OER Tools and Courses for Teaching Database Systems as Developed in the Project EILD.nrw

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Abstract

In the EILD.nrw project, Open Educational Resources (OER) are being developed for teaching databases. Instructors can use the tools and courses in a variety of learning scenarios. Students of computer science and application subjects learn the complete life cycle of databases. For this purpose, quizzes, interactive tools, instructional videos, and courses for learning management systems are developed and published under a Creative Commons license.

Keywords

Database systems, OER, higher education

The use of digital teaching and learning materials in teaching offers potential for the design of new scenarios: the *availability* anytime and anywhere, the *customization*, especially with the individual speed of *reception*, the automatable *review* of solutions, the *traceability* of use as well as the easy *reproducibility* [3, 4]. The content consists of presentations, scripts, and tasks; the activities can be forums and chats, surveys, and tests, which are also enriched with gaming elements, all provided for learning management systems.

The EILD.nrw project has been funded by the Ministry of Culture and Science of the State of North Rhine-Westphalia since the winter semester of 2020 as a cooperation project with the Digital University of North Rhine-Westphalia (DH.NRW) [2]. The content created in this and the other projects of the OERContent funding line will be made available under the CC BY-SA 4.0 license – sharing and editing with attribution and passing on under the same conditions. The project partners from four universities have years of experience in teaching databases with self-developed learning units. About 1,000 students can acquire knowledge every

semester in supported self-study and work on practical tasks for the conception, creation, and programming of databases.

Due to the intended use in basic courses, the content is in German. Translatability into other languages is intended, but there are no funds available for this in the project, so the OER community will be approached for voluntary work. However, learning instructions for German-language textbooks, for example, can only be mapped into other language settings with a great effort.

For quality assurance, the learning and teaching modules created in the project are used and evaluated in current teaching [5]. Scaled answers are supplemented with free text entries. The anonymously submitted evaluations of the students were visible to the students in the course. Due to the transparency, the students can compare their answers with other learners. The evaluation of the feedback and an outlook on how it is considered are also presented in the course. The quantitative information enables the assessment by the students to be recorded. The information on the actual

processing time of tasks, for example, made it possible to check the workload specifications in the module manual. Combined with qualitative feedback, improvements can be made.

Several tools from the life cycle of databases such as modeling, relational data model, SQL and functionality and structure of database systems have been developed by the project partners or are nearing completion. In courses on selected subject areas, the tools are used in specific learning scenarios. Learning units on NoSQL database systems and the analysis of large amounts of multimedia data are developed as advanced topics.

1. The *MCT-trainer* contains over 1300 questions on database system concepts. In related quizzes, solution hints and explanations in the final evaluation enable an understanding of the correct answers. The question can be adopted to specific needs by database operations.

2. Modeling with the entity-relationship diagram can be practiced in the *ERD-trainer* using several application examples. The different notations for describing the cardinality of relationships can be compared interactively for binary relationships. The mapping to a relational schema into the relational schema can be done interactively in the *ER-mapping-trainer*.

3. A Moodle course contains an introduction to *the relational data* model with tutorial videos, reading tips and practical exercises on unary and binary operations and normalization. The tool RelaX of the University of Innsbruck [1] used to execute relational expressions is introduced with a screencast. The *NF-trainer* contains tasks for the transfer to the first, second and third normal form. The course contains commented references to textbooks, evaluation results, didactic recommendations for use in teaching and technical framework conditions.

4. The *SQL-trainer* and the *PL/SQL-trainer* offer an interactive learning application for SQL statements (DDL, DQL, DML) based on SQLite or for interactively practicing triggers, functions, and procedures. The use of Oracle SQLcl® (command line interpreter) is explained in a screencast.

5. The structure and functionality of database management systems are presented with the *serialization-trainer* for synchronizing parallel transactions and the *B-tree-animator* for interactive creation of an index

6. For the area of *NoSQL databases*, learning modules with instructional videos, pools of questions, case studies, online exercises and associated model solutions are integrated into learning sequences in the learning management system ILIAS.

7. The text and image-based introduction to *data analysis* presents specific problems, enables users to solve a problem interactively and contains questions with integrated feedback.

Modifiability and extensibility to adapt didactic preparation, integrability to a learning environment, and free availability are essential for using the tools and courses as OER. These requirements are met using open environments such as JavaScript, SQLite, Jupyter notebooks, the useability for freely available learning management systems such as Moodle and ILIAS as well as SCORM, software versioning via GitHub provisioning [7], inclusion of didactic descriptions and evaluation results within courses, and accessibility via the ORCA.nrw platform [6].

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[7] EILD.nrw GitHub repository https://github.com/EILD-nrw/.