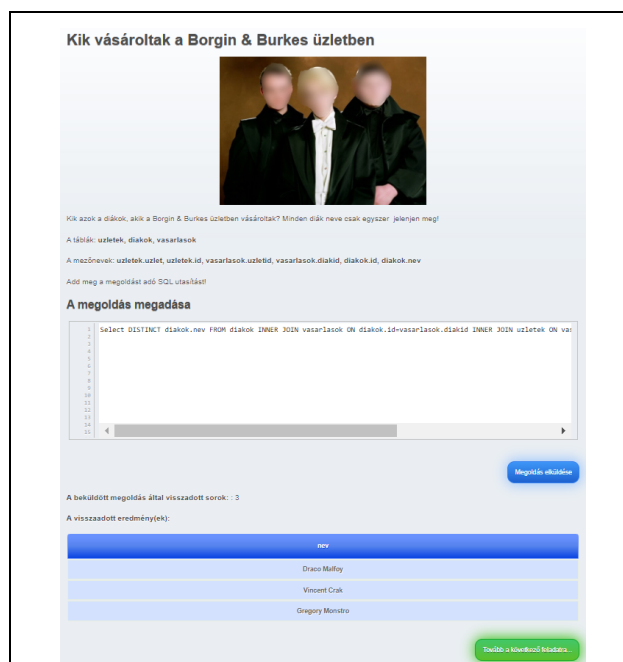


Figure 5: An independent task with blurred image and the solution

The registered users can also learn the DDL and DML SQL statements. To check the submitted SQL statements, the portal uses MySQL, but in the text, we draw the students' attention to the differences between the Oracle SQL and MS Access, such as TOP, LIMIT and ROWNUM, or the usage of apostrophes and quotation mark.

The portal describes the process of designing the *Harry Potter* and the *Star Wars* databases. Why the given tables are used, why we do not use only one table, and examples of how we eliminated the deletion and modification anomalies. Normal forms are also presented in these chapters.

To assess the knowledge of our students of database planning a very special test is used. They need to choose the correct answer from several answers by submitting a *select* statement. Each answer has a simple *select* statement. Our grader checks whether the *select* statement that belongs to the correct answer has been submitted. Thus, the completing these chapters is recommended for those who already know how to use the *select* command.

5. Conclusion and Future work

The aim of this study is to demonstrate a new website, *sqlsuli.hu*, an online interactive platform that offers a free SQL course. The goal is to reach secondary school students who wish to learn SQL and help them to be successful in the final exam in computer science. The website starts by presuming no prior knowledge at all, and lets students work through short exercises with gradually increased complexity. This website offers a SQL curriculum that uses *Harry Potter* and *Star Wars* databases. The developed LMS and Forum support keeping track of students' progress during lessons and foster the improvement of the material.

The site is open for anyone but used by the authors' students currently. We count on feedback from the authors' students, that makes it possible to correct any errors that may still exist in the portal, or make changes to lessons, wording and assignments. Then the portal will be promoted.

Development of educational games is also planned to provide a better understanding of the material.

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¹ The data as indicated in the source are to be followed. The main principle is to make the source reachable.

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Authors

KIRÁLY Sándor
Eszterházy Károly Catholic University,
Institute of Mathematics and Informatics,
Hungary,
e-mail: kiraly.sandor@uni-eszterhazy.hu

BALLA Tamás
Eszterházy Károly Catholic University,
Institute of Mathematics and Informatics,
Hungary,
e-mail: balla.tamas@uni-eszterhazy.hu

KIRÁLY Roland
Eszterházy Károly Catholic University,
Institute of Mathematics and Informatics,
Hungary,
e-mail: kiraly.roland@uni-eszterhazy.hu

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