UPPSALA
UNIVERSITET

Teaching SQL in Database Design I

TUK 2019

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Relational databases store data in one or more tables (*relations*).

Student

SSN	First_Name	Last_Name
8302141234	John	White
8112272345	John	Newman
8208123456	Anna	Johansson

Course

Code	Title
1DL210	Algorithms and Data Structures I
1DL301	Database Design I

Grade

FK FK

Student	Course	Grade
8302141234	1DL301	3
8302141234	1DL210	U
8112272345	1DL301	4
8208123456	1DL301	5

CRASH COURSE IN *RELATIONAL DATABASES AND SQL*

Relational databases store data in one or more tables (*relations*).

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8302141234	John	White
8112272345	John	Newman
8208123456	Anna	Johansson

Course

Code	Title
1DL210	Algorithms and Data Structures I
1DL301	Database Design I

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Student (FK)	Course (FK)	Grade
8302141234	1DL301	3
8302141234	1DL210	U
8112272345	1DL301	4
8208123456	1DL301	5

SQL = Structured Query Language. Example of an SQL query:

```
SELECT Student.First_Name, Student.Last_Name,
       Grade.Grade
FROM Grade, Student
WHERE Grade.Student=Student.SSN AND
      Grade.Course='1DL301'
ORDER BY Last_Name, First_Name
```

→

First_Name	Last_Name	Grade
Anna	Johansson	5
John	Newman	4
John	White	3

1DL301 DATABASE DESIGN I

- Undergraduate course, 5 credits (hp).
- Introducing the basics of how to design, create, modify and query relational databases.
- 206 students in the second period of Fall 2018, mainly from the following programs:
  - Master Program in Computer and Information Engineering (IT)
  - Master Program in Molecular Biotechnology Engineering (X)
  - Master Program in Sociotechnical Systems Engineering (STS)
  - Master Program in Bioinformatics
- Student's prior knowledge, skills and competence vary a lot between the programs

MOTIVATION FOR OUR WORK

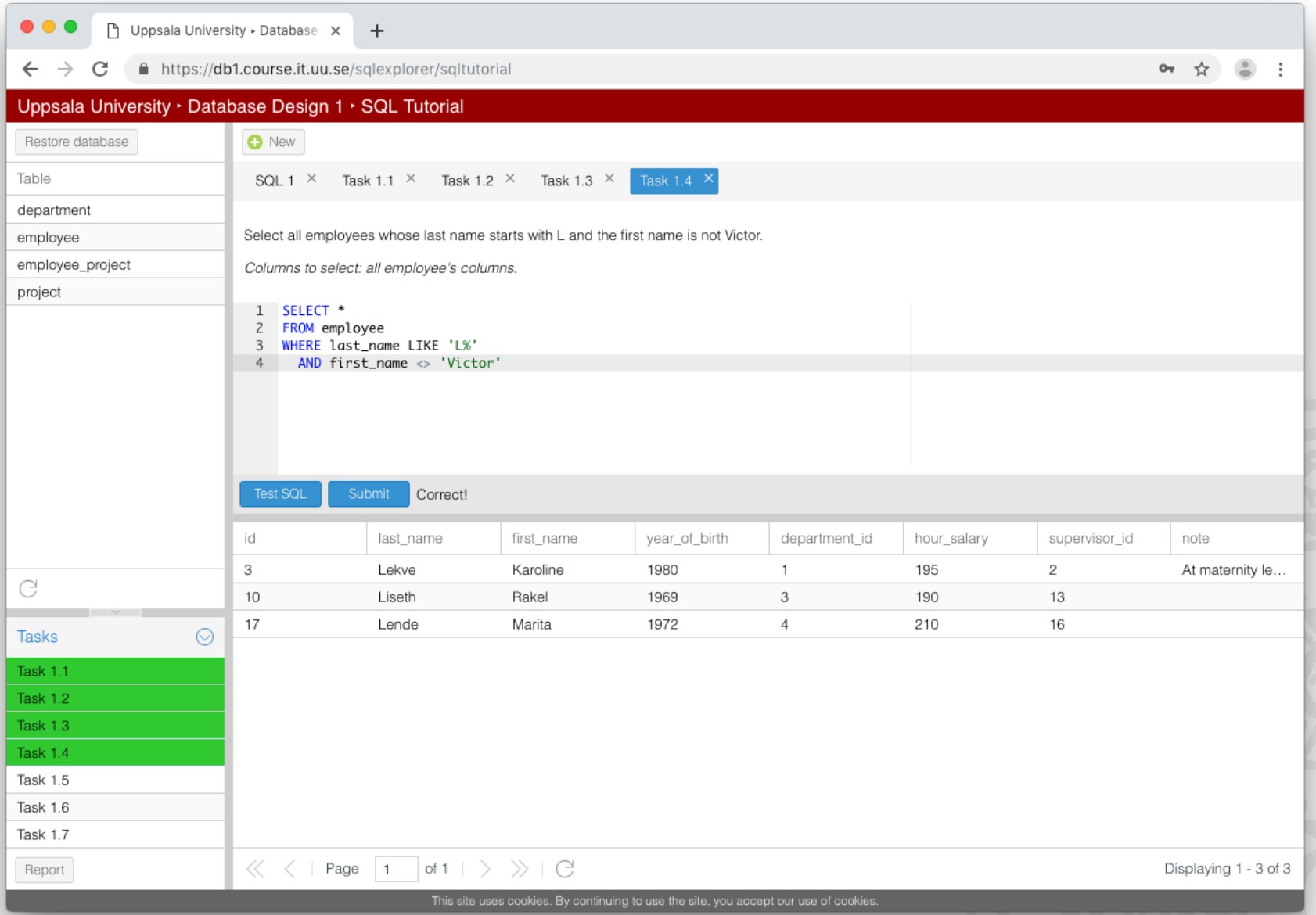
- SQL is the most used language for managing data stored in relational databases.
- Although the language is relatively simple, students usually experience some difficulty learning how to write complex queries (queries involving joining multiple tables, grouping of data, and nested queries).
- With more than 200 students in the course, teaching SQL effectively is a challenge.

CLASSES RELATED TO SQL

SQL is one of the most difficult parts of the course for students.

- **3 tutorial sessions** (à 2 hrs) in auditoria
  - The content is divided into several parts.
  - Each part is briefly explained + example queries.
  - Students practice SQL by solving a set of tasks with the help of the main teacher and two–three assistants.
- **Labs** (à 4 hrs) in computer lab rooms
  - 1 lab dedicated to practicing SQL queries
  - 2 labs where students apply acquired knowledge and skills

DEMO OF SQL EXPLORER



SQL EXPLORER

We developed a web-based tool for teaching and learning SQL, primarily intended to be used in-class.

- **Student interface**
  - Students use the web interface to enter and run an SQL query against a sample database.
  - Each student uses the tool anonymously, but has its own copy of the database.
  - Easy to restore the copy to the original state.
- **Tasks and automated assessment**
  - Each sample database has an accompanying set of tasks.
  - Students get automated feedback on the correctness of the query.

SQL EXPLORER, CONT'D

- **Teacher inteface**
  The main teacher can see all submitted queries (without possibility to identify who submitted them) in real time. This allows detecting and immediately reviewing concepts not fully understood by the students.

Task	Time	Query

Task 5.5	10:32:57	`SELECT title, avg(hour_salary) AS avg_hour_salary`
		`FROM employee, department`
		`WHERE department_id = department.id`
		`GROUP BY department_id`
		`HAVING avg_hour_salary = (`
		`  SELECT max(avg_hour_salary) FROM (`
		`  SELECT avg(hour_salary) AS avg_hour_salary`
		`  FROM employee`
		`  GROUP BY department_id`
		`) )`

Task 5.5	10:32:10	`select title, max(avg)`
		`from (select title, avg(hour_salary) as avg`
		`from employee, department`
		`where department_id=department.id`
		`group by department.id)`

Task 5.4	10:29:41	`select *`
		`from employee e`
		`where hour_salary = (select max(hour_salary) from employee, department where d...`

Task 5.3	10:25:23	`select e.last_name, e.first_name, s.last_name, s.first_name` `from employee e left join employee s on e.supervisor_id=s.id`

Task 5.3	10:24:34	`select e.last_name, e.first_name, s.last_name, s.first_name`
		`from employee e, employee s`
		`where e.supervisor_id=s.id`

Task 5.2	10:23:45	`select *`
		`from employee`
		`where id not in (select employee_id from employee_project)`

OUR EXPERIENCE

More than 17000 queries submitted during the term.

Results of the their “offline” inspection will be used to adjust the content of the lectures, tasks and sample databases.

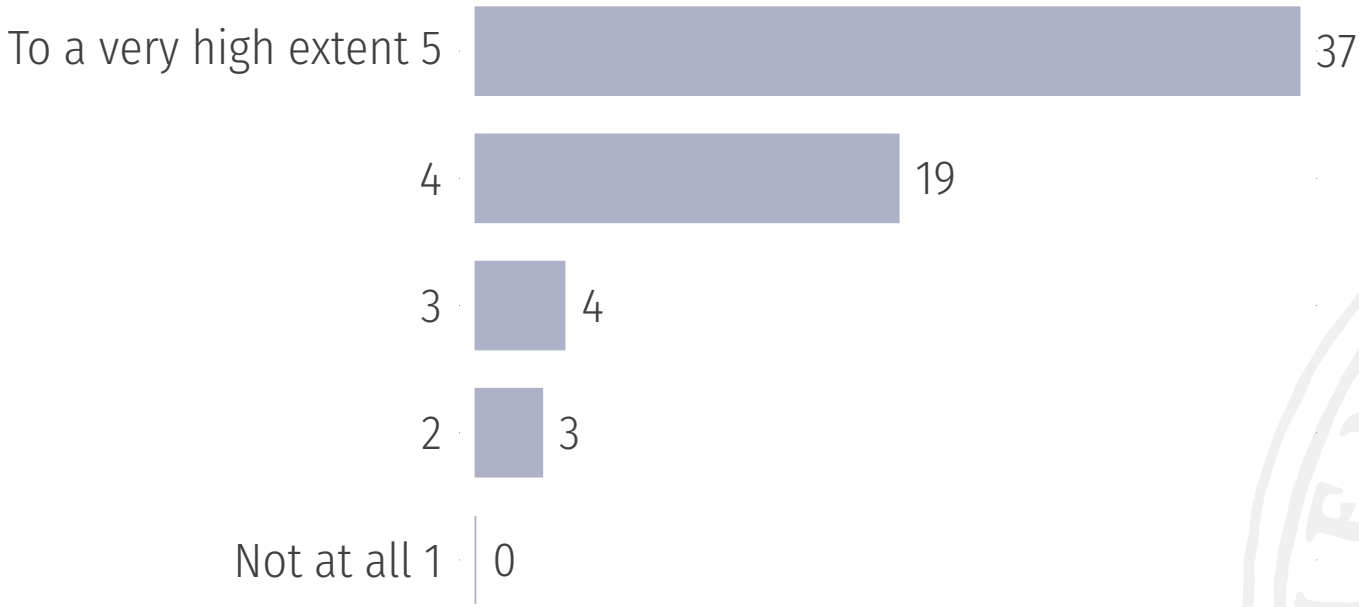
Using the tool during the tutorial sessions and the SQL lab:

- changed the dynamics of teaching and learning SQL in a large-class setting,
- eliminated manual checking of the correct queries and allowed the teachers to concentrate on helping and guiding the students,
- allowed us to detect and immediately review not fully understood concepts.

EVALUATION BY THE STUDENTS

To what extent has solving the tasks in the SQL Explorer contributed to your learning of SQL queries?

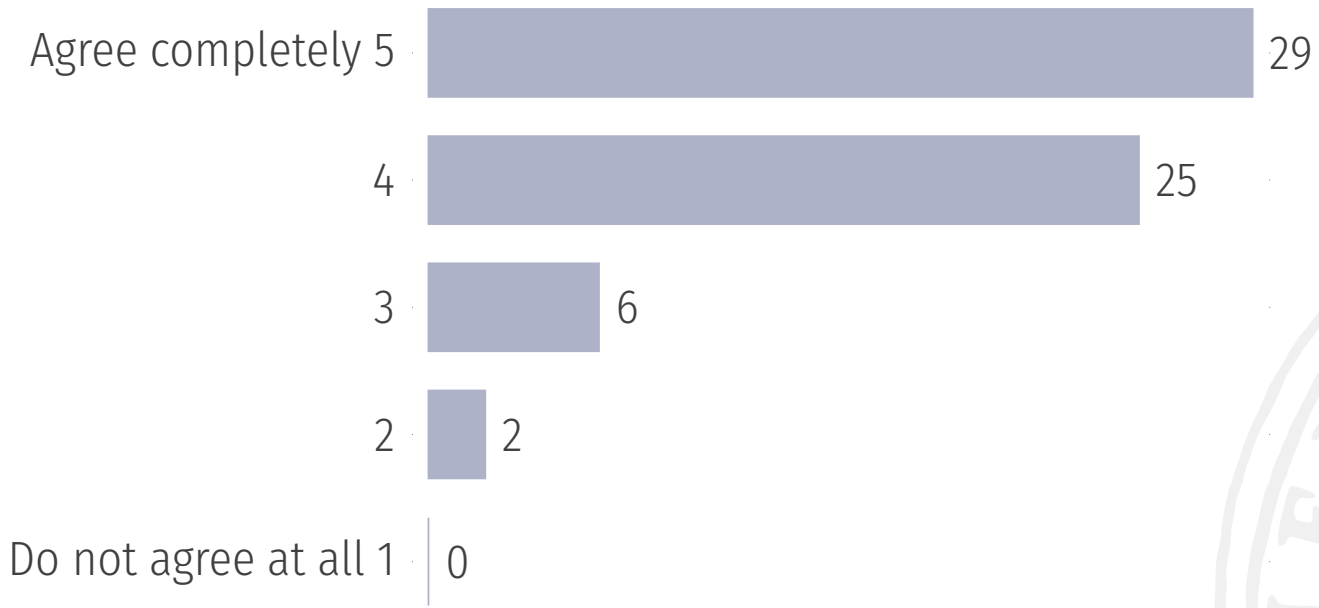
(Optional, students who knew SQL from before were asked not to answer the question)



EVALUATION BY THE STUDENTS, CONT'D

The tasks in the SQL Explorer have sufficiently covered all relevant parts of SQL queries.

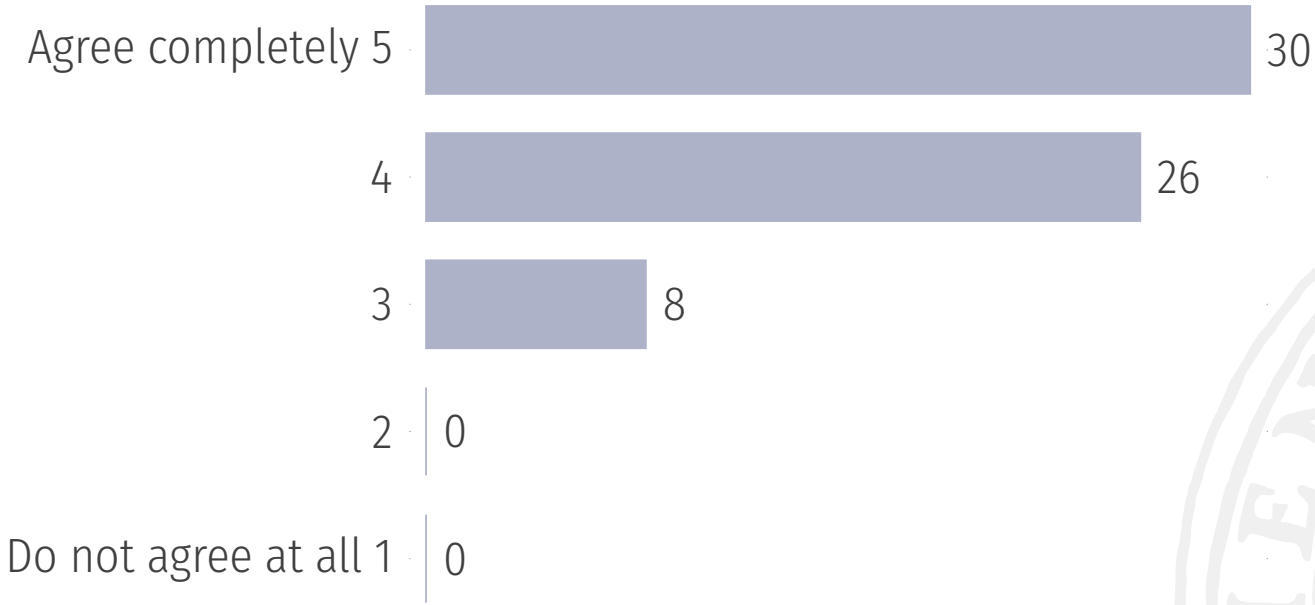
(Optional)



EVALUATION BY THE STUDENTS, CONT'D

The tasks in the SQL Explorer vary in difficulty from very easy to very difficult.

(Optional)



PLANS FOR THE FUTURE

In the long term we wish to:

- extend the automated assessment to be able to detect common mistakes and to provide hints,
- replace the SQL part of the written final exam by a computer-based exam using SQL Explorer,
- extend the tool to be able to evaluate students' progress and to propose next tasks to work on,
- add a few sample databases with tasks that students can use outside-of-class,
- release the software under an open source license (GPL).

Thank you!

Questions?

Do you want to try the SQL Explorer?
Come and talk to me during the poster session!