Designing database lecture model in informatics engineering study program

C E Supriana

1Informatics Engineering Study Program, Faculty of Engineering, Pasundan University, Bandung, Indonesia
caca.e.supriana@unpas.ac.id

Abstract - Database lectures in the informatics engineering study program teach the life cycle of database system development, both in terms of concepts, utilization, administration to database application systems to be studied, practiced and understood by students. Database teaching in the informatics engineering department of a private university with very diverse student participants, the ability to master computer and information technology and skills requires teaching material, lecturing strategies, lecturer quality, and facilities must also be able to adjust toward challenges, concept development, and database technology. This database design research model used Hevner's information systems research framework, starting with reference research, database lecture analysis, rigor and research relevance. This research covered the steps of constructing artifacts in the form of constructs, models, methods, instantiation, and evaluation of artifacts. The use of the framework intended to support business strategies and processes in study programs and ensure the relevance of research. The benefits of this research will produce a database lecture model that can be used as a reference and lecture development in the informatics engineering study program. Reference to produce graduates with understanding and skills in database design, the use of Database Management System (DBMS), the ability in administration and professional capability in the database field. This research will be relevant to the study program environment as well as scientific benefits in research and database teaching.

1. Introduction

Higher education has a goal to develop an innovative, responsive, creative, skilled, competitive, cooperative academic community and has the technological capabilities used in the job market. Students majoring in informatics engineering are not only trained to have skills in information technology, especially Database Management Systems (DBMS) but also have reliable computer-aided system design and administration skills [19]. The success of teaching process will be determined by the ability of students to design and implement database systems that are in accordance with the requirements and are useful for the user. Factors of database design and implementation skills possessed by students are very important to be owned, tested and assessed. How the study programs and lecturers can determine, identify, improve, teach, and assess student design skills matching with the educational objectives of the department of informatics engineering. It is necessary to design a database lecture model for teaching material, teaching methods, technology literacy skills and student skills needed to achieve educational goals in the informatics engineering study program.
2. Research Methodology
The methodology carried out in this research was as follows (1) Literature study relating to database lectures and database syllabus in informatics engineering study programs which are database design, Database Management System (DBMS) and database administration. (2) Analysis of database lectures, student’s skills and practices, and their application in lectures. The analysis was carried out by observing and assessing the database lecture activities in 3 different semesters, semesters 1 to 3 in the informatics engineering study program. (3) Database lecture model design, database lecture model teaching components and database lecture model based on the results of the analysis as a model development process (4) Evaluation of design teaching model was carried out using case studies, the test model was carried out by observing the final grades of each database material delivered in 3 classes, in 3 different semester database courses. This research contributes: (1) Scientific contribution to find facts of database lectures for students as a condition of student graduation, knowledge and skills of students in the database field and the determination of study program strategies and (2) practical contribution, to describe aspects considered by a researcher in building a database lecture model in an informatics engineering study program and improving the quality of lectures, student skills, research and recommendations for improvement in database lectures.

3. Study in Informatics Engineering
Lecturing at the informatics engineering and utilizing technology related to database technology aimed to provide relevant material and activities that make students gain experience and make observations. Teaching and learning required a syllabus that will provide students the ability to think creatively, solve problems, make decisions in addition to academic abilities [16]. The role of lecturers in universities is not only as a provider of lecture material but also has a key role in the educational process, that is as a role model for students, facilitator, assessor, lecturer planner, and resource builder for lecture material [15]. Literacy skills as a prerequisite for full participation in the information society and industry, and will be connected to physical artifacts such as books or computers, and other sources of information, not only receive information but also produce it, and literacy will eliminate digital disparities [4] [17]. The development of literacy skills requires good teaching methods that must involve the students so they can understand the purpose of teaching, understand the benefits of the skills learned, be able to practice skills and get feedback from these activities and practice utilizing teaching materials. Teaching methods must be supported by a quality curriculum, an assessment that can be accounted for, the use of information and communication technology and clear literacy policies [13] [23].

4. Database Lecture
Students who attend database lectures are expected to gain insights on technological developments in the database field, the use of such technology in the real world, professions in the database field, and information systems in general and experience in solving database cases, both individuals and in groups [24]. The case study of this research is the implementation of a database lecture at the Informatics Engineering University of Pasundan Bandung, West Java, where the database lecture is divided into three parts, which is:
1. Database lecture is taught to students in the first semester. Students will learn the use of DBMS, by emphasizing aspects of practice, both computer use and database applications. Students will learn basic things in using database applications such as making databases, making tables in databases, making fields and determining the types of fields, making relations between tables and determining the cardinality of those relations. The next thing learned by students is to manipulate data and make database queries using structure query language (SQL), an insight into the database programmer professions [1] [2] [3]. Students attend lectures in class with teaching lecturers and take practicum in a computer laboratory. This lecture is referred to as a database accessing lecture [20].
2. Database lecture in second semester which will teach database modelling, database mapping to query languages, database normalization and case studies. Database modelling will teach students the real-world conditions in a company or organization where the database will be built, used and
how the database model will be able to meet the information requirements. Students will learn about the abstraction of problems using entity relationship diagrams (ERD) to determine entities, attributes, primary keys, relations and cardinalities. Students will learn the functional dependency between attributes in an entity that comes from the business processes of a company or organization [11]. Normalization of the database becomes the next stage of study before mapping into a logical database and physical database. Advanced mastery of DBMS and SQL is studied in this lecture. The subject of this lecture is database design [21]. Students who graduate from this course are expected have insight into database designers’ professions in the database field.

3. Database lecture in third semester which will teach database management and administration, database administration using DBMS, case studies and database security. Database management will teach database queries that will form transactions in database schemes and concepts and programs in the DBMS that will support these transactions in producing the information needed. Database administration will discuss the use of database schemes in serving the information needs of various parts of a company or organization as well as managing the right of access to that data [1] [11]. The case studies in this lecture will emphasize the importance of teamwork in completing a database scheme that can be utilized in a particular environment [18]. The subject of this lecture is database management system [22]. Students who graduate from this lecture are expected to have insight into database administrator.

5. Design Science
Hevner presents a conceptual framework for understanding, carrying out, and evaluating information systems research by combining the behavioural-science and design-science paradigms [8]. An environment for defining the scope of problem spaces where there are interesting phenomena. Information systems research includes people, business processes and technology in organizations that are being used or planned. This research included goals, tasks, problems, and opportunities that define business needs as perceived by the actors in an organization. Business needs were assessed and evaluated in the context of organizational strategy, structure, culture, and business processes, and are positioned relative to the available technological infrastructure. The purpose of design science research was to build or design artefacts to solve real, practical problems [9]. Research design science was aimed at building and evaluating artefacts that were designed to meet business needs. The aim of behaviour-science research is truth. The aim of design science research was utility. The resulting artefacts consisted of (1) construct (vocabulary and symbols), (2) models (abstraction and representation), (3) methods (algorithm and practice), (4) instantiation (implementation and prototype of the system), (5) better design theory and (6) methodology provides guidelines used in justifying or evaluating phases. The contributions of behavioural science and design science in information systems research were valued because they are applied to business needs in an appropriate environment [6] [10].

6. Analysis of Database Model Lecture Design
This section was conducted by a strategic analysis of informatics engineering study programs, database lecture analysis, database lecture component analysis and database lecture model analysis.

6.1. Rigor Analysis
Rigor analysis was carried out to obtain knowledge that can be used, this analysis intended to determine the construct that will be used in research. Database lectures taught the students about the importance of data management factors in an organization. Data that were processed using a DBMS concerned with the input data needed, computer-aided data management processes to produce information that will support the organization's business. The resulting construct was the concept or science of databases and the practice of using DBMS. Students and lecturers must understand the information needs needed by the organization is in line with the business processes within the organization. Business process analysis was needed in the initial stages of database design to ensure that the design model can accommodate and manage only the data needed. The resulting construct was a business process. Teaching system design must be supported by a good level of literacy, from
lecturers and from students. Utilization of digital literacy is necessary to support skills in design and practice in database implementation [7]. Teaching supported by digital literacy requires four competencies, which is technical competence, information competency, social competence to interact within the social sphere and epistemological competence, competence in teaching to create new knowledge from previous competencies [12]. The resulting construct was digital literacy. Studying at universities is a planned effort to create an atmosphere of learning and learning process so that students can actively develop themselves to reach their potential [26]. Education is not an activity that have immediately impact the results, the task of the instructor is to carry out the teaching process as well as possible because a good, planned and measurable teaching process is also an educational product [20]. A class meeting that discusses the concept carried out through database lecture is not enough, so it is balanced with the practice of using DBMS to provide skills in database implementation. The resulting construct is teaching and practice. Database lectures are also directed to support higher education, in addition to teaching science and practice, database teaching can be directed to the field of research. Research in the framework of lectures or final research to complete undergraduate education. The resulting construct is higher education.

Figure 1. Research Framework Database Model Design (Adaptation from Information System Research Framework).

6.2. Relevance Analysis
The relevance of this research is divided into three parts, the first is lectures are given to students in stages, with increasing levels of difficulty and ability of students in understanding the database material provided, theory and practice. Students are educated to have knowledge and ability to use database applications supported by analytical, literacy, self-management and teamwork skills. The second part is to provide a teaching syllabus that is suitable with undergraduate scientific material, practical material that is aligned with the needs of the labour market. The preparation of the syllabus is also adjusted to the strategy of study programs, the alignment strategy of graduates, must be provided in supporting of lecturers in the database field. The last part is the implementation of database lectures, where the implementation refers to the established syllabus and lectures. The lecture is carried out by ensuring that teaching materials are in line with technological developments, providing opportunity to repeat the material to provide a better understanding and reviewing the implementation of practicum, specifically coordination and assessment between lectures and practicum.

7. Determination of Construct
Based on the analysis, the construct used in designing the database lecture model is compatible with the relevance analysis, where database knowledge has a relationship with the database to answer
‘what’, has a relationship with lectures to answer ‘when’, has a relationship with an informatics engineering study program to answer ‘where’, have a relationship with students to answer ‘who’, have a relationship with database skills to answer ‘why’ and have a relationship with teaching and practice to answer ‘how’.

8. Database Environment in Informatics Engineering

Database lectures will receive input from: (1) syllabus, teaching material for lecturers, the implementation of teaching that refers to the syllabus will be delivered to students in class. The lecture material in the syllabus is sourced from the latest database textbooks, DBMS user’s guides, database websites and others. Teaching delivered in the syllabus includes the number of meetings, lecture material, lecture strategies, assessment weights including assignments or quizzes. (2) Lecturers as education implementers, facilitators and database lecturers who carry out the teaching process, give examples, implement DBMS utilization practices and student assessments (3) Database lecture model with its constituent components referring to the construct that has been analysed (4) Design teaching materials supported by the process of utilizing digital literacy, specifically the use of database applications (5) Database practices attended by students, carried out in computer laboratories, guided by a teaching assistant with material compiled by a teaching lecturer (6) Students as subjects of education who carry out the learning process (7) Lectures in the field of software engineering and information systems that will use the results of database lectures.

![Figure 2. Components in Teaching Database Design Lectures.](image)

9. Database Lecture Model

The database lecture model gets input from digital literacy taught by lecturers and understood by students as a support for database teaching. Database lectures, which also discuss current topics in the field of data and information management, will provide input, both for digital literacy and database practices following the demands of technological progress. Students during the database course will get the following materials, although the teaching of this material is not top-down which begins with understanding the importance of data and information in the real world, especially in organizations or companies. The concept of database will explain the management of data and information, as well as how students understand from the many types of databases, the focus of learning is only on the most popular database type, which is the relational database. The ability of data abstraction will be taught in database modeling. Students also learn the importance of connectivity between data items obtained from requirements and business processes for functional dependency as the basis for normalizing the database. The results of database modeling, mapping, and implementation of the database using a DBMS with SQL as a database description language (DDL) and database manipulation language (DML). Using a DBMS, students will use a physical database to understand database transactions, transaction concepts, and theories and again use SQL as a transaction control language (TCL). Students will re-learn SQL to make a comparison of access between queries to determine the optimal SQL query. Database administration will be studied further, not only by repeating designing database
models, but also the deepening of the organization's business processes that have an impact on database administration [14]. Students will learn data control language (DCL) from SQL and database security. The final component in this model is a lecture on advanced database topics that specifically addresses the latest developments in database concepts and technology as an introduction for students who will then explore data warehouses, big data, noSQL and others [5]. The components of the database lecture model, as mentioned previously are not taught top-down but are taught starting from a practice first, making database models and subsequently database administration. The practice of using DBMS is taught in the first semester for reasons of equitable mastery of computers and supporting applications, the use of simple DBMS such as Microsoft Access before learning web-based DBMS. The second semester will teach modeling, where database concepts are increasingly complex and increase the ability to master DBMS. Likewise the material in the third semester, again repeats course material in semester 1 and semester 2 and then learns new lecture material on administration.

![Figure 3. Database Lecture Model.](image)

10. Method & Instantiation Database Lecture Model
The method, which is an artefact of design science, defines the ways and uses of models that have been created [9]. The method will utilize components that have been designed in the database lecture model in the implementation of database lectures in the informatics engineering department, the basic activity of this model is the lecture process. Instantiation is the implementation of constructs, models and methods into a lecture system, practicum for increasing DBMS mastery skills and evaluating lecture results.

11. Evaluation of Database Lecture Model
The evaluation of this model was carried out by observing and evaluating the results of teaching at the Informatics Engineering Study Program at Pasundan University in 2018 and 2019. The first evaluation was carried out on 1 class of accessing database lectures conducted in 2018, with 35 students participating. Students who graduated from this study were 81.71% and 14.29% did not graduate. The second evaluation was carried out on 1 class database design lecture which was conducted in 2018-2019, with 37 students participating in the lecture. Students who graduated from this study were 75.68% and 24.32% did not graduate. The third evaluation was conducted on 1 class of database management system lectures conducted in 2019, with 44 students participating in the lecture. Students who graduated from this college were 60.2% while 39.8% did not graduate. Components of the database lecture model taught for three semesters are generally well-received by students. There are 4 lecture materials whose results are unsatisfactory, while 15 other material results are good and very
good. These results are the feedback from the results of the practicum assessment, quizzes, exercises and examinations in the first semester, quiz assessment, exercises and examinations in the second and third semesters. The assessment falls into the excellent category if more than 80% of students graduate, the good category if 60% of students graduate and the category is not good if less than 60% of students graduate. The high number of students who did not graduate in semester 3 was due to a lack of student presence in the class and getting failed at the time of the quiz or test assessment. Based on the determination of constructs, analysis of model design and evaluation of database lectures, several results are obtained: (1) Students: equal distribution of student’s ability to master computers and supporting applications is very important especially in the first semester, then education to strengthen self-management and technological literacy capabilities is needed in the next semester. (2) Lecturer: required lecturers who not only have concept and practice abilities but also have skills and experience in the database field so that they can provide case studies that are fit with real-world database practices. (3) Syllabus: a balanced syllabus is needed between database concepts and practices, always updated with the latest technological developments. An adequate syllabus gives room for discussion, training, and discussion of technological advances in the field of databases supported by adequate facilities.

| Database Lecture |  |  |
|------------------|---------------|-------------|
| 1st Semester     |  |  |
| Lecture Materials| Lecture Model | Lecture results |
| 1 Database concepts | Database Management Systems (DBMS) | not good | good | very good |
| 2 Database Management Systems | Database Management Systems (DBMS) |  |  |  |
| 3 Data Description Language using SQL | Structure Query Language (SQL) |  |  |  |
| 4 Data Manipulation Language using SQL | Structure Query Language (SQL) |  |  |  |
| 5 SQL query exercises | Structure Query Language (SQL) |  |  |  |
| 6 Case studies | Structure Query Language (SQL) |  |  |  |

| 2nd Semester |  |  |
| Lecture Materials | Lecture Model | Lecture results |
| 1 Database model concepts | Business Process, Requirements |  |  |  |
| 2 Recognizing database model using ERD | Database Concept, Relational Database Model |  |  |  |
| 3 Advanced database modeling | Database Concept, Relational Database Model |  |  |  |
| 4 Functional dependency & normalization | Functional Dependency, Normalization |  |  |  |
| 5 Database model mapping using SQL | SQL, DBMS, Normalization |  |  |  |
| 6 Case studies | SQL, DBMS, Normalization |  |  |  |

| 3rd Semester |  |  |
| Lecture Materials | Lecture Model | Lecture results |
| 1 Database administration concepts | Database Concept, Relational Database Model | not good | good | very good |
| 2 Transaction Control Language using SQL | Database Transactions |  |  |  |
| 3 Database administrator | Business Process, Requirements |  |  |  |
| 4 SQL query optimization | Database Transactions, SQL, DBMS |  |  |  |
| 5 Data Control Language using SQL | Database Transactions, SQL, DBMS |  |  |  |
| 6 Database security | Business Process, Requirements, SQL, DBMS |  |  |  |
| 7 Advanced database topics | Advanced Database Topics |  |  |  |

Figure 4. Database Lecture Material, Components Model Mapping and Assessment Results.

12. Conclusion
The conclusion obtained is that the research using this information system framework contributes to the knowledge base, namely the design of database lecture models in the informatics engineering study program as well as a review for teaching utilizing technology and database applications, analyzing the needs of technology literacy for designing database models and administration management, as well as contributions to the environment, provide input to the database syllabus, database lecturers, teaching strategies, evaluation of database lectures and the results of their evaluations.

Acknowledgments
The author thanks the Faculty of Engineering and Informatics Engineering Study Program of Pasundan University, the Informatics Engineering Study Program Research Group and fellow lecturers for their advice and assistance in carrying out this research.
References

[1] Coronel C and Morris S 2015 Database Systems : Design, Implementation, and Management, Eleventh Edition (Cengage Learning)

[2] Connolly T and Begg C 2015 Database Systems A Practical Approach To Design, Implementation, And Management, 6th Edition (Pearson)

[3] Eckstein J and Schultz B R 2018 Introductory Relational Database Design for Business with Microsoft Access (Wiley)

[4] Ellis T J and Levy Y 2010 A Guide for Novice Researchers: Design and Development Research Methods (Proceedings of Informing Science & IT Education Conference (InSITE))

[5] Fowler B, Godin J and Geddy M 2016 Teaching Case Introduction to NoSQL in a Traditional Database Course (Journal of Information Systems Education, Vol. 27(2))

[6] Gregor S and Hevner A 2013 Positioning And Presenting Design Science Research For Maximum Impact (MIS Quarterly Vol. 37 No. 2)

[7] Hellwell J R 2017 Skills for a Scientific Life (CRC Press)

[8] Hevner A, March S T, Park J and Ram S 2004 Design Science In Information Systems Research (MIS Quarterly Vol. 28 No. 1, pp. 75-105)

[9] Hevner A 2007 A Tree Cycle View of Design Science Research (Scandinavian Journal of Information Systems Volume 19 Issue 2)

[10] Hevner A and Chatterjee S 2010 Design Research in Information Systems Theory and Practice (Springer)

[11] Hoffer J A , Ramesh V and Topi H 2016 Modern Database Management, 12th Edition (Pearson)

[12] Ingvaldsen S and Oberg D 2017 Media And Information Literacy In Higher Education Educating the Educators (Elsevier, Chandos Publishing)

[13] Iinuma M 2016 Learning and Teaching with Technology in the Knowledge Society New Literacy, Collaboration and Digital Content (Springer)

[14] Kung H , Kung L and Gardiner A 2013 Comparing Top-down with Bottom-up Approaches : Teaching Data Modeling (Information Systems Education Journal (ISEDJ) 11)

[15] Lokse M , Lag T , Andreassen H and Stenersen M 2017 Teaching Information Literacy in Higher Education (Elsevier, Chandos Publishing)

[16] Naga Subramani P C and Iyappan V 2018 Innovative Methods Of Teaching And Learning (Journal of Applied and Advanced Research : 3 (Suppl. 1) S20-S22)

[17] Novikov A M and Novikov D A 2013 Research Methodology : From Philosophy of Science to Research Design (CRC Press)

[18] Post G V 2014 Database Management Systems Designing and Building Business Applications (www.jerrypost.com)

[19] Saeed A 2017 Role of Database Management Systems (DBMS) in Supporting Information Technology in Sector of Education (International Journal of Science and Research (IJSR) Volume 6 Issue 5)

[20] Syllabus Of Database Accessing Lecture, Informatics Engineering, Engineering Faculty Of Pasundan University, 2016

[21] Syllabus Of Database Design Lecture, Information Technology Engineering, Engineering Faculty Of Pasundan University, 2016

[22] Syllabus Of Database Management System Lecture, Informatics Engineering, Pasundan University Faculty Of Engineering, 2016

[23] Supriana C E 2018 System Design Teaching Model in Informatics Engineering Study Program (Journal of Physics : Conference Series volume 1165, IOP Publishing Ltd.)

[24] Yuelana L , Yiweia L , Yuyana H and Yuefan L 2011 Study on Teaching Methods of Database Application Courses (Procedia Engineering 15 5425 – 5428, Elsevier)