

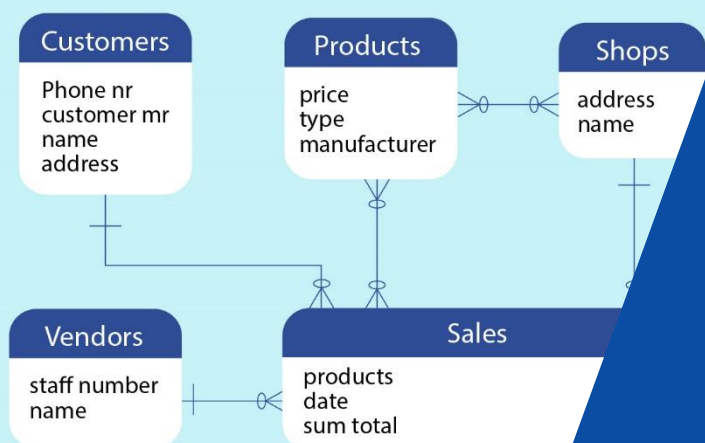


RQF LEVEL 4



SWDDD401
SOFTWARE
DEVELOPMENT

Database Development



TRAINER'S MANUAL

October, 2024



DATABASE DEVELOPMENT

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ACRONYMS

B-tree: Balanced tree

CODASYL: Conference on Data Systems Languages.

CPU Power: Central Processing Unit Power

DBMS: Database Management System

DCL: Data Control Language

DDL: Data Definition Language

DML: Data Manipulation Language

DQL: Data Query Language

ERD: Entity Relationship Diagram

I/O: Input/Out put

KOICA: Korean Cooperation International Agency

MD5: Message Digest Algorithm 5

NFRs: Non-Functional Requirements

OODBMS: Object-Oriented Database Management Systems

RTB: Rwanda TVET Board

SHA: Secure Hash Algorithm

SQL: Structured Query Language

SSMS: SQL Server Management Studio

TCL: Transaction Control Language

TQUM Project: TVET Quality Management Project

INTRODUCTION

This trainer's manual includes all the methodologies required to effectively deliver the module titled "**Database Development.**" Trainees enrolled in this module will engage in practical activities designed to develop and enhance their competencies.

The development of this training manual followed the Competency-Based Training and Assessment (CBT/A) approach, offering ample practical opportunities that mirror real-life situations.

The trainer's manual is organized into Learning Outcomes, which is broken down into indicative content that includes both theoretical and practical activities. It provides detailed information on the key competencies required for each learning outcome, along with the objectives to be achieved.

As a trainer, you will begin by asking questions related to the activities to encourage critical thinking and guide trainees toward real-world applications in the labor market. The manual also outlines essential information such as learning hours, didactic materials, and suggested methodologies.

This manual outlines the procedures and methodologies for guiding trainees through various activities as detailed in their respective trainee manuals. The activities included in this training manual are designed to offer students opportunities for both individual and group work. Upon completing all activities, you will assist trainees in conducting a formative assessment known as the end learning outcome assessment. Ensure that trainees review the key reading and the points to remember section.

MODULE CODE AND TITLE: SWDDD401 DATABASE DEVELOPMENT

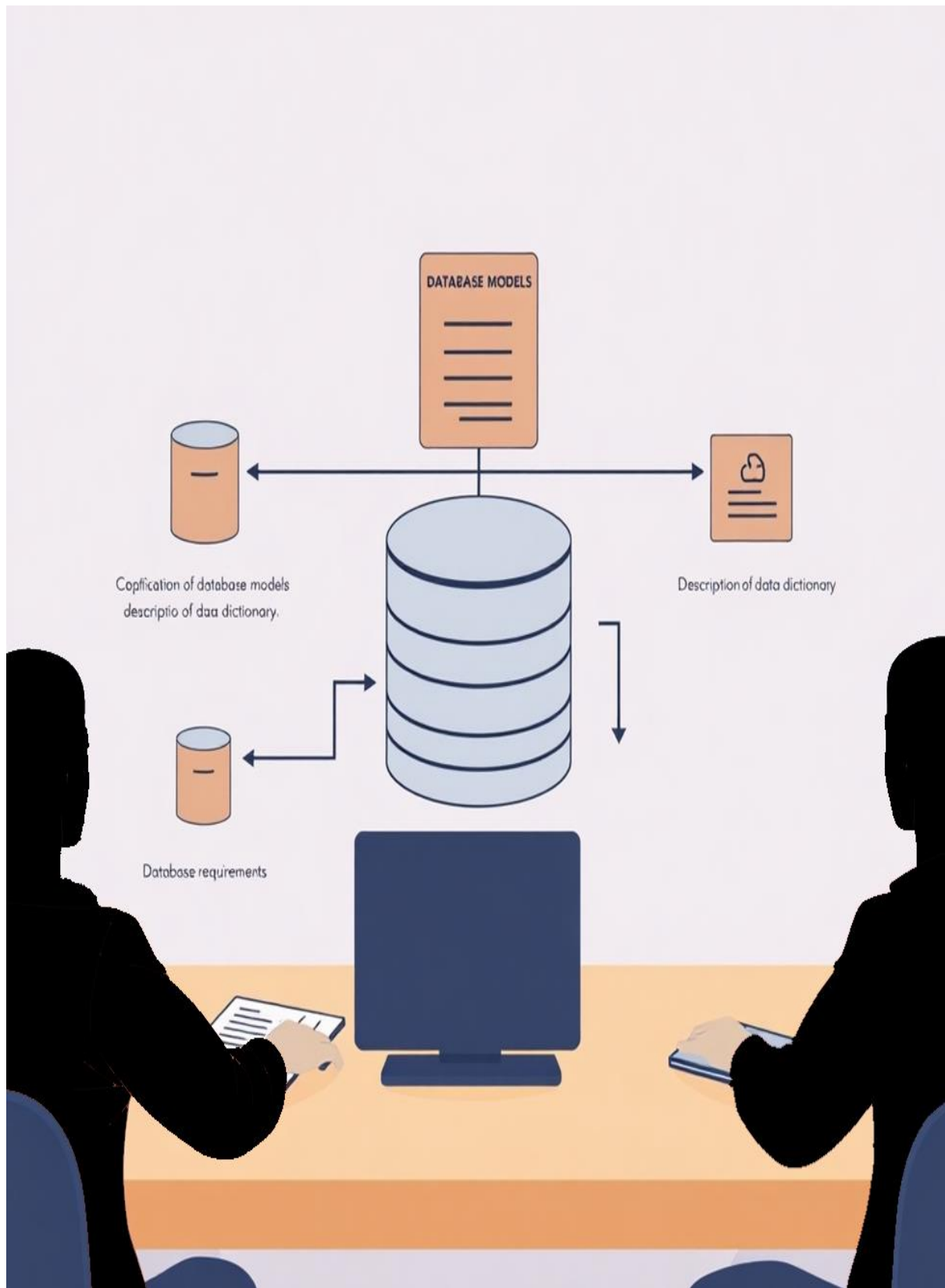
Learning Outcome 1: Analyse Database

Learning Outcome 2: Design Database

Learning Outcome 3: Implement Database

Learning Outcome 4: Secure Database

Learning Outcome 1: Analyse Database



Indicative contents

1.1 Description of database fundamental

1.2 Description of data dictionary

1.3 Identification of database requirements

Key Competencies for Learning Outcome 1: Analyse Database

Knowledge	Skills	Attitudes
• Description of database Concepts • Identification of database models • Identification of database relationships • Determination of database datatypes • Description of data dictionary • Identification of database requirements • Identification of data collection methods	• Creating data dictionary • Gathering data based on user requirement • Analysing database requirements	• Being Innovative • Having adaptability skills • Being Flexible • Having teamwork skills • Having self confidence • Being Time manager • Being Organizer



Duration: 20 hrs



Learning outcome 1 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Describe properly Database concepts based on database standards.
2. Identify properly Database models based on database standards
3. Identify properly Database relationship based on database standards
4. Determine correctly Datatypes based on database standards
5. Describe clearly Data dictionary based on database models.
6. Creating properly data dictionary according to the user requirements
7. Identify properly database requirements based on user requirements
8. Analyse effectively database requirements based on user requirement



Resources

Equipment	Tools	Materials
• Computer	• Ms office	• Internet



Advance Preparation:

Before delivering this learning outcome, you are recommended to:

- Avail computer lab with Ms office installed in the computers



Indicative content 1.1: Description of Database Fundamental



Duration: 7 hrs



Theoretical Activity 1.1.1: Introduction to database



Notes to the trainer:

- Trainer may use small groups for introducing database.
- Use images as didactic materials differentiate database elements



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer to the following questions:

1. Define the following terms:
 - a. Database
 - b. Data
 - c. Information
 - d. Entities
 - e. Attributes/Field
 - f. Records
 - g. Table
 - h. Database schema
 - i. DBMS
 - j. SQL
2. Where a database can be applied?
3. Give advantages and disadvantages of database

Step 2: Ask trainees to present their answers.

Step 3: Provide expert view and clarifies ideas by using didactic materials.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read key reading 1.1.1. in the trainee manual.



Points to Remember

- **A database** is a structured collection of data that is organized and stored in a way that can be easily accessed, managed, and updated.
 - **Data are raw** facts materials that needs to be processed in order to have meaning while **information** is data after being processed
 - **Entity:** Is something that exist distinguishable from others
 - **Attributes/Field:** Properties of Entity
 - **Record:** Raw of information
 - **Table:** A table is a data structure used to organize and store data in a relational database management system (RDBMS)
 - **A database schema** is a blueprint or design that defines the structure of a database system, including its tables, columns, data types, relationships, and constraints.
 - **DBMS:** A Database Management System (DBMS) is a software system that is designed to manage and organize data in a structured manner.
 - **SQL:** Structured query language (SQL) is a programming language for storing and processing information in a relational database.
 - Database can be applied in Business, E-commerce, Banking and Finance, Healthcare, Education,.
 - To store data in database, offer more advantages like:
 - ✓ Data become Centralized
 - ✓ Store consistency data
 - ✓ Secure data
 - ✓ facilitate Sharing and Collaboration
 - ✓ Data Integrity and Reliability
- But also, there are disadvantages like:
- ✓ Complexity
 - ✓ Cost
 - ✓ Performance Overhead
 - ✓ Scalability Challenges



Theoretical Activity 1.1.2: Identification of database models



Notes to the trainer:

- Trainer may use small groups for describing database models.



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- i. What do you understand by term database model?
- ii. Explain types of database models

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification and address any questions or concerns.

Step 4: Ask trainees to read the key reading 1.1.2 in the trainee manual.



Points to Remember

- A database model defines the logical structure of a database, determining how data is stored, organized, and accessed.
- Database models are:
 - ✓ Relational Model
 - ✓ Hierarchical Model
 - ✓ Network Model
 - ✓ Object-Oriented Model



Theoretical Activity 1.1.3: Identification of database Relationships



Notes to the trainer:

- Trainer may use small groups for describing database relationships.



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- i. What do you understand by relationship in database?

ii. Identify types of relationship

Step 2: Ask trainees to present their answers.

Step 3: Provide expert view and clarify ideas by using didactic materials.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read key reading 1.1.3 in the trainee manual.



Points to Remember

- Relationship is an association between entities
- Types of relationship in database are:
 - ✓ One to one
 - ✓ One to many
 - ✓ Many to one
 - ✓ Many to many



Theoretical Activity 1.1.4: Determination of data types



Notes to the trainer:

Trainer may use small groups for determining datatypes.



Key steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- What do you understand by datatype?
- What are main categories of datatype?

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

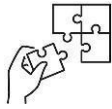
Step 5: Ask trainees to read the key reading 1.1.4 in the trainee manual.



Points to Remember

- It is a keyword used in database to identify type of data a column will store
- Categories of datatypes are:
 - ✓ Characters
 - ✓ Numbers

✓ Dates



Application of learning 1.1.

XYZ University is a large institution with thousands of students, faculty members, and administrative staff. To efficiently manage the records of students, faculty, and courses, the university decided to implement a student information management system (SIMS). The goal of the system is to store, organize, and retrieve relevant data related to student enrolment, faculty assignments, and course offerings.

As a database analyst you are asked to identify entities, attribute for each entity, datatype for each attribute and identify relationship between each pair of entities

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	Database fundamentals are well described	1.1.Entities are identified		
		1.2.Relationships are specified		
		1.3.Attributes are provided		
		1.4.Datatype for each attribute is provided		



Indicative content 1.2: Description of Data Dictionary



Duration: 7hrs



Theoretical Activity 1.2.1: Description of data dictionary



Notes to the trainer:

- Trainer may use small groups for describing data dictionary.



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce activity and ask trainees to answer the following questions:

- 1) What is a data dictionary?
- 2) What are elements of data dictionary?

Step 2: Ask trainees to share their findings in groups.

Step 3: Provide the expert view.

Step 4: Address any questions or any concern

Step 5: Ask trainees to read key reading 1.2.1 in the trainee manual.



Points to Remember

- Data dictionary is a document that hold data to describe database
- Elements of data dictionary are:
 - ✓ Table name
 - ✓ Attributes name
 - ✓ Datatype and length
 - ✓ Constraints
 - ✓ Descriptions



Practical Activity 1.2.2: Creating data dictionary



Notes to the trainer

- This activity is individual
- Avail data dictionary format
- Avail computers with installed Microsoft office word



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the Activity and ask trainees to read the below task:

Library has various sections such as Fiction, Non-Fiction, Reference, and Children's Books, each containing thousands of books for that reason to manage the books it is difficult because their information is stored in Microsoft excel. The library needs a system to efficiently manage its inventory of books, track member borrowing history, and handle day-to-day operations. The system will hold information of books: Each book has specific attributes, including title, author, and publication year, along with availability status. Additionally, the library needs to keep track of members, including their personal details, membership status, and borrowing history. To ensure that the database is well-structured and can meet the library's operational needs, you are asked to prepare a comprehensive data dictionary.

By creating this data dictionary, you will provide a detailed blueprint that guides the database design, ensuring clarity and consistency throughout the development process.

Step 2: Demonstrate how to create data dictionary, while demonstrating, explain each step

Step 3: Verify whether data dictionary is well created

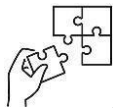
Step 4: Ask trainees to read key reading 1.2.2.

Step 5: Ask trainees to perform the task provided in application of learning 1.2



Points to Remember

- To create a data dictionary, follow the below steps:
 - ✓ Identify the Entities
 - ✓ Define Attributes for Each Entity
 - ✓ Assign Data Types to attributes
 - ✓ Specify Constraints for each attribute
 - ✓ Establish Relationships Between Entities
 - ✓ Create a Data Dictionary Table



Application of learning 1.2

NST is a university that need to expand its digital infrastructure and needs to develop a comprehensive database system to manage its student information, course offerings, faculty details, and enrollment records. The university administration wants to ensure that all aspects of student and course management are streamlined, including tracking student profiles, course registrations, grades, and faculty assignments. To achieve this, you, as the database developer, are tasked with creating a detailed data dictionary that will serve as the foundation for the database design.

This data dictionary should define all the entities involved, such as Students, Courses, Faculty, and Enrollments, along with their respective attributes, data types, and relationships. Additionally, it should specify any constraints, such as primary and foreign keys, to ensure data integrity and consistency across the database. By preparing this data dictionary, you will provide a clear and organized blueprint that guides the development process, ensuring that the database meets the university's operational and academic requirements.

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	Data dictionary is well created	1.1.Entities are Identified		
		1.2.Attributes for Each Entity are Defined		
		1.3.Datatypes are Assigned		
		1.4.Datatypes size is specified		
		1.5.Constraints are Specify		
		1.6.Relationships Between Entities are Established		
		1.7.Data Dictionary Table is Created		



Indicative content 1.3: Identification of Database Requirements



Duration: 6hrs



Theoretical Activity 1.3.1: Identification of data collection methods



Notes to the trainer:

- Trainer may use small groups to deliver this activity



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- I. What is data collection?
- II. Explain data collection methods?

Step 2: Ask trainees to present their findings

Step 3: Provide the expert view and address any questions or any concern

Step 4: Ask trainees to read key reading 1.3.3. In the trainee manual.



Points to Remember

- Data collection is the process of systematically gathering information from various sources to gain insights, make informed decisions, and answer research or business-related questions.
- Data collection methods are:
 - ✓ **Interview:** is conversation between interviewee and interviewer
 - ✓ **Documentation:** It involves gathering by analyzing existing documentation to understand the system architecture, requirements, design decisions, or codebase.
 - ✓ **Questionnaire:** A questionnaire is a structured set of questions designed to collect specific information from respondents.
 - ✓ **Observation:** Observation is a data collection technique where researchers or developers directly observe and analyze how people or processes behave in real-life situations.



Practical Activity 1.3.2: Collecting data



Notes to the trainer:

- This activity is individual based
- Avail Data Collection tools
- Avail data recording tools



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to read the below task:

In your role as a database analyst, you have been tasked with gathering essential information for the development of a website for Bright Future Secondary School. This project aims to create a platform that will make important school information accessible to students, parents, and stakeholders. To ensure the database is accurately designed and captures all necessary data, you are required to collect detailed information on student records, parent contacts, academic performance, staff details, and other relevant data points such as school events and notices. You will need to engage with various stakeholders, including school administrators, teachers, and parents, utilizing methods such as interviews, questionnaires, observation checklists, and online forms to ensure comprehensive data collection. The goal is to create a database that can be easily integrated into the website and meets the functional and reporting requirements of the school.

Step 2: Ask trainees to collect data

Step 3: Verify whether the data are well collected

Step 4: Ask trainees to read key reading 1.3.2.



Points to Remember

- Collecting data using interview the below steps are used:
 - ✓ Introduce

- ✓ Follow the Interview Script
- ✓ Ask questions
- ✓ Probing and Clarification
- ✓ Record Responses
- ✓ Address Participant Questions
- ✓ Closing the Interview
- Steps to collect data by using documentation method
 - ✓ Determine Relevant Documents
 - ✓ Obtain Access to Documents
 - ✓ Review and Analyze the Documents
 - ✓ Extract and Organize Data
 - ✓ Cross-Verify Data
 - ✓ Document Findings
- To collect data by using questionnaire follow the below steps:
 - ✓ Prepare for Distribution
 - ✓ Distribution
 - ✓ Monitor Responses
- To collect data by using observation the below steps are used:
 - ✓ Conduct the Observation
 - ✓ Maintain Objectivity
 - ✓ Record data



Theoretical Activity 1.3.3: Identification of database requirements



Notes to the trainer:

Trainer may use small groups to identify database requirements



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce activity and ask trainees to answer the following questions:

- I. What do you understand by database requirements.
- II. Differentiate Functional requirements from non-functional requirements?

Step 2: Ask trainees to present their answers.

Step 3: Provide the expert view.

Step 4: Address any questions or any concern

Step 5: Ask trainees to read key reading 1.3.3 in the trainee manual.



Points to Remember

- Database requirements is: Database requirements are the detailed specifications and criteria that a database system must meet to fulfil the needs of a particular application, organization, or project.
- **Functional requirements** define the specific actions and operations the database system must perform. While **Non-functional requirements** describe the qualities and characteristics of a database system, rather than its specific functions.



Practical Activity 1.3.4: Analysing database requirements



Notes to the trainer

- This activity is individual based



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to read the below task:

A university is planning to develop a new Student Information System (SIS) to manage student records, academic performance, and enrolment. The system will be used by students, faculty, and administrative staff.

You are tasked to:

Identify the potential database requirements for this SIS. Consider both functional and non-functional requirements.

Step 2: Demonstrate how to analyse database requirements, while demonstrating, explain each step

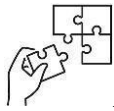
Step 3: Verify whether database requirements are well analysed

Step 4: Ask trainees to read key reading 1.3.4.



Points to Remember

- **Steps to analyse database requirements**
 - ✓ Define the System's Purpose
 - ✓ Identify Stakeholders
 - ✓ Gather Information
 - ✓ Define Functional Requirements
 - ✓ Define Non-Functional Requirements:
 - ✓ Prioritize Requirements
 - ✓ Validate Requirements



Application of learning 1.3.

TechLearn Academy, an online educational platform, is looking to develop a robust database system to manage its courses, students, instructors, and learning resources. As the database analyst, your task is to collect data using Interview, Questionnaire, Documentation, and Observation and analyze both the functional and non-functional requirements for this new system.

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	Data are well collected	Collecting data using interview		
		1.Conversation is Introduced		
		2.Interview Script is followed		
		3.Responses are Recorded		
		4.Participant Questions Addressed		
		5.Interview is closed		
		Collecting data using Questionnaire		
		1.Questionnaire is distributed		
		2.Responses are monitored		
		3.Responses are collected		
		Collecting data by using documentation		
		1. Relevant Documents are Determined		
		2. Access to documents are obtained		
		3. Documents are reviewed and analysed		
		4. Data are extracted and organized		
		5. Data are Cross-Verified		
		Collecting data by using observation		
		1. Observation is Conducted		
		2. Objectivity is maintained		
		3. Data are recorded		
2	Database requirements are properly analysed	1. System's Purpose is defined		
		2. Stakeholders are Identified		
		3. Information are gathered		
		4. Functional Requirements are defined		
		5. Non-Functional Requirements are defined		
		6. Requirements are prioritized		
		7. Requirements are validated		



Learning outcome 1 end assessment

Theoretical assessment

Question1: Match the database terms in column A with their definitions in column B.

Answers	Column A	Column B
...B...	1. Database	A) A person, place, thing, or event.
...J...	2. Data	B) A structured collection of related data.
...E...	3. Information	C) The logical structure of a database, defining entities, attributes, and relationships
...A...	4. Entity	D) A characteristic or property of an entity.
...D...	5. Attribute/Field	E) Data after being processed
...F...	6. Record	F) A row in a table, representing an instance of an entity.
...I...	7. Table	G) Software used to manage databases.
...C...	8. Database schema	H) A language used to interact with databases.
...G...	9. DBMS	I) A collection of related records.
...H...	10. SQL	J) Raw facts and figures.

Question2: Choose the correct answers:

I. Which database model is based on a hierarchical structure

- a. Relational database
- b. Hierarchical database
- c. Network database
- d. Object-oriented database

Answer: b. Hierarchical database

II. What is the relationship between a department and its employees?

- a. One-to-one
- b. One-to-many
- c. Many-to-one
- d. Many-to-many

Answer: b. One-to-many

III. Which data type would be suitable for storing a person's age

- a. Character
- b. Number

- c. Date
- d. Boolean

Answer: b. Number

Question3: Identify the type of relationship below between each pair of entities from the below provided statements:

- a) A table of employees and a table of their corresponding addresses. **Answer: Many to Many**
- b) A table of customers and a table of their orders. **Answer: One to Many**
- c) A table of books and a table of their authors. **Answer: Many to One**

Question4: Match the data collection methods (in the second column) to their description (in the third column) in the below table and write answers in the column first column of a table.

Answers	Methods	Description
...D...	1. Interview	A. Reviewing existing records, files, reports, or other documentation to gather relevant data.
...A...	2. Documentation	B. Using a set of predefined questions, often distributed to a large number of people, to collect structured responses.
...B...	3. Questionnaire	C. Directly watching or monitoring individuals or processes to gather data.
...C...	4. Observation	D. Engaging in face-to-face or virtual conversations to obtain detailed information from participants.

Question5: Which of the following is *NOT* typically included as an element in a data dictionary?

- A. Data Type
- B. Attribute Description
- C. Data Owner
- D. Relationship Cardinality

Answer: D. Relationship Cardinality

Practical assessment

Bright Future Secondary School is expanding its digital infrastructure by developing a new student information management system. As part of this project, you, as the database analyst, have been tasked with creating a detailed data dictionary that outlines the structure and attributes of the data to be stored in the system. You are required to collect data from various stakeholders, including school administrators, teachers, and students, using methods such as interviews, questionnaires, and reviewing existing records. This will include gathering information about student enrolment, class schedules, exam results, teacher assignments, and attendance records. Once the data is collected, you will need to analyze the database requirements by identifying the key entities, attributes, and relationships between them.

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	Data dictionary is well created	1.1 Entities are Identified		
		1.2. Attributes for Each Entity are Defined		
		1.3. Datatypes are Assigned		
		1.4. Datatypes size is specified		
		1.5. Constraints are Specify		
		1.6. Relationships Between Entities are Established		
		1.7. Data Dictionary Table is Created		
2	Data are well collected	Collecting data using interview		
		1. Conversation is Introduced		
		2. Interview Script is followed		
		3. Responses are Recorded		
		4. Participant Questions are addressed		
		5. Interview is closed		
		Collecting data using Questionnaire		
		1. Questionnaires are distributed		
		2. Responses are monitored		
		3. Responses are collected		
		Collecting data by using documentation		

		1. Relevant Documents are Determined		
		2. Access to documents are obtained		
		3. Documents are reviewed and analysed		
		4. Data are extracted and organized		
		5. Data are Cross-Verified		
		Collecting data by using observation		
		1. Observation is Conducted		
		2. Objectivity is maintained		
		3. Data are recorded		
3	Database requirements are properly analysed	1. System's Purpose is defined		
		2. Stakeholders are Identified		
		3. Information are gathered		
		4. Functional Requirements are defined		
		5. Non-Functional Requirements are defined		
		6. Requirements are prioritized		
		7. Requirements are validated		

END



Further information to the trainer

Books

Abraham Silberschatz, Henry F. Korth, and S. Sudarshan, 2020. Database System Concepts (7th Edition)

Steve Hoberman, 2011. Data Modeling Made Simple: A Practical Guide for Business and IT Professionals (2nd Edition)

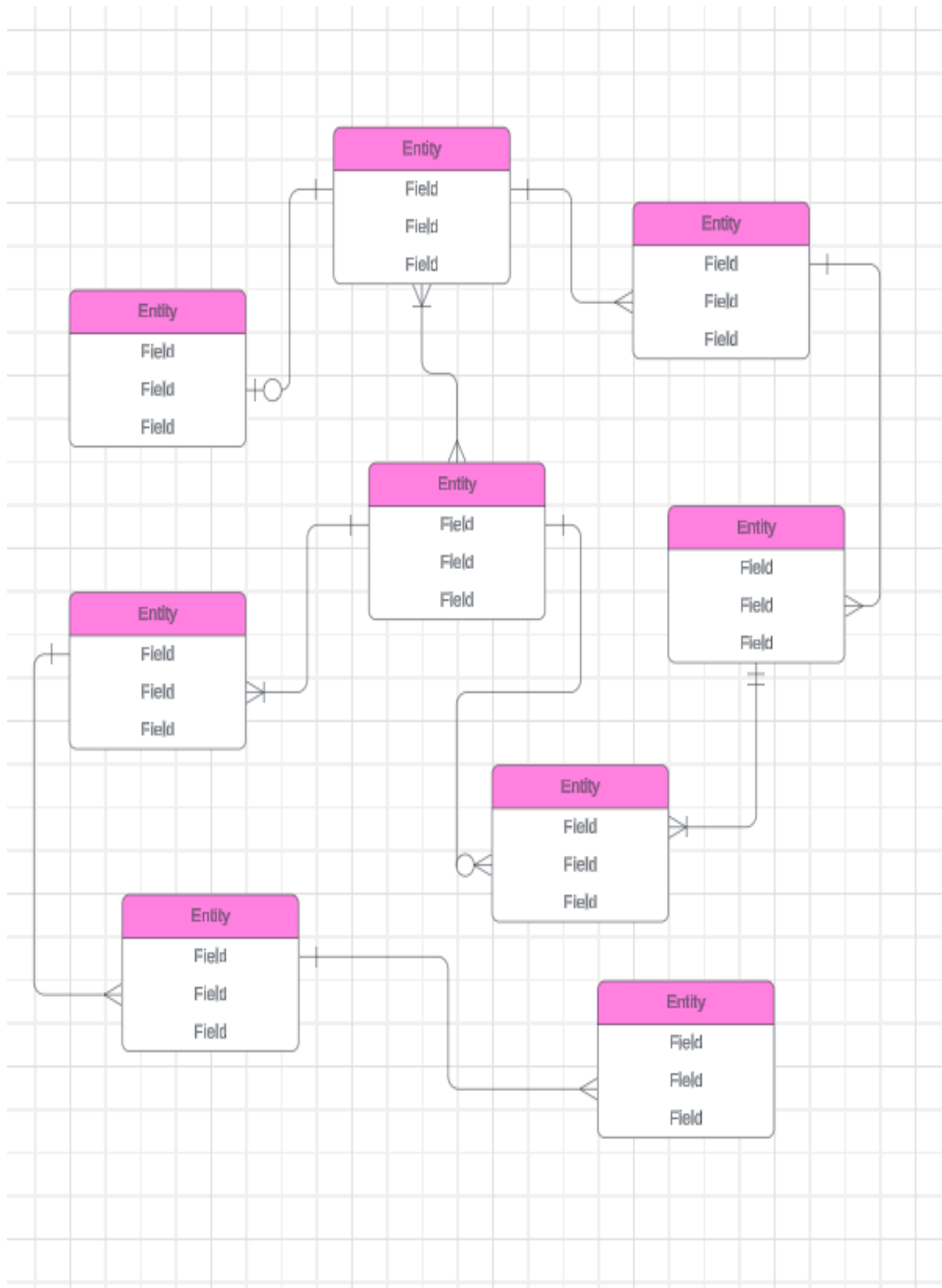
Michael J. Hernandez 2021, Database Design for Mere Mortals: A Hands-On Guide to Relational Database Design (4th Edition)

Web links

LLC, D. (2024, 10 30). RelationalDBDesign. Retrieved from www.relationaldbdesign.com
<https://www.relationaldbdesign.com/database-analysis/module1/intro-relational-data-analysis.php>

Study.com. (2024, 10 30). What is an Entity in a Database? Retrieved from Study.com:
<https://study.com/academy/lesson/what-is-an-entity-in-a-database.html>

Learning Outcome 2: Design Database



Indicative contents

2.1 Description of database schema

2.2 Design of conceptual database schema

2.3 Design of logical database schema

2.4 Optimization of database

2.5 Design of Physical database schema

Key Competencies for Learning Outcome 2: Design Database

Knowledge	Skills	Attitudes
● Description of database schema ● Description of conceptual database schema ● Description of logical database schema ● Description of physical database schema	● Designing conceptual database schema ● Designing logical database schema ● Optimizing database ● Designing Physical database schema	● Having creativity skills ● Being Innovative ● Having adaptability skills ● Being Flexible ● Having teamwork skills ● Having self confidence ● Being Time manager ● Being Organizer



Duration: 25hrs



Learning outcome 2 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Describe properly database schema based on DBMS
2. Describe properly conceptual database schema based on DBMS
3. Design correctly ERD based on system requirements
4. Design properly logical database schema based on system requirements
5. Enforce effectively Database optimization based on database schema
6. Create appropriately Physical Database Schema based on the Physical Data Model



Resources

Equipment	Tools	Materials
• Computer	• E-Draw max • MySQL	• Internet •



Advance Preparation:

Before delivering this learning outcome, you are recommended to:

- Have a computer with installed Draw max
- Have internet connection
- Avail MySQL set up



Indicative content 2.1: Description of Database Schema



Duration: 2hrs



Theoretical Activity 2.1.1: Description of database schema



Notes to the trainer:

- Trainer may use groups, to describe database schema



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer to the following questions:

- i. What do you understand with database schema?
- ii. Discuss about types of database schema
- iii. What are three levels of database abstraction
- iv. Differentiate types of data independence

Step 2: Ask trainees to present their findings to the whole classroom

Step 3: Provide expert view and address any questions or concerns

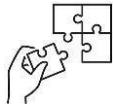
Step 4: Ask trainees to read the key reading 2.1.1 in the trainee manual, for more clarification.



Points to Remember

- A database schema is a logical blueprint or design that defines the structure, organization, and relationships of a database.
- Database schemas are:
 - ✓ Conceptual database schema
 - ✓ Logical database schema
 - ✓ Physical database schema
- Database abstraction levels are:
 - ✓ Physical Level
 - ✓ Logical Level
 - ✓ View Level

- Types of data independence:
 - ✓ Logical Data Independence
 - ✓ Physical Data Independence



Application of learning 2.1.

Bright Future University is developing a new **Student Information System (SIS)** to manage student records, academic performance, and enrollment. The university wish to hire a database designer who will helps it to take a decision about a database structure to be by identifying elements of each structure, Explaining the Levels of simplifying the database structure, then advise the university if it is possible to expand the structure of database after its implementation.

Checklist

S N	Criteria	Indicators	Observation	
			Yes	No
1	Database schemas are properly identified	Conceptual database schema elements		
		1.Entities are indicated		
		2.Relationship is indicated		
		Logical database schema elements		
		1.Entities are indicated		
		2.Relationship is indicated		
		3.Attributes are indicated		
		4.Primary key is indicated		
		5.Foreign key is indicated		
		Physical database Schema		
		1.Table name is indicated		
		2.Column name is indicated		
		3.Primary key is indicated		
		4.Foreign key is indicated		
		5.Datatypes are indicated		
2	Database abstraction levels are correctly identified	1.Physical abstraction level is identified		
		2.Logica abstraction level is identified		
		3.View level is identified		
3	Data independence is properly explained	1.Logical data independence is explained		
		2. Physical data independence is explained		



Indicative content 2.2: Design of Conceptual Database Schema



Duration: 6hrs



Theoretical Activity 2.2.1: Description of conceptual database schema



Notes to the trainer:

- Trainer may use groups to describe conceptual database schema



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- Explain why conceptual database schema is required in database design?
- What is an Entity Relationship Diagram (ERD)
- Describe ERD by explaining its components

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 2.2.1 in the trainee manual.



Points to Remember

- Conceptual database schema is required when designing database because it provides a conceptual representation of how the data is organized and stored. It defines the entities (tables) and attributes (columns) that make up the database, as well as the relationships between these entities.
- Components of ERD are:
 - ✓ Entities
 - ✓ Attributes
 - ✓ Relationship
 - ✓ Cardinality symbols



Practical Activity 2.2.2: Designing ERD



Notes to the trainer:

- This activity should be individual
- Avail drawing materials
- Avail images as didactic materials



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

Step 2: The management team of "Book Nook," a small independent bookstore, is seeking to develop a simple database system to manage its core operations. They require a database that can efficiently handle the essential aspects of their business with a focus on simplicity. The system should manage customer information, including basic contact details and a record of their past purchases. It should also track the inventory of books, including details such as the title, author, genre, and stock levels. As a database designer you are requested to create an ERD that includes up to four tables, representing customers, books, sales transactions, and transaction details.

Step 3: Demonstrate how design ERD. While demonstrating, explain each step

Step 4: Ask trainees to design ERD

Step 5: Verify whether the ERD is well designed

Step 6: Ask trainees to read key reading 2.2.2.



Points to Remember

- Steps to create ERD
 - ✓ Defining entities
 - ✓ Establishing relationships
 - ✓ Adding attributes
 - ✓ Defining the Relationship type by using cardinality symbols



Practical Activity 2.2.3: Draw an ERD using E-Draw max



Notes to the trainer:

- This activity should take place in computer lab and it is individual
- Avail computers connected to the internet
- Use video as didactic material
- Avail an ERD

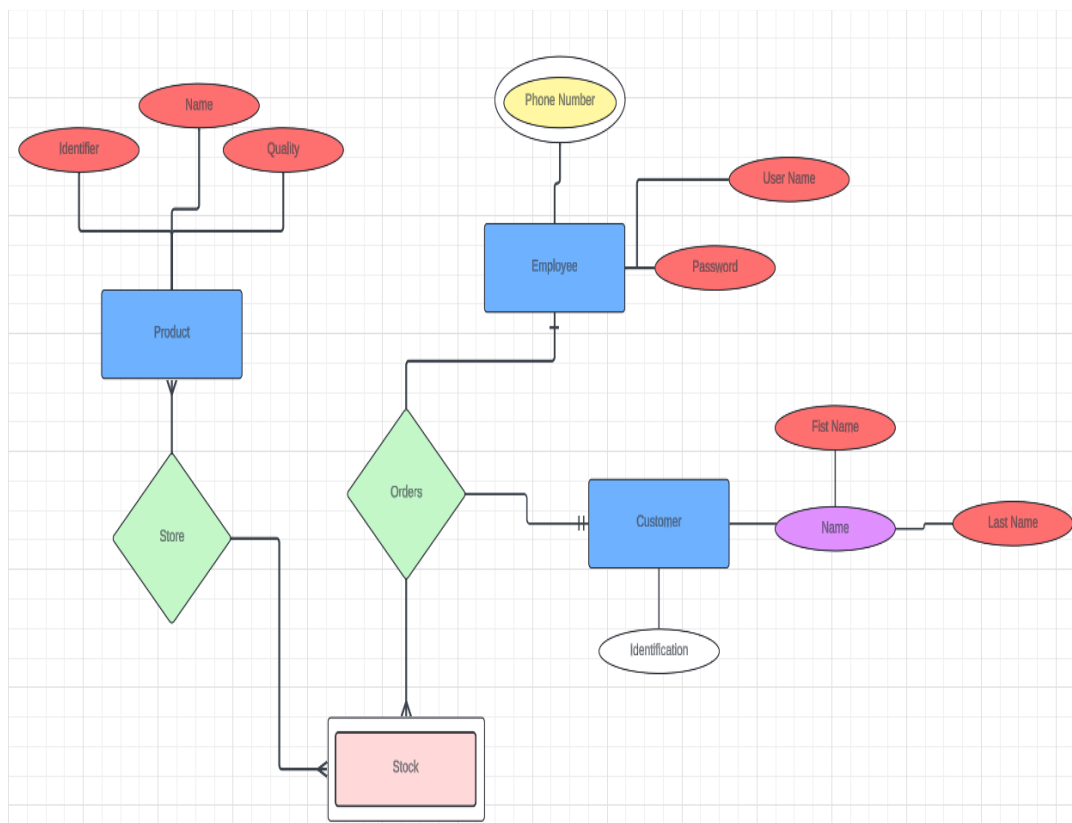


Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

As a database designer you are requested to go in computer lab to draw ERD by using E-draw max, use a provided ERD



Step 2: Demonstrate how to draw ERD. While demonstrating, explain each step

Step 3: Ask trainees to draw ERD using E-Draw max

Step 4: Verify whether the ERD is well drawn

Step 5: Ask trainees to read key reading 2.2.3.



Points to Remember

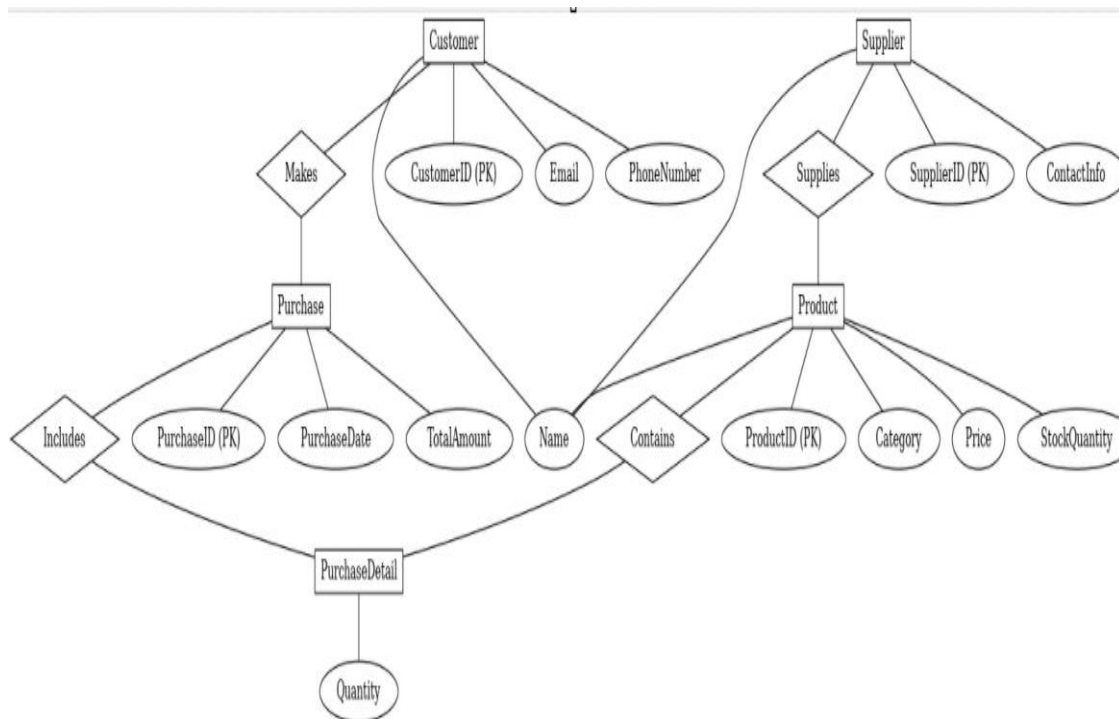
- Steps to draw ERD by using Edraw max
 - ✓ Open Edraw Max Online
 - ✓ Choose the ER Diagram
 - ✓ Create an ER Diagram
 - ✓ Customize Your ER Diagram
 - ✓ Save File



Application of learning 2.2.

The owner of "Fresh Harvest Market," a local grocery store, wants to implement a new database system to streamline the store's inventory and sales operations. The system should manage product information, including product name, category, price, and stock quantity. It should also handle supplier details, such as supplier name, contact information, and the products they supply. The store needs to keep track of customer purchases, including the date of purchase, items bought, and the total amount spent. Additionally, the database should support inventory management, enabling the store to monitor stock levels and automatically reorder products when they fall below a certain threshold. The database design should include an ERD that clearly models these entities and their relationships, ensuring the system can efficiently manage daily operations and support future business growth. As a database designer design ERD and draw it by using Edraw max

Checklist:



SN	Criteria	Indicators	Observation	
			Yes	No
1	ERD is well created	1.1.Entities are defined		
		1.2. Entities types are specified		
		1.3.Relationships are established		
		1.4. Attributes for each are defined		
		1.5. Types of attributes are specified		
		1.6.Relationships are defined by using cardinality symbol		
2	ERD is well drawn	2.1. E-draw Max is opened		
		2.2. ERD is drawn		
		2.3. ERD is clearly drawn		
		2.4. The File is saved		



Indicative content 2.3: Design of Logical Database Schema



Duration: 6hrs



Theoretical Activity 2.3.1: Description of logical database schema



Notes to the trainer:

- Trainer may use groups to deliver this content



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer to the following questions:

- i. What do you understand with logical database schema?
- ii. List and explain constraints in SQL

Step 2: Ask trainees to present their answers.

Step 3: Provide expert view and address any questions or concerns

Step 4: Ask trainees to read the key reading 2.3.1 in the trainee manual, for more clarification.



Points to Remember

- logical database schema defines all the logical constraints that need to be applied to the stored data, and also describes tables, views, entity relationships, and integrity constraints.
- **Table constraints are:**
 - ✓ NOT NULL Constraint
 - ✓ UNIQUE Constraint
 - ✓ DEFAULT Constraint
 - ✓ CHECK Constraint
 - ✓ PRIMARY KEY Constraint
 - ✓ FOREIGN KEY Constraint.



Practical Activity 2.3.2: Convert conceptual database schema to logical database schema



Notes to the trainer:

- This activity should be individual
- Avail conceptual database schema
- Avail images as didactic material
- Avail computers with installed software to draw logical database schema

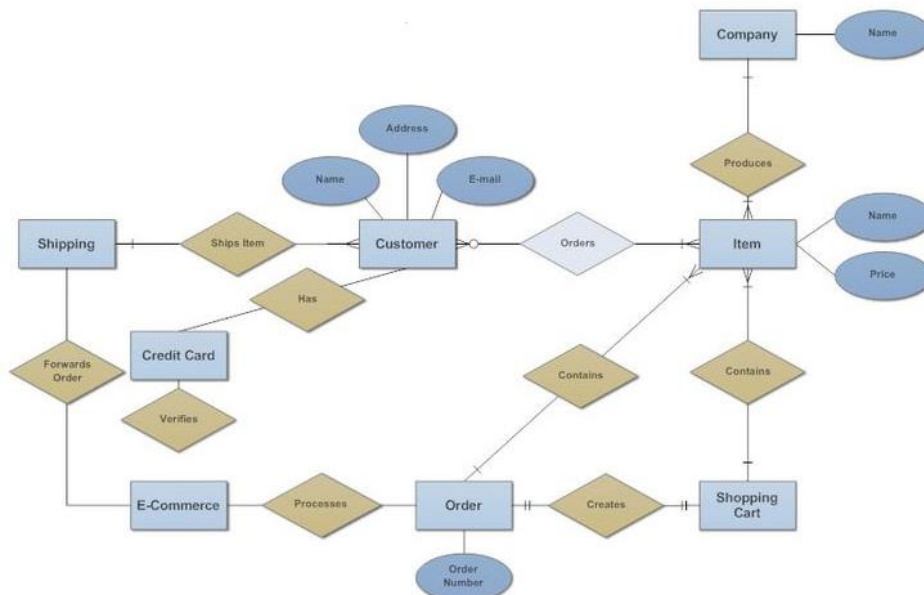


Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

As a database designer you are requested to go in computer lab to transform the provided ERD into logical database schema



Step 2: Demonstrate how draw logical database schema. While demonstrating, explain each step

Step 3: Ask trainees to transform conceptual database schema into logical database schema

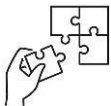
Step 4: Verify whether the logical database schema is well drawn

Step 5: Ask trainees to read key reading 2.3.2.



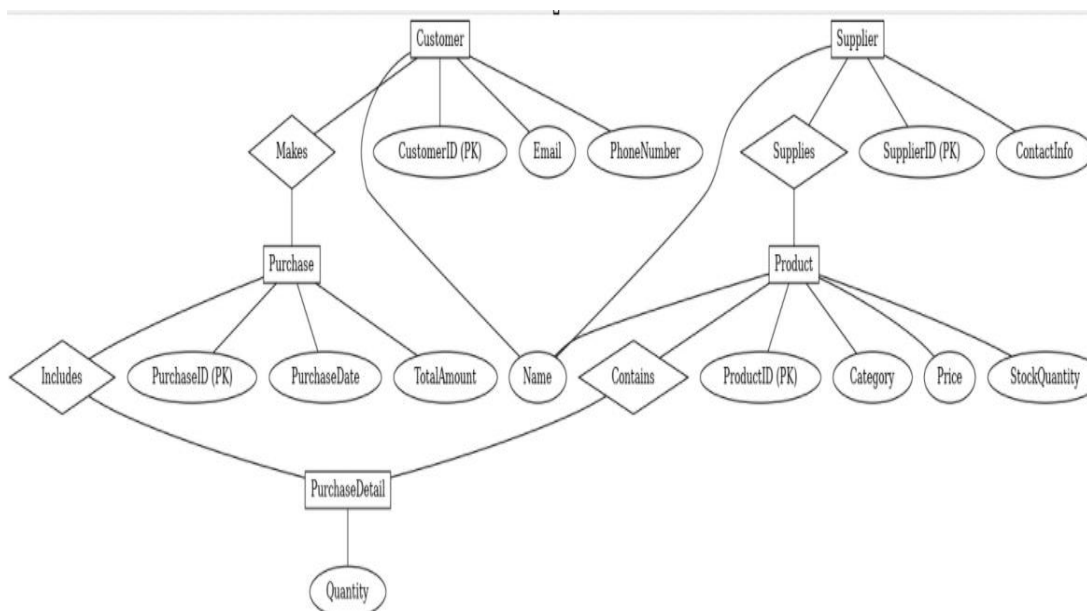
Points to Remember

- Steps to **convert** conceptual schema to logical scheme
 - ✓ Identify Entities and Attributes
 - ✓ Design Tables
 - ✓ Define Primary Keys
 - ✓ Establish Relationships
 - ✓ Define Constraints
 - ✓ Review and Refine

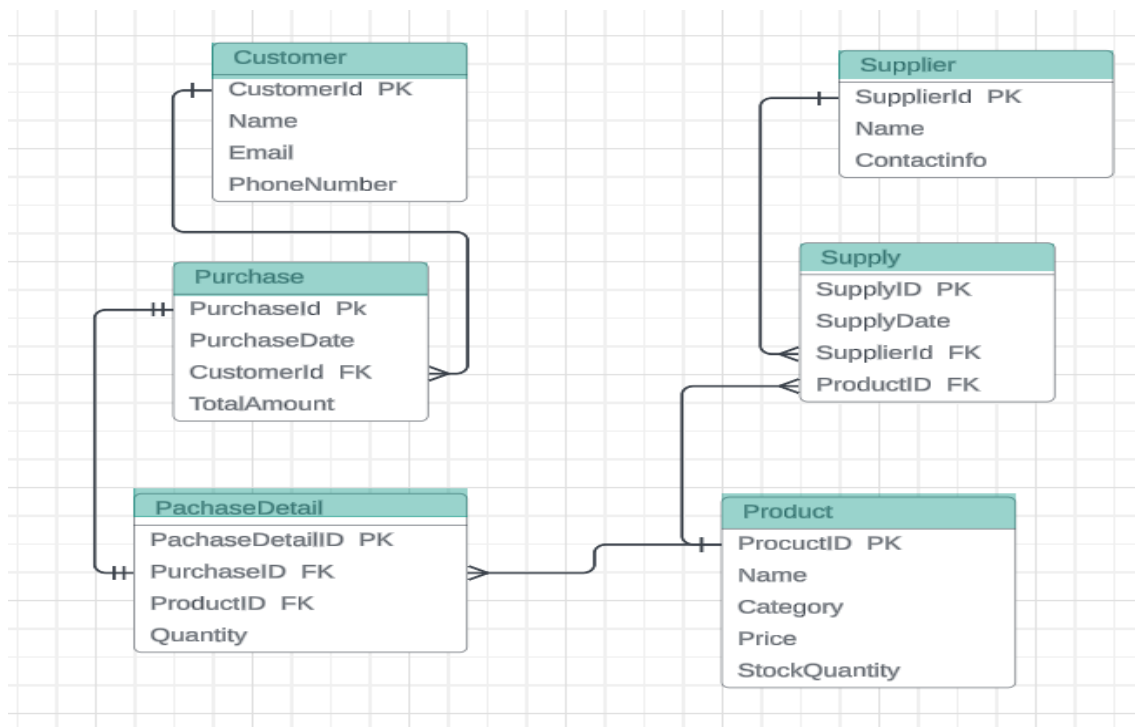


Application of learning 2.3.

The owner of “Fresh Harvest Market,” provide the below ERD and he is seeking for a database developer to develop to transform it into Logical database schema.



You as a database designer you are requested to transform it in Logical database schema.



Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	Logical database schema is elaborated	1.Entities are defined		
		2.Relationships are established		
		3.Attributes are specified		
		4.Primary key is selected		
		5.Foreign key provided		



Indicative content 2.4: Optimization of Database



Duration: 6hrs



Theoretical Activity 2.4.1: Description of database optimisation



Notes to the trainer:

- Trainer may use groups to describe database optimisation



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- What do you understand by database optimisation?
- Explain the ways that can be used to optimise database

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 2.4.1 in the trainee manual.



Points to Remember

- Database optimization refers to a variety of strategies for reducing database system response time.
- The ways to optimise database are:
 - ✓ Normalization, form of normalisation are: 1NF, 2NF, 3NF
 - ✓ Indexing



Practical Activity 2.4.2: Normalising database data



Notes to the trainer:

- Facilitation of this activity may be individual
- Avail sample abnormal tables



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to do the task described below:

As a database designer you are requested to perform the task described below:
A small retail company, "KIGALITechs," maintains a database to keep track of its inventory and sales. The current database structure stores information in a single table, which includes the following attributes: OrderID, CustomerName, CustomerAddress, ProductID, ProductName, Quantity, UnitPrice, and OrderDate. Over time, the company has experienced several issues, such as redundant data, difficulty in maintaining accurate customer information, and inconsistencies in product pricing. As a database designer you are tasked with normalizing this table to improve its efficiency and integrity. Check 1NF, 2NF, and 3NF

Step 2: Demonstrate how to normalise a table. While demonstrating, explain each step

Step 3: Ask trainees to Normalise table

Step 4: Verify whether table is correctly normalised

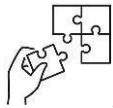
Step 5: Ask trainees to read key reading 2.4.2



Points to Remember

- Steps to normalise a table
- ✓ Check if column values are atomic if yes jump to the next step; if no make column values atomic

- ✓ Check if non key column depends on one prime attribute (one prime attribute). If yes jump to the next step if no; separate the columns that are depending on different prime attributes by splitting a table into other tables
- ✓ Check if non key attributes are mutual independent. If no you are done. If yes separate the non key columns that are depending to one another
- ✓ Note that if you split a table into more tables, you must create relationship between those new tables.



Application of learning 2.4

IBYIWACU restaurant has a restaurant management application that is used to store data about the company's employees it is annoyed by the information in that table because of duplications of data. It needs to hire a database designer to help it to change the structure of employee table to remove data duplication. As a database designer normalize the below table:

employee_id	name	job_code	Job	state_code	home_state
E001	Alice	J01	Chef	26	Michigan
E001	Alice	J02	Waiter	26	Michigan
E002	Bob	J02	Waiter	56	Wyoming
E002	Bob	J03	Bartender	56	Wyoming
E003	Alice	J01	Chef	56	Wyoming

Solution:

All the entries are atomic and there is a composite primary key (employee_id, job_code) so the table is in the first normal form (1NF).

2NF

even if you only know someone's employee_id, then you can determine their name, home_state, and state_code (because they should be the same person). This means name, home_state, and state_code is dependent on employee_id (a part of primary composite key). So, the table is not in 2NF. We should separate them to a different table to make it 2NF.

employee_roles Table

employee_id	job_code
E001	J01
E001	J02
E002	J02
E002	J03
E003	J01

Employees Table

employee_id	name	state_code	home_state
E001	Alice	26	Michigan
E002	Bob	56	Wyoming
E003	Alice	56	Wyoming

jobs table

job_code	job
J01	Chef
J02	Waiter
J03	Bartender

home_state is now dependent on state_code. So, if you know the state_code, then you can find the home_state value.

To take this a step further, we should separate them again to a different table to make it 3NF.

employee_roles Table

employee_id	job_code
E001	J01
E001	J02
E002	J02
E002	J03
E003	J01

employees Table

employee_id	name	state_code
E001	Alice	26
E002	Bob	56
E003	Alice	56

jobs **Table**

job_code	job
J01	Chef
J02	Waiter
J03	Bartender

states **Table**

state_code	home_state
26	Michigan
56	Wyoming

Now our database is in 3NF.

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	Data are correctly normalised	1.1NF is respected		
		2.2NF is respected		
		3.3NF is respected		



Indicative content 2.5: Design of Physical Database Schema



Duration: 5hrs



Theoretical Activity 2.5.1: Description of DBMS



Notes to the trainer:

- Trainer may use groups to facilitate this activity



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- I. What do you understand by DBMS?
- II. What are the components of DBMS?

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 2.5.1 in the trainee manual.



Points to Remember

- DBMS is a software system that is designed to manage and organize data in a structured manner. It allows users to create, modify, and query a database, as well as manage the security and access controls for that database.
- Components of DBMS are:
 1. Hardware
 2. Software
 3. Data
 4. Procedures
 5. Database Access Language
 6. People



Practical Activity 2.5.2: Preparing DBMS Environment (MySQL)



Notes to the trainer

- The activity is individual
- Avail computers and MYSQL DBMS set up



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

As a database designer you are requested to prepare MySQL environment

Step 2: Demonstrate how to prepare MySQL environment. While demonstrating, explain each step

Step 3: Ask trainees to prepare MySQL environment

Step 4: Verify whether environment is well prepared

Step 5: Ask trainees to read key reading 2.5.2.



Points to Remember

- Steps to prepare MySQL environment
 - ✓ Install MySQL
 - ✓ Configure MySQL
 - ✓ Start MySQL Server
 - ✓ Connect to MySQL



Practical Activity 2.5.3: Converting logic database schema to physical database.



Notes to the trainer:

- This activity should be individual
- Avail logical database schema

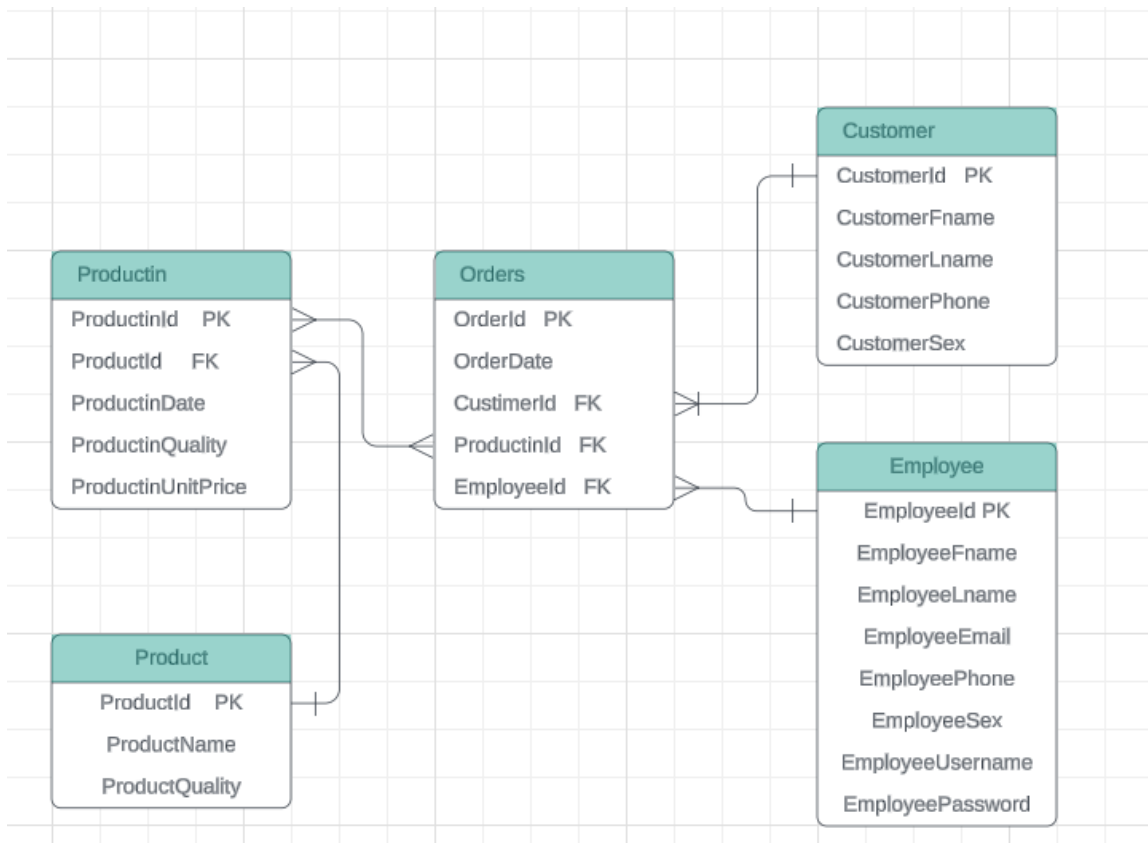


Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

As a database designer you are requested to transform logical database schema into physical database schema



Step 2: Demonstrate how convert logical database schema into physical database schema. While demonstrating, explain each step

Step 3: Ask trainees to convert logical database schema into physical database schema

Step 4: Verify whether physical database schema is well designed

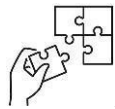
Step 5: Ask trainees to read key reading 2.5.3



Points to Remember

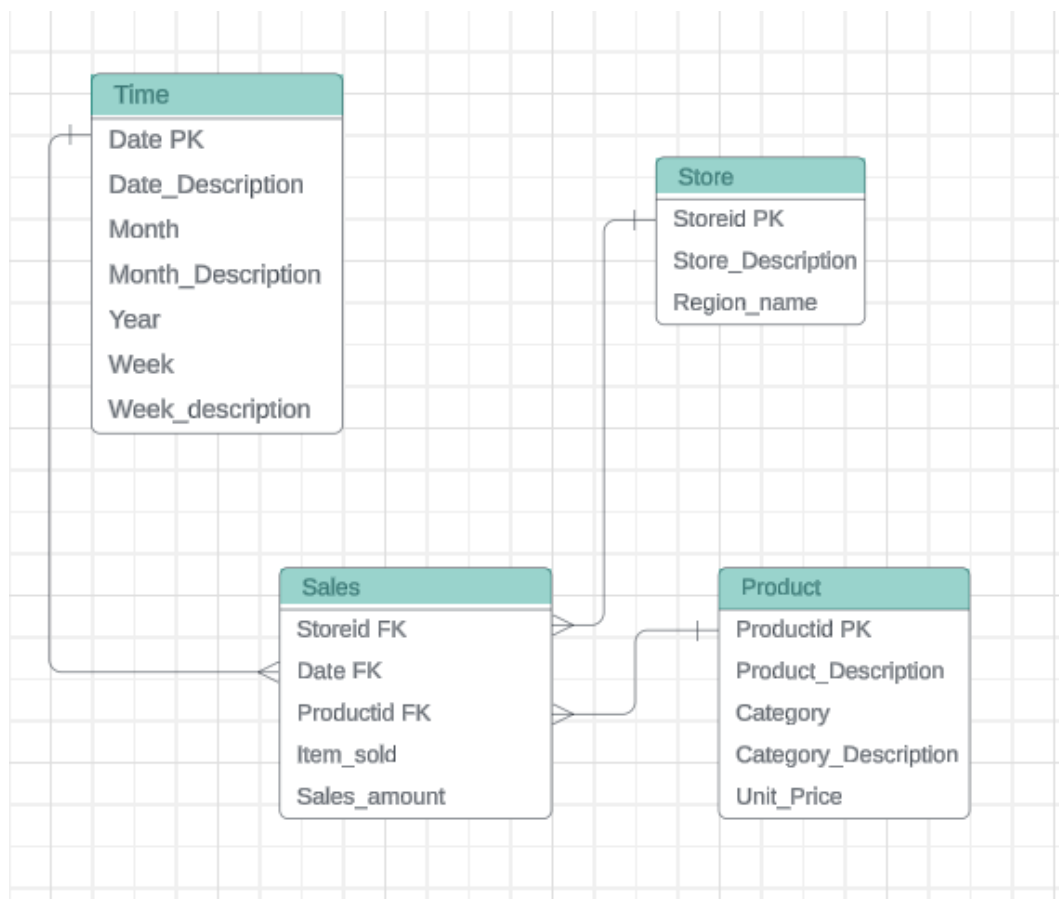
- Steps to convert logical database schema into physical database schema
 - ✓ Select a Database Management System (DBMS)

- ✓ Define Tables
- ✓ Specify Columns and Data Types
- ✓ Define Constraints
- ✓ Define relationship
- ✓ Normalize Data (if needed)



Application of learning 2.5

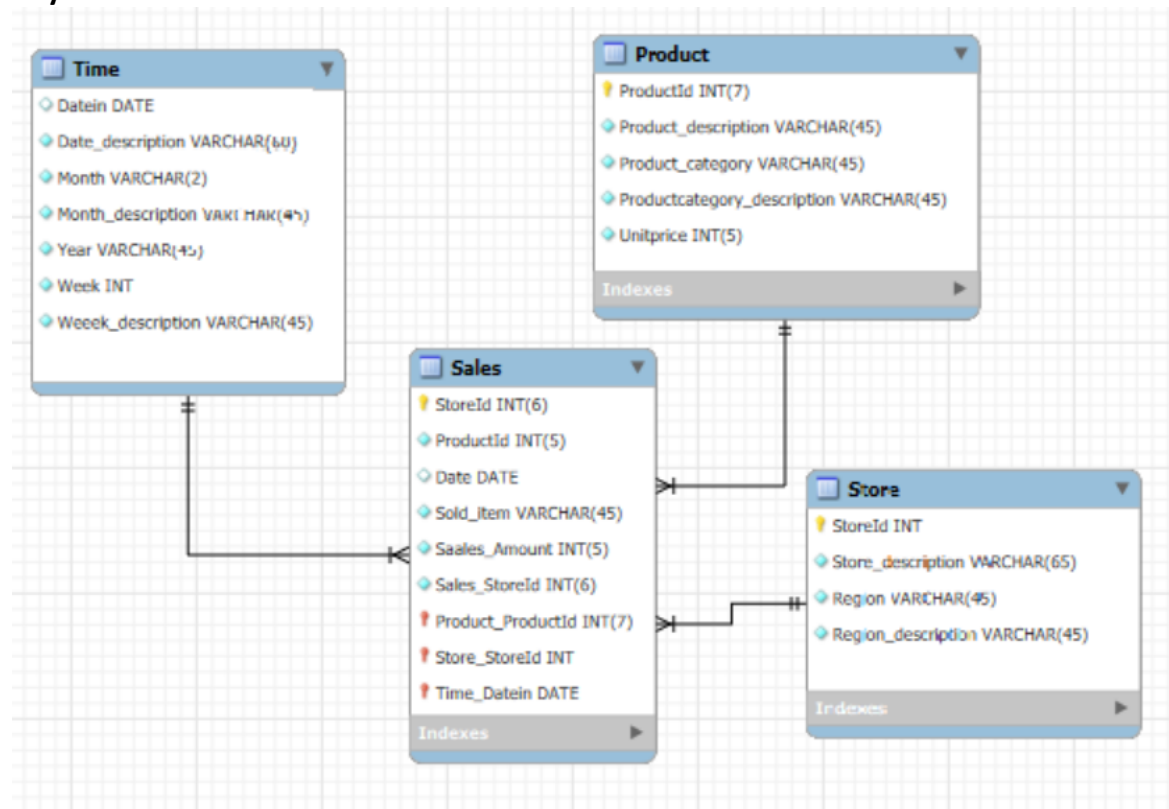
RAHABU is a company that sales its product online, it is located near your school. It is in the process of designing a database that will helps their employees to manage online sales the previous database designer lost the job after designing logical database schema shown below



you are hired as a database designer to prepare MySQL environment, then convert the above logical database schema into physical database schema

Checklist:

Physical database schema



SN	Criteria	Indicators	Observation	
			Yes	No
1	MySQL environment is well prepared	1.MySQL is installed		
		2.MySQL is Configured		
		3.MySQL Server is Started		
		4.MySQL is Connected		
2	Physical database schema is elaborated	5.Table names are provided		
		6.Column names are provided		
		7.Primary key is selected		
		8.Foreign key is provided		
		9.datatypes are indicated		



Learning outcome 2 end assessment

Theoretical assessment

Question1: Match the following terms with their correct definitions:

Answers	Terms	Definitions
...F...	1. Database Schema	A. A big-picture view of what the system will contain, how it will be organized, and which business rules are involved.
...A...	2. Conceptual Schema	B. Clearly defines schema objects with table names, field names, relationships, and integrity constraints but lacks technical requirements.
...B...	3. Logical Schema	C. is the lowest level of data abstraction, which deals with the physical storage and representation of data.
...D...	4. Physical Schema	D. Provides a high-level representation of the data, defining tables, columns, and relationships without concerning physical storage details.
...C...	5. Physical Level of Data Abstraction	E. Is a process of simplifying the structure of database by removing data duplication
		F. Defines the structure, organization, and relationships of a database, including tables, columns, data types, and constraints.

Question2: Read careful the below statements and encircle the correct answer from the provided options

1) The following features are included in a database schema Except:

- A) Tables and columns
- B) Primary key constraints
- C) User interface designs
- D) Data types and lengths

Answer:C

2) A conceptual schema provides:

- A) The syntax for creating data structures on disk storage
- B) A high-level view of the system's organization and business rules
- C) Detailed technical requirements for database implementation
- D) A specific view for different database users

Answer:B

3) The following are table constraints Except.....

- A) Primary Key
- B) Foreign Key
- C) Data Type
- D) Unique

Answer:C

4) PRIMARY KEY constraint ensures that.....

- A) All values in the column(s) are unique.
- B) The column(s) cannot contain NULL values.
- C) The column(s) uniquely identify each row in the table.
- D) All of the above.

Answer:D

5) A constraint ensures that a column must have a value (i.e., it cannot be NULL) is

- A) PRIMARY KEY
- B) FOREIGN KEY
- C) CHECK
- D) NOT NULL

Answer: D

6) A constraint that is used to enforce a relationship between two entities is known as a.....

- A) PRIMARY KEY
- B) FOREIGN KEY
- C) UNIQUE
- D) CHECK

Answer:B

7) The role of a UNIQUE constraint is to:

- A) Ensures that all values in the column(s) are different.
- B) Ensures that no two rows have the same values in the specified column(s).
- C) Allows only one NULL value in the column.
- D) All of the above.

Answer:D

8) The constraint used to limit the range of values that a column can store is known as:

- A) PRIMARY KEY
- B) CHECK
- C) UNIQUE
- D) FOREIGN KEY

Answer: B

Question3: write T to the correct statement and F to the wrong statement

- a) A strong entity is an entity that does not depend on any other entity for its existence. **Answer: T**
- b) A weak entity can exist independently without being associated with a strong entity. **Answer: F**
- c) In a one-to-one relationship, each entity in one entity set can be associated with multiple entities in the other entity set. **Answer: F**
- d) A one-to-many relationship means that one entity in an entity set is associated with many entities in another entity set. **Answer: T**
- e) In a many-to-many relationship, each entity in one entity set can be associated with multiple entities in another entity set, and vice versa. **Answer: T**
- f) Attributes are properties or characteristics of entities that help to describe the entity. **Answer: T**
- g) A composite attribute is an attribute that can be divided into smaller sub-attributes. **Answer: T**

Question 4: Match Normal forms to their descriptions

Answers	Forms of Normalisation	Description
...a...	1.1NF	a. Ensures that a table has no repeating groups and that each column contains atomic (indivisible) values.
...c...	2.2NF	b. Requires that a table be in 2NF and that all transitive dependencies are eliminated, ensuring that non-key attributes are only dependent on the primary key.
...b...	3.3NF	c. Requires that a table be in 1NF and that all non-key attributes be fully functionally dependent on the primary key.

Practical assessment

GS KABURINGA is a secondary school located in your village, it needs a database designer to redesign a database for its system that cover all key aspects of the school's operations, including student information, teacher details, class schedules, subjects, and grades. The current database it uses it turn errors in the weekly report because of the gaps in database design. You as a database designer you are hired by that school and your tasks are:

- To create an Entity-Relationship Diagram (ERD) that outlines the relationships between different entities such as Students, Teachers, Classes, and Subjects.
- Logical database schema that details the structure of the database.
- Design a physical database schema.

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	ERD is well created	1.1.Entities are defined		
		1.2.Entities types are specified		
		1.3.Relationships are established		
		1.4.Attributes are defined		
		1.5.Types of attributes are specified		
		1.6.Relationships are defined by using cardinality symbol		
2	ERD is well drawn	2.1. Edraw Max is Opened		
		2.2. ERD is created		
		2.3.Customize Your ER Diagram		
		2.4.Save File		
3	Logical database schema is elaborated	3.1.Entities Defined		
		3.2.Relationships are established		
		3.3.Attributes are specified		
		3.4 .Primary key is selected		
		3.5.Foreign key provided		
4	MySQL environment is well prepared	4.1 .MySQL is installed		
		4.2.MySQL is Configured		
		4.3 MySQL Server is Started		
		4.4.MySQL is Connected		
5	Physical database schema is elaborated	5.1 Table names are provided		
		5.2 Column names are provided		
		5.3.Primary key is selected		
		5.4.Foreign key is provided		
		5.5.datatypes are indicated		

END



Further information to the trainer

Books

Michael J. Hernandez, 2013. Database Design for Mere Mortals: A Hands-On Guide to Relational Database Design

Jan L. Harrington, 2026. Relational Database Design and Implementation

Martin Kleppmann, 2017. Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems

Web links

edrawsoft.com. (2024, 10 30). *Entity Relationship Diagram (ERD)*.

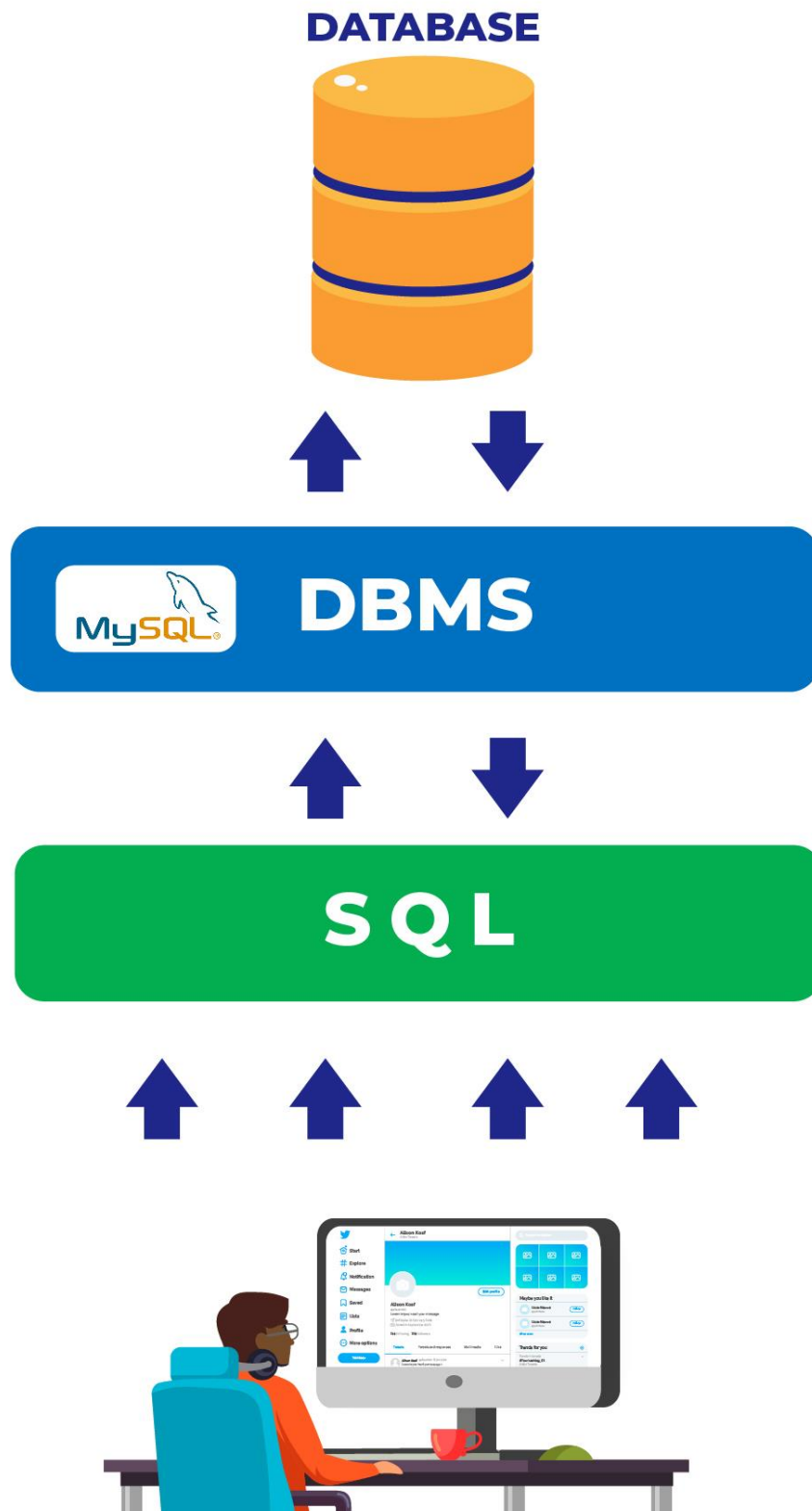
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geeksforgeeks.org. (2024, 10 30). *Database Schemas*. Retrieved from <https://www.geeksforgeeks.org/database-schemas/>:
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<https://miro.com/diagramming/how-to-draw-an-er-diagram/>

Learning Outcome 3: Implement Database



Indicative contents

3.1 Description to SQL

3.2 Application of DDL commands

3.3 Application of DML commands

3.4 Application of DQL Command

3.5 Application of DCL commands

3.6 Application of TCL commands

Key Competencies for Learning Outcome 3: Implement Database

Knowledge	Skills	Attitudes
• Description of SQL • Description of DDL Command • Description of DML Commands • Description of DQL Commands • Description of DCL Commands • Description of TCL Commands	• Writing DDL queries • Applying DDL Commands • Applying DMLCommands • Applying DQL Commands • Applying DCL Commands • Applying TCL Commands	• Being Creative • Having Innovative skills • Having Adaptability skills • Being Flexible • Having Teamwork • Having self Confidence



Duration: 36 hrs



Learning outcome 3 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Describe properly SQL as used in database
2. Describe properly SQL queries as used in Database
3. Apply effectively DDL Queries based on database schema
4. Apply effectively DML Queries based on database schema
5. Apply effectively DQL Queries based on database schema
6. Apply effectively DCL queries based on database schema
7. Apply effectively TCL queries based on database schema



Resources

Equipment	Tools	Materials
• Computer	• MySQL • Apache • XAMPP • WAMP • LAMP	• Pen • Papers



Advance Preparation:

Before delivering this learning outcome, you are recommended to:

- Avail computer lab with XAMPP, APACHE, web browser to be installed



Indicative content 3.1: Description to SQL



Duration: 3hrs



Theoretical Activity 3.1.1: Description of SQL



Notes to the trainer:

- Trainer may use small groups for describing SQL.



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce activity and ask trainees to answer the following questions:

1. What do you understand by SQL
2. Differentiates SQL sub-Languages
3. Discuss on four SQL operators

Step 2: Ask trainees to present their findings.

Step 3: Provide the expert view.

Step 4: Address any questions or any concern

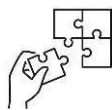
Step 5: Ask trainees to read key reading 3.1.1 in the trainee manual.



Points to Remember

- SQL stands for Structured Query Language. It's a specialized programming language designed to manage and manipulate data stored in relational databases.
- SQL sub-languages are:
 - ✓ DDL
 - ✓ DML
 - ✓ DCL
 - ✓ DQL
 - ✓ TCL
- SQL operators are:
 1. Arithmetic operators
 2. Bitwise operators
 3. Compound operators

4. Logical operators
5. Comparison operators



Application of learning 3.1

Bright Future University is developing a new **Student Information System (SIS)** to manage student records, academic performance, and enrollment. The database structure that shows how the database will be implemented was developed, the university needs to hire a database developer to implement database in MySQL by using SQL, to ensure that you are able to implement is you are asked to describe SQL Components (Sub-languages) and their respective commands, and the operators that can be used to Apply SQL commands.

SN	Criteria	Indicators	Observation	
			Yes	No
1	SQL Sub-languages are correctly identified	1.1 DDL and its Commands are identified		
		1.2 DML and its Commands are identified		
		1.3 DDL and its Commands are identified		
		1.4 DCL and its Commands are identified		
		1.55 TCL and its Commands are identified		
2	SQL Operators are correctly identified	2.1 .SQL Arithmetic Operators		
		2.2 SQL Bitwise Operators		
		2.3 SQL Compound Operators		
		2.4 SQL Logical Operators		



Indicative content 3.2: Application of DDL Commands



Duration: 6hrs



Theoretical Activity 3.2.1: Description of DDL commands



Notes to the trainer:

- Trainer may use small groups for describing DDL commands.



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer to the following questions:

1. Describe DDL Create Commands
2. Describe DDL Drop Commands
3. Describe DDL Alter Commands
4. Describe DDL Truncate Commands

Step 2: Ask trainees to present their answers.

Step 3: Provide expert view and address any questions or concerns

Step 4: Ask trainees to read the key reading 3.2.1 in the trainee manual, for more clarification.



Points to Remember

- General syntax to Create database: `Create database database_name;`
- General syntax to Drop Database: **Drop database** database_name;
- General syntax to modify table structure:
 - ✓ Add Column: **ALTER TABLE** table_name **ADD** column_name datatype;
 - ✓ Modify column datatype and constraint: **ALTER TABLE** table_name **MODIFY COLUMN** datatype and constraint;
 - ✓ Drop column: **ALTER TABLE** table_name **DROP COLUMN** column_name;
 - ✓ Change Column name: **ALTER TABLE** table_name **CHANGE** Current_column_name New_column_Name Datatype and constraint;
 - ✓ Rename table: **ALTER TABLE** Table_Name **RENAME TO** New_Table_Name;
- General syntax Truncate Table: **TRUNCATE TABLE** table_name;



Practical Activity 3.2.2: Applying DDL Commands



Notes to the trainer

- Facilitation of this activity can be individual based; you are supposed to demonstrate trainees how to create database and database tables in DBMS.
- Consider well defined physical database schema.
- Verify that DBMS environment is well maintained.

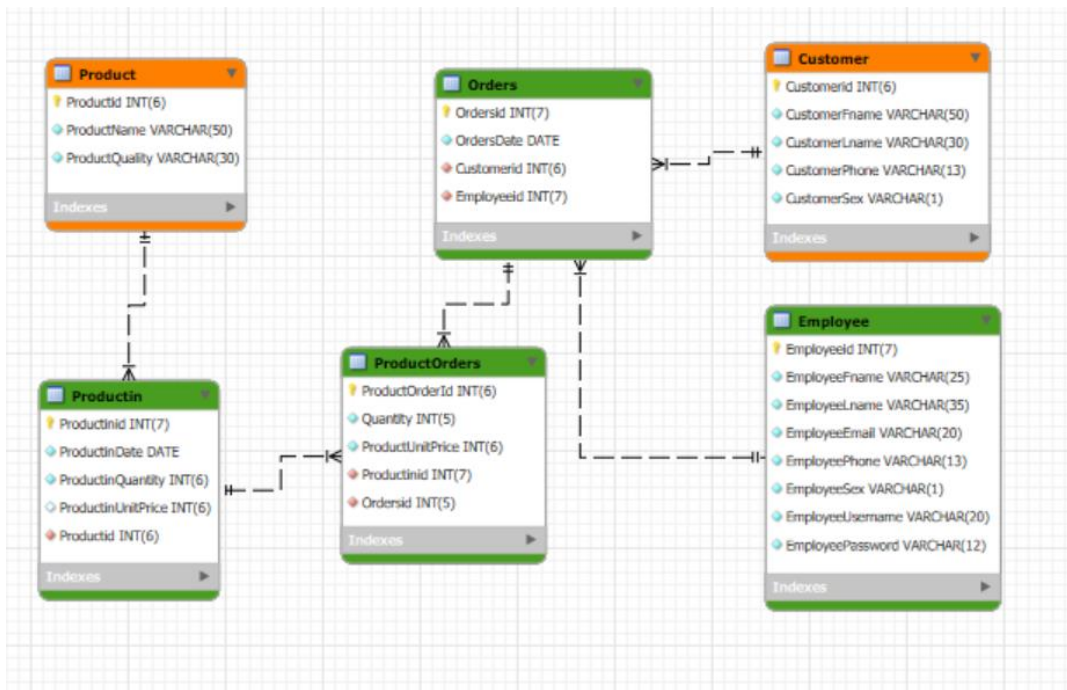


Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

As database developer you are asked to go in computer lab to create database and tables by considering the provided physical database schema.



Step 2: Demonstrate how to create database and database tables while explaining the procedures.

Step 3: Ask trainees to create database and tables and make modifications where required

Step 4: Verify whether database and tables are properly created.

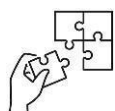
Step 5: Ask trainees to read key reading 3.2.2. for more clarification



Points to Remember

Steps to Create database and tables in MYSQL using XAMPP server

- To create database in the DBMS, use the following steps:
 - ✓ Run XAMPP control panel
 - ✓ Start Apache and MYSQL
 - ✓ Run MySQL Admin
 - ✓ Select SQL menu
 - ✓ Write a statement to create Database
 - ✓ Run the statement
- To add tables in the created database, use the following steps:
 - ✓ Select the database
 - ✓ Select SQL menu
 - ✓ Write a statement to create Table
 - ✓ Run a statement
- To remove unwanted tables from database, use the below steps:
 - ✓ Select the database
 - ✓ Select SQL menu
 - ✓ Write a statement to modify table structure
 - ✓ Run a statement
- To Truncate tables, use the below steps:
 - ✓ Select the database
 - ✓ Select SQL menu
 - ✓ Write a statement to truncate table
 - ✓ Run a statement



Application of learning 3.2

As a database developer, a physical database schema for a university management system is provided to you. The schema outlines the structure for several tables, including Students, Courses, Enrollments, and Professors, along with their respective columns, data types, keys, and constraints. Your task is to use Data Definition Language (DDL) commands to build and maintain this database.

Initially, you'll need to **CREATE** the tables according to the schema, establishing all necessary relationships through primary and foreign keys. As the system evolves, you might need to **ALTER** existing tables to accommodate new requirements, such as adding a column to track students' graduation status or modifying the data type of the Course Description field to allow more text.

If a specific table, like Enrollments, is no longer needed due to a change in the system's design, you may be required to **DROP** it entirely. Additionally, before migrating data or resetting a table for new data, you might need to **TRUNCATE** tables such as Courses, clearing all records while retaining the table structure for future use.

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	DDL commands are applied	1.Database is well created		
		2.Tables are correctly created		
		3.Datatype are appropriately used		
		4.Primary key attribute is properly selected		
		5.Foreign key column is properly used		
		6.Constraints are appropriately used		
		7.Unwanted table was properly removed		
		8.Column datatype and constraint are properly modified		
		9.Table is truncated		



Indicative content 3.3: Apply DML Commands



Duration: 8hrs



Theoretical Activity 3.3.1: Description of DML commands



Notes to the trainer:

- Trainer may use small groups for describing DDL commands.



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer to the following questions:

1. Describe DML INSERT Commands
2. Describe DML UPDATE Commands
3. Describe DML DELETE Commands
4. Describe DML CALL Commands
5. Describe DML EXPLAIN CALL Commands
6. Describe DML LOCK Commands

Step 2: Ask trainees to present their answers to the whole classroom.

Step 3: Provide expert view and address any questions or concerns

Step 4: Ask trainees to read the key reading 3.3.1 in the trainee manual, for more clarification.



Points to Remember

- **To insert data in database table use a General Syntax:** INSERT INTO tablename(column1, column2,...columnn)VALUES(value1, value2,...valuen);
- **To update data from database, use a General Syntax:** UPDATE Table_name SET column1 = value1, column2 = value2, columnn = valuen WHERE condition;
- **To delete data from atabase, use a General Syntax:** DELETE FROM Table_name WHERE condition;
- **To call a stored procedure from database use a General Syntax:** CALL procedure_name(argument1, argument2, argumentn);

- To explain call from database, use a General Syntax: `EXPLAIN CALL stored_procedure_name(parameters);`
- To lock database table, use a General Syntax: `LOCK TABLES table_name [AS alias] lock_type [, table_name [AS alias] lock_type] ...;`



Practical Activity 3.3.2: Apply DML Commands



Notes to the trainer:

- Facilitation of this activity can be individual based; you are supposed to demonstrate trainees how to manipulate database data in DBMS.
- Consider well created database and database objects.



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

Bright Future University is in the process of implementing a new database system to manage its academic operations, including student enrollment, class assignments, and professor-course allocations. The database structure includes six key tables:

1.Student (StudentID INT (10) PK, StudentName varchar (100), StudentEmail varchar (100), StudentPhone varchar (20), StudentBirthDay date)

2.Subject (SubjectID int(7)PK, SubjectName varchar(100))

3.Professor(ProfessorIDint(7) PK,ProfessorNamevarchar(100),ProfessorEmail varchar(100), ProfessorPhone varchar(20))

4.ProfessorSubject (ProfessorSubjectID Int(10), ProfessorID INT(10)FK, SubjectID INT(10)FK)

5.Class (ClassID INT(10)PK, ClassCode varchar(20),BeginDate date, EndDate Date, SubjectID int(7)FK, ProfessorID int(7)Fk)

6. ClassStudent(ClassStudentID int(10)PK, ClassID int(10)FK, StudentID int(10)FK) which are already created with appropriate relationships and constraints.

As the database designer for this project, your task is to use these existing tables and perform the following tasks:

1. Insert Four Sample Records:

Add four sample records for each of the following tables: Student, Subject, Professor, ProfessorSubject, Class, and ClassStudent.

Each record should represent actual student enrollment in courses, professors assigned to subjects, and class schedules.

2. Delete Two Records from the ProfessorSubject Table:

After inserting the sample records, identify and delete two records from the ProfessorSubject table, ensuring that the relationships between professors and subjects are maintained in the system.

3. Update Two Records in the Student Table:

Choose two student records from the student table and update specific fields such as StudentEmail or StudentPhone to reflect new information.

Step 2: Demonstrate how to manipulate database data, while demonstrating explain the procedures.

Step 3: Ask trainees to perform task described on step 2 and explain the procedures.

Step 4: Verify whether the tasks are clearly performed.

Step 5: Ask trainees to read key reading 3.3.2



Points to Remember

- To apply DML commands use the below steps:
 - ✓ Open your DBMS
 - ✓ Select database
 - ✓ Go to my SQL Menu and select is
 - ✓ Write the commands
 - ✓ Run it
 - ✓ Verify if it was modified data as expected



Application of learning 3.3

You are a database developer working for a Neighboring secondary school that uses a School Management System (SMS) to handle its day-to-day operations. The SMS database is already set up, containing multiple tables to manage students, teachers, courses, and enrollments.

Your task is to manipulate the data in the provided database by performing various operations such as inserting new records, updating existing records, and deleting records as needed.

Database Structure: Below is the simplified structure of the SMS database:

1. **Students Table** (students):
 - ◆ student_id (Primary Key, INT)

- ◆ first_name (VARCHAR)
 - ◆ last_name (VARCHAR)
 - ◆ date_of_birth (DATE)
 - ◆ enrollment_date (DATE)
 - ◆ grade_level (INT)
2. **Teachers Table** (teachers):
- ◆ teacher_id (Primary Key, INT)
 - ◆ first_name (VARCHAR)
 - ◆ last_name (VARCHAR)
 - ◆ subject (VARCHAR)
 - ◆ hire_date (DATE)
3. **Courses Table** (courses):
- ◆ course_id (Primary Key, INT)
 - ◆ course_name (VARCHAR)
 - ◆ teacher_id (Foreign Key, INT)
4. **Enrollments Table** (enrollments):
- ◆ enrollment_id (Primary Key, INT)
 - ◆ student_id (Foreign Key, INT)
 - ◆ course_id (Foreign Key, INT)
 - ◆ enrollment_date (DATE)

Tasks:

1. Insert New Data:

- A new student, *Emma Watson*, has enrolled in the school. Insert her information into the students table. She was born on *2008-09-15*, enrolled on *2024-09-01*, and is in grade 10.
- A new teacher, *Dr. Sarah Smith*, has been hired to teach *Physics*. Insert her information into the teachers table. Her hire date is *2024-08-20*.

2. Update Existing Data:

- *John Doe* (with student_id = 3) has advanced from grade 9 to grade 10. Update his grade_level in the students table.
- *Mrs. Jane Roberts* (with teacher_id = 5) has been promoted and will now teach *Mathematics* instead of *History*. Update her subject in the teachers table.

3. Delete Data:

- A course with the course_id of 7 (*Art History*) is no longer offered at the school. Remove this course from the courses table.
- A student, *Mark Wilson* (with student_id = 12), has transferred to another school. Delete his record from the student's table.

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	DML commands are applied	1.1 Records are inserted		
		1.2 Data are updated		
		1.3 Records are deleted		



Indicative content 3.4: Apply DQL Commands



Duration: 8hrs



Theoretical Activity 3.4.1: Description of DQL commands



Notes to the trainer:

- The trainer may use small groups to describe data query language command



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

1. Describe DQL SELECT Command
2. What is the use of aggregation functions in SQL?
3. Explain the use of where, order by, group by, having, and join SQL clauses

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 3.4.1 in the trainee manual.



Points to Remember

- **General syntax for select command:** SELECT column1, column2, ... FROM table_name;
- An aggregate function is a function that performs a calculation on a set of values, and returns a single value
- SQL Clauses are:
 - ✓ Where clause
 - ✓ Group By
 - ✓ Order By
 - ✓ Having
 - ✓ Join



Practical Activity 3.4.1: Description of DQL commands



Notes to the trainer:

- This activity should be individual
- Avail a created database with data



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

Customer table:

Customerid	CustomerFname	CustomerLname	CustomerPhone	CustomerSex
1	Anne	HAWA	567	F
2	John	RWEMA	789	M
3	Regis	MANZI	678	M
4	Charles	RWEMA	780	M
5	Kellia	UWASE	+250783345459	F

Employee table

Employeeid	EmployeeFname	EmployeeLname	EmployeeEmail	EmployeeSex	EmployeeUserName	EmployeePassword	EmployeePhone
1	Bonaventure	HABIMANA	habventure@gmail.c	M	k89	kin89	409
2	Aime	KEZA	keme@gmail.com	F	F789	Yun	+250788888888

Orders table

OrdersId	OrdersDate	Customerid	Employeeid
1	2014-09-17	4	1
2	2014-09-18	4	2
3	2014-09-19	2	2
4	2014-10-22	3	2
5	2024-10-17	2	1
6	2024-11-12	5	2

Based on the provided data stored in database;

- Make a report of all customers we have in database arrange their first names ascending
- Make a report that displays sex and number of customers for each sex
- Make a report of customers who ordered more than one time
- Generate a report that displays a Customer whose last name is RWEMA and Last name is John

Step 2: Demonstrate how to select data, while demonstrating explain the procedures.

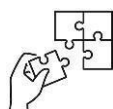
Step 3: Ask trainees to select data according to requested report

Step 4: Verify whether the data are properly selected.



Points to Remember

- To select data from database table, follow the steps below:
 - ✓ Select the Database
 - ✓ Select SQL Menu
 - ✓ Write a statement to select data
 - ✓ Run it



Application of learning 3.4

You are a database developer working for a Neighboring secondary school that uses a School Management System (SMS) to handle its day-to-day operations. The SMS database is already set up, containing multiple tables to manage students, teachers, courses, and enrollments with information.

Database Structure: Below is the simplified structure of the SMS database:

Notes: The given data are sample; the tables contain more information

Students table

student_id	first_name	last_name	date_of_birth	enrollment_date	grade_level
1	Emma	Watson	2008-01-15	2024-09-01	10
3	John	Doe	2008-09-15	2024-09-01	9
5	Smith	Doe	2007-09-15	2024-09-01	10
12	Mark	Wilson	2009-03-03	2024-09-01	9

Teachers table

teacher_id	first_name	last_name	subject	hire_date
1	Dr. Sarah	Smith	Physics	2024-08-20
5	Mrs. Jane	Roberts	History	2024-08-20
3	Sarah	Bovia	Mathematics	2024-08-20

Courses table

course_id	course_name	teacher_id
1	Biology	3
7	Art History	1
4	Mathematics	3
2	Physics	1
3	History	5

Enrolments

enrollment_id	student_id	course_id	enrollment_date
1	1	1	2024-09-07
2	3	1	2024-09-07
3	12	1	2024-09-07
4	3	4	2024-09-08
5	1	4	2024-09-08

As a database developer your task is to generate different reports depending on the manager needs:

1. Generate a report that shows the information of all students
2. Display students who born in 2008
3. Generate a report that shows first name and last name of all students who enrolled in Biology
4. Display the maximum grade_level from students table
5. Display informations of student sort them ascending based on students date_of_birth
6. Display a number of students who enrolled in Mathemetics whose gradeleve is greater than or equal to 10

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	Select command is well applied	1.1 Aggregation functions are used		
		1.2 Where clause is used		
		1.3 Order by clause is used		
		1.4 Group by is used		
		1.5 Having is used		
		1.6 Join is used		



Indicative content 3.5: Applying DCL Commands



Duration: 4hrs



Theoretical Activity 3.5.1: Description of DCL commands



Notes to the trainer:

- The trainer may use small groups group to describe DQL commands



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

1. Describe DCL GRANT Command
2. Describe DCL REVOKE Command

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 3.5.1 in the trainee manual.



Points to Remember

- General Syntax for the GRANT command is: GRANT privilege_name
ON object_name
TO {user_name | PUBLIC | role_name}
[WITH GRANT OPTION];
- **General syntax:** REVOKE privilege_name
ON object_name
FROM {user_name | PUBLIC | role_name}



Practical Activity 3.5.2: Applying DCL Commands



Notes to the trainer

- This activity is individual based
- The trainer may avail a sample database which include tables and data
- Suggest database users and their roles in the database



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

With the provided users and their privileges in the database you are requested to apply DCL commands by:

1. Creating the provided users in the database
2. Granting privileges to the users as provided
3. Revoking access right to the users that are not currently active

Step 2: Demonstrate how to Grant and Revoke user's privileges while demonstrating explain the procedures.

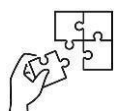
Step 3: Ask trainees to Grant and Revoke user's privileges

Step 4: Verify whether the privileges are properly Granted/Revoked to/from the user.



Points to Remember

- To grant and Revoke users access right/privileges follow the below steps:
 - ✓ Login to MySQL as an Administrator
 - ✓ Create a User
 - ✓ Grant Privileges
 - ✓ Apply Changes
 - ✓ Verify User Privileges
 - ✓ Grant with Grant Option



Application of learning 3.5

You are a database developer working for a Neighboring secondary school that uses a School Management System (SMS) to handle its day-to-day operations. The SMS database is already set up, containing multiple tables to manage students, teachers, courses, and enrollments with information. The database is not secured, everyone can access information in database, this may cause the data loss and falsified data. To avoid that issue the school need to hire a database developer to add the database users that are:

- ✓ Students record his/her information in students table and enroll in the courses
 - ✓ Teacher views the courses he/she has to teach and a list of students enrolled in that courses. She/he can also add a new teacher in the database.
 - ✓ Admin
- Withdraw adding a new teacher from a teacher user

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	Grant command is well applied	1.1. Administrator is logged in to MySQL		
		1.2.Users are created		
		1.3.Users are authenticated		
		1.4.Privileges are assigned to the users		
2	Revoke Command is well applied	2.1 Access right is revoked		



Indicative content 3.6: Applying TCL Commands



Duration: 7hrs



Theoretical Activity 3.4.1: Description of DCL commands



Notes to the trainer:

- The trainer may use small groups to describe TCL commands



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- Describe TCL COMMIT Command
- Describe Save Point Command
- Describe TCL Roll Back Command
- Describe TCL Set Transaction Command
- Describe TCL set constraint Command

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 3.5.1 in the trainee manual.



Points to Remember

- **COMMIT:** Ensure all operations are validated and correct before using COMMIT to make changes permanent.
- **SAVEPOINT:** Use SAVEPOINT to create a rollback point within a transaction for better error recovery.
- **ROLLBACK:** Apply ROLLBACK to undo changes since the last COMMIT or to a specific SAVEPOINT for maintaining data integrity.
- **SET TRANSACTION:** Define the transaction's isolation level and access mode using SET TRANSACTION to control data consistency and concurrency.
- **SET CONSTRAINTS:** Utilize SET CONSTRAINTS to defer constraint checks until the end of a transaction for more flexibility in data operations.



Practical Activity 3.6.2: Applying TCL Commands



Notes to the trainer

- This activity is individual
- Avail a database with tables that contain data.



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

You manage a retail database with Employees, Orders, and Customers tables. Perform the following tasks using TCL commands to control the transaction flow:

1. Insert Records and Commit:

- ◆ Insert records into Employees with:
(EmpID: 1, Name: 'John Doe', Department: 'HR')
(EmpID: 2, Name: 'Jane Smith', Department: 'Finance')
- ◆ Use COMMIT to save the changes.

2. Create Savepoint and Insert:

- ◆ Insert (OrderID: 101, ProductName: 'Laptop', Quantity: 2) into Orders.
- ◆ Set a SAVEPOINT named savepoint1.
- ◆ Insert another record: (OrderID: 102, ProductName: 'Phone', Quantity: 5).

3. Rollback to Savepoint:

- ◆ Realize the second order insert is incorrect; ROLLBACK TO savepoint1 to undo it.

4. Update and Full Rollback:

- ◆ Update Employees to set Department = 'Marketing' for EmpID = 1.
- ◆ Delete the employee with EmpID = 2.
- ◆ Use ROLLBACK to undo both changes.

5. Set Transaction and Query:

- ◆ Set the transaction to READ ONLY.
- ◆ Retrieve all employees from the HR department.

6. Defer Constraints:

- ◆ Set constraints to DEFERRED.

- ◆ Insert (OrderID: 103, CustomerID: 201) into Orders.
- ◆ Update Customers to change Customer Name for CustomerID = 201 to 'Michael Johnson'.
- ◆ Enforce constraints immediately after the changes.

Step 2: Demonstrate how to Grant and Revoke user's privileges while demonstrating explain the procedures.

Step 3: Ask trainees to Perform the task provided on step 1

Step 4: Verify whether the privileges are properly Granted/Revoked to/from the user.



Points to Remember

- Steps to BEGIN and COMMIT a transaction
 - ✓ Write and run a statement to begin a transaction
 - ✓ Write and run operations of a transaction
 - ✓ Write and run a commit statement
- Steps to add save point and Roll Back a transaction to the saved point
 - ✓ Write and run a statement to begin a transaction
 - ✓ Write and run some operations of a transaction
 - ✓ Write and run a statement to create a save point
 - ✓ Write and run statements to add operations in a transaction
 - ✓ Write and run a statement to Roll Back a transaction to the created save point
 - ✓ Verify if the change of operations next to saved point are removed
 - ✓ Write and run a statement to COMMIT a transaction



Application of learning 3.6

You are tasked with managing a database for a school. The database contains information about students, courses, and grades. You will need to use SQL commands to create the database structure, insert data, update records, query information, and control transactions.

Tasks:

1. Create the Database Structure:

- ◆ Create a database named "SchoolDB".
- ◆ Create a table named "Students" with columns: StudentID, FirstName, LastName, and GradeLevel.

- ◆ Create a table named "Courses" with columns: CourseID, CourseName, and Department.
- ◆ Create a table named "Grades" with columns: GradeID, StudentID, CourseID, Grade.

2. Insert Data:

- ◆ Insert 5 student records into the "Students" table.
- ◆ Insert 3 course records into the "Courses" table.
- ◆ Insert 10 grade records into the "Grades" table, linking students to courses and assigning grades.

3. Update Data:

- ◆ Change the grade of a student in a specific course.
- ◆ Update the department of a course.

4. Query Data:

- ◆ Find the average grade for a specific course.
- ◆ List all students in a particular grade level.
- ◆ Retrieve the names of students who have a grade higher than 90 in a specific course.

5. Transaction Management:

- ◆ Begin a transaction to update multiple records related to a student's information.
- ◆ Create a savepoint before updating the student's grade.
- ◆ If an error occurs during the update, roll back the transaction to the savepoint.
- ◆ If the update is successful, commit the transaction.

6. Data Security:

- ◆ Grant privileges to a specific user to view and modify student data.
- ◆ Revoke privileges from a user who no longer needs access.

Checklist:

	Criteria	Indicators	Observation	
			Yes	No
1	Transaction control language commands are applied	1.Statement to begin a transaction is written		
		2.Statements to perform some operations of a transaction are written		
		3.Statement to create a save point is written		
		4.Statements to add operations in a transaction after a saved point are written		
		5.Statement to Roll Back a transaction to the created save point is written		
		6.Statement to COMMIT a transaction is written		



Learning outcome 3 end assessment

Theoretical assessment

1) Match the terms in COLUMN A and their definition in COLUMN B

	COLUMN A	COLUMN B
.....J..	1. SQL Arithmetic Operators	A. Used to update an existing table structure, such as adding or modifying columns.
.....A...	2. ALTER Table	B. Command to permanently save all changes made during the current transaction.
.....C...	3. INSERT	C. Allows you to add new rows to a table.
.....B...	4. COMMIT	D. Operator used for bit-level operations, e.g.: &.
.....H...	5. SQL Aggregate Function	E. Command used to control access privileges to database objects.
.....E...	6. GRANT	F. Keyword used to retrieve data from a database, often with conditions and sorting.
.....I...	7. EXPLAIN CALL	G. Command to set a point in a transaction that you can roll back to.
.....F...	8. SELECT	H. Function used to perform calculations on a set of values, such as SUM or AVG.
.....G...	9. SAVEPOINT	I. Used to describe the details of how a stored procedure is called.
.....D...	10. BITWISE AND Operator	J. Performs mathematical operations, like addition or subtraction, on numeric data.

2) Fill-in-the-Blank Questions

- i. The _____ operator is used in SQL for adding two numeric values together.

Answer: +

- ii. The _____ command in SQL is used to create a new table in the database.

Answer: CREATE TABLE

- iii. To revoke previously granted privileges in SQL, the _____ command is used.

Answer: REVOKE

- iv. SQL's _____ command is used to insert new records into a table.

Answer: INSERT

- v. The _____ SQL command is used to temporarily set a point to which a transaction can be rolled back.

Answer: SAVEPOINT

3) Chose the correct answers:

- i. **What is the correct syntax for creating a new database named "mydb"?**
a. CREATE DATABASE mydb; b) CREATE DATABASE mydb(); c) DATABASE CREATE mydb; d) NEW DATABASE mydb;

Answer: a) CREATE DATABASE mydb;

- ii. **Which clause is used to specify conditions for selecting rows in a SELECT statement?**
iii. WHERE b) FROM c) GROUP BY d) HAVING

Answer: a) WHERE

- iv. **What is the correct syntax for inserting a new row into a table named "Customers"?**

- A. INSERT INTO Customers (CustomerID, CustomerName) VALUES (1, 'John Doe')
B. INSERT Customers (CustomerID, CustomerName) = (1, 'John Doe')
C. ADD ROW Customers (CustomerID, CustomerName) = (1, 'John Doe')
D. CREATE ROW Customers (CustomerID, CustomerName) VALUES (1, 'John Doe')

Answer: A. INSERT INTO Customers (CustomerID, CustomerName) VALUES (1, 'John Doe')

- v. **Which SQL aggregate function calculates the average value of a column?**
a. A. SUM() B. AVG() C. COUNT() D. MAX()

Answer: B. AVG()

4) What command is used to delete a database?

Answer: DROP DATABASE

5) What SQL clause is used to group rows based on a specified column?

Answer: GROUP BY

Practical assessment

GS AGAPE is a secondary school that is located in your sector, the school has a large number of students within different options; for that reason, the school needs a comprehensive database to manage students, teachers, courses, and grades because the manual system it uses returns errors in the termly reports and annual reports. Your first task as a database developer is to use DDL commands to create the necessary tables: Students, Teachers, Courses, and Grades, ensuring the correct relationships, are in place. After creating the tables, populate them with sample data using DML commands, including inserting records for students, teachers, and courses, as well as updating and deleting specific entries as needed. Then, apply DQL commands to retrieve information, such as the list of students enrolled in a specific course or the grades of a particular student in term and at the end of the year. Manage permissions to database by ensuring that only authorized users can view or modify certain data. Lastly, employ TCL commands to handle transactions, ensuring that operations like grade updates are completed successfully and, if any issues arise, the system can roll back to maintain data integrity.

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	DDL commands are properly applied	1.1.Database is well created		
		1.2.Tables are correctly created		
		1.3.Datatype are appropriately used		
		1.4.Primary key attribute is properly selected		
		1.5.Foreign key column is properly used		
		1.6.Constraints are appropriately used		
2	DML commands are properly applied	2.1.Records are inserted		
		2.2.Data are updated		
		2.3.Records are deleted		
3	DQL commands are properly applied	3.1.Aggregation functions are used		
		3.2.Where clause is used		
		3.3.Order by clause is used		
		3.4.Group by is used		
		3.5.Having is used		

		3.6.Join is used		
4	DCL commands are properly applied	4.1 Administrator is logged in to MySQL		
		4.2.Users are created		
		4.3.Users are authenticated		
		4.4.Privileges are assigned to the users		
		4.5.Access right is revoked		
5	TCL commands are properly applied	5.1.Statement to begin a transaction is written		
		5.2.Statements to perform some operations of a transaction are written		
		5.3.Statement to create a save point is written		
		5.4.Statements to add operations in a transaction after a saved point are written		
		5.5.Statement to Roll Back a transaction to the created save point is written		
		5.6.Statement to COMMIT a transaction is written		

END



Further information to the trainer

Books

Zanini, A. (2024, 10 30). *SQL DDL: The Definitive Guide on Data Definition Language*.

Morgan Kaufmann, 2002. Relational database design principles.

C. J; 2003. Introduction to Database Systems

Jeffrey Ullman and Jennifer Widom, 1997.fundamental concepts of database systems.

Web links

<https://beginner-sql-tutorial.com/sql-grant-revoke-privileges-roles.htm>

www.geeksforgeeks.org. (2024, 10 30). *SQL Joins*. <https://www.geeksforgeeks.org/sql-join-set-1-inner-left-right-and-full-joins/>

<https://www.dbvis.com/thetable/sql-ddl-the-definitive-guide-on-data-definition-language/>

Learning Outcome 4: Implement Database Security



Indicative contents

4.1 Enforcement of data access control

4.2 Management of Auditing and logging

4.3 Implementation of Data encryption

4.4. Configuration of database backup and restore

Key Competencies for Learning Outcome 4: Implement Database Security

Knowledge	Skills	Attitudes
• Description of database security • Description of data control access • Description of auditing and logging • Description of data encryption • Introduction of data backup and restore	• Enforce data access control • Manage Auditing and logging • Implement Data encryption • Configure database backup and restore	• Being Creative • Having Innovative skills • Having Adaptability skills • Being Flexible • Having Teamwork • Having self Confidence



Duration: 19 hrs



Learning outcome 4 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Describe properly database security based on database security measures
2. Describe properly data access control based on database security measures
3. Enforce properly access control based on database security measures
4. Manage clearly auditing and logging based on the security policies
5. Implement correctly data encryption based on data security measures

6. Configure regularly Backup and Recovery of data based on DBMS



Resources

Equipment	Tools	Materials
• Computer	• Ms SQL Server • Browsers	• Internet



Advance Preparation:

Before delivering this learning outcome, you are recommended to:

- Avail Computer Lab with installed Ms SQL server and web Browser
- Avail a Physical database schema of any case study



Indicative content 4.1: Enforcement of Data Access Control



Duration: 4hrs



Theoretical Activity 4.1.1: Description of database security



Notes to the trainer:

- Trainer may use groups to describe database security



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- What do you understand by database security?
- Explain types of database security

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 4.1.1 in the trainee manual.



Points to Remember

- Database security is the processes, tools, and controls that secure and protect databases against accidental and intentional threats.
- Types of database security are:
 - ✓ Physical Security
 - ✓ Authentication and authorization
 - ✓ Encryption
 - ✓ Auditing
 - ✓ Backup and recovery



Theoretical Activity 4.1.2: Description of data access control



Notes to the trainer:

- Trainer may use small groups to describe data control access.



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- What is data access control?
- Identify data classifications
- Differentiate role from permission
- Differentiate authentication from authorisation

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 4.1.2 in the trainee manual.



Points to Remember

- Database access control is a method of allowing access to a company's sensitive information only to user groups who are allowed to access.
- Data classifications are:
 - ✓ Public Data
 - ✓ Internal Data
 - ✓ Confidential Data
 - ✓ Restricted Data (Highly Confidential)
- A role is a collection of permissions that define what actions a user can perform While Permissions define what actions a user or role can perform on a specific object.
- Authentication is the method of verifying the identity of a consumer or system to ensure they're who they claim to be while Authorization is the method of figuring out and granting permissions to a demonstrated user or system, specifying what assets they can access and what actions they're allowed to carry out.



Practical Activity 4.1.3: Authenticating database in SQL Server



Notes to the trainer:

- This activity should be individual
- Avail a created database with information



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

Perform the following tasks using SQL Server Management Studio (SSMS)

XYZ University is expanding its student information system (SIS) to support more users as part of a digital transformation project. As the university's database developer, you have been tasked with ensuring robust user management and security for the SQL Server database supporting this system. Your first step is to **identify the existing user accounts** in the system and audit their current permissions to ensure they align with best practices. Next, you will need to **create new logins and users** for additional staff, including the admissions and academic departments, ensuring that each user has appropriate access. You will also need to **assign server-level and database-level roles**, such as db_owner, db_datareader, and db_datawriter, to these users based on their job responsibilities. Furthermore, you are required to **configure SQL Server authentication settings**, ensuring a mix of Windows and SQL Server authentication for flexibility, while also implementing strong password policies and enforcing the use of Multi-Factor Authentication (MFA). Once the configurations are in place, you will **test the authentication system** by logging in with newly created accounts to verify that access control is functioning as expected. Finally, ongoing responsibilities include **monitoring and maintaining user accounts** by regularly reviewing their privileges, deactivating accounts for users who no longer need access, and ensuring compliance with the university's data security policies.

Step 2: Demonstrate how to create accounts and their authentication while explaining the procedures.

Step 3: Ask trainees to create accounts and their authentication

Step 4: Verify whether accounts and their authentication are properly created.



Points to Remember

- Use the Object Explorer: Navigate to the "Security" folder, expand "Logins" or "Users" to view existing accounts.
- Use the Object Explorer: Right-click on "Logins" or "Users" and select "New Login" or "New User".
- Use the Object Explorer: Navigate to the "Security" folder, expand "Server Roles" or "Database Roles", and assign them to users or logins.
- Use SQL Server Configuration Manager: Modify settings related to Windows authentication, SQL Server authentication, and mixed mode.
- Use SSMS: Attempt to log in with different credentials to verify authentication.
- Use SSMS: Regularly review user accounts, their roles, and permissions. Use the Audit Logs Viewer to monitor activity.



Practical Activity 4.1.4: Authorizing database users in SQL server



Notes to the trainer:

- This activity should be individual
- Avail a created database with information



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to do the task described below:

As the database developer for ABC Corporation, you have been tasked with enhancing the security and authorization controls within the company's SQL Server environment. Your first task is to create roles to manage user permissions efficiently. Begin by creating a server-level role named CustomServerRole and assign an appropriate owner. Then, within the Test1 database, create a database role named Test1DBRole to handle specific database-level permissions.

Once the roles are set up, proceed to assign permissions to ensure proper access control. Grant server-level permissions such as ALTER, CONTROL, and CONNECT to

CustomServerRole. For Test1DBRole, assign database-level permissions including SELECT, INSERT, UPDATE, and DELETE within the Test1 database.

Next, assign these roles to users. Link CustomServerRole to a specific login that requires server-level access, and assign Test1DBRole to a user within the Test1 database to ensure they have the necessary permissions to manage data.

After configuring these roles and permissions, test the authorization by logging in with the respective user credentials. Perform various actions such as selecting data, updating a table, and attempting to create a database to ensure the user permissions are functioning correctly as defined.

Finally, set up an ongoing process to monitor and maintain these roles and permissions. Regularly review user roles, permissions, and assignments to ensure they remain aligned with organizational needs. Remove any unused or outdated roles and establish auditing to track user activity, helping to detect any unauthorized actions or potential security breaches.

Step 2: Demonstrate how to authorise database users while explaining the procedures.

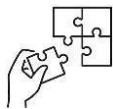
Step 3: Ask trainees to perform the task provided on step1

Step 4: Verify whether users are properly authorised.



Points to Remember

- Create **Roles**: Create server and database roles and assign an owner.
- Assign **Permissions**: Grant necessary permissions to server and database roles.
- Assign **Roles to Users**: Assign roles to specific logins or users.
- Test **Authorization**: Log in with user credentials and verify assigned permissions.
- Monitor **and Maintain**: Regularly review roles, permissions, and set up auditing to track user activities.



Application of learning 4.1

You are the Database Administrator for "BrightFuture Academy," a school that manages a large amount of data for students, teachers, courses, grades, and administrative operations in a SQL Server database named **SchoolDB**. To ensure secure access and maintain proper controls over the data, you need to set up and manage roles, permissions, authentication, and authorization within SQL Server Management Studio (SSMS).

Tasks to Perform:

1. **Define Roles and Permissions**
2. **Authenticate database**
3. **Authorize: database users.**

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	Database is properly Authenticated	1.1. Authentication method is defined.		
		1.2. Login credentials are configured.		
		1.3.Strong password policies are enforced.		
		1.4.Login auditing is configured		
2	Database Users are properly authorized	2.1.Database users and roles are mapped.		
		2.2 .Users are assigned to permissions.		
		2.3.Least privilege principle is applied.		
		2.1. Authorization is tested.		
		2.5 Changes of Transaction are applied to database		



Indicative content 4.2: Management of Auditing and Logging



Duration: 5hrs



Theoretical Activity 4.2.1: Description of database Auditing and logging



Notes to the trainer:

- This activity should be individual
- Avail a secured database with information



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- I. What do understand by database auditing
- II. Explain the use of logging in database

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 4.2.1 in the trainee manual.



Points to Remember

- Database auditing is the process of tracking and recording database activities to monitor and ensure compliance with security policies, detect unauthorized access, and ensure data integrity.
- Logging in databases records events such as data changes, user activities, and system errors, providing a way to track operations, detect security incidents, and facilitate recovery from failures.



Practical Activity 4.2.2: Managing database logging



Notes to the trainer:

- This activity should be individual
- Avail a created database with information



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to do the task described below:

As the Database Administrator at DataSecure Solutions, your role involves configuring and managing auditing for the CompanyDB database using SQL Server Management Studio (SSMS) to ensure security and compliance. To begin, you will identify the key events that need to be audited, such as login attempts, data modifications, permission changes, and schema changes. Next, you will configure the audit settings by creating a SQL Server Audit with a designated target (e.g., file, Application Log, Security Log). This will be followed by setting up a Server Audit Specification to track server-level events like FAILED_LOGIN_GROUP and a Database Audit Specification to monitor specific database-level activities like SELECT, INSERT, and UPDATE operations. Once configured, you will enable the audit and review the audit logs in SSMS to monitor activities and identify any unauthorized access or changes. Using the Audit Logs Viewer, you will analyze the audit data by filtering entries based on user activity, timestamps, and actions performed, paying close attention to any suspicious activities. If any unauthorized access or suspicious activity is detected, you will take corrective actions by adjusting user permissions, tightening security settings, or modifying the audit specifications to improve monitoring accuracy.

Step 2: Demonstrate how to manage logging while explaining the procedures.

Step 3: Ask trainees to manage the logging

Step 4: Verify whether logging is well managed.



Points to Remember

- **Identify Logging Requirements:** Determine which events, like DELETE or UPDATE operations and failed logins, need to be logged.
- **Configure Logging Settings:** Set up SQL Server error logs and Extended Events sessions to capture specific activities.
- **Monitor Log Data:** Use SSMS to view and monitor error logs and Extended Events for tracking logged activities.
- **Analyze Log Data:** Review logs for patterns of unauthorized activities or failed login attempts using SQL queries.



Practical Activity 4.2.3: Managing database auditing



Notes to the trainer:

- This activity should be individual
- Avail a created database with information



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

As the Database Administrator at DataSecure Solutions, you are responsible for configuring and managing auditing for the CompanyDB database using SQL Server Management Studio (SSMS) to ensure security and compliance. Your tasks begin with identifying the data to audit, focusing on key events such as login attempts, data modifications, permission changes, and schema alterations. Next, you will configure the audit settings by creating a SQL Server Audit with a designated target destination (e.g., file, Application Log, Security Log). You will then create a Server Audit Specification to track server-level events such as FAILED_LOGIN_GROUP and a Database Audit Specification to monitor database-level activities like SELECT, INSERT, and UPDATE operations. Once the audit and specifications are configured, you will enable the audit and regularly review the audit logs in SSMS to monitor activities, looking for any unauthorized access or changes. To analyze audit

data, you will use the Audit Logs Viewer in SSMS, filtering entries based on user activity, timestamps, and actions performed, with a focus on identifying suspicious or unusual activities. If any unauthorized access or suspicious behavior is detected, you will take corrective actions by adjusting user permissions, strengthening security settings, or modifying the audit specifications to improve monitoring of relevant data.

Step 2: Demonstrate how to manage auditing while explaining the procedures.

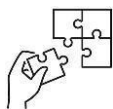
Step 3: Ask trainees to manage database auditing as requested to task 1

Step 4: Verify whether auditing is properly managed.



Points to Remember

- Identify Data to Audit: Determine events to be audited, such as login attempts, data modifications, and permission changes.
- Configure Audit Settings: Set up SQL Server Audit, Server Audit Specification, and Database Audit Specification for targeted events.
- Enable and Review Audits: Enable audit settings and review audit logs in SSMS for monitoring activities.
- Analyse Audit Data: Use SSMS to analyse audit logs for user activities and detect any unusual actions.
- Take Corrective Actions: Adjust permissions, tighten security, or update audit settings if suspicious activity is found.



Application of learning 4.2

As the Database Administrator for Bright Future Academy, you are responsible for ensuring the security and compliance of the SchoolDB database, which stores sensitive information such as student records, grades, and personal data. To maintain security and adhere to compliance standards, you will implement logging and auditing mechanisms using SQL Server Management Studio (SSMS). First, you will identify logging requirements, focusing on tracking events like DELETE operations on the Grades table, UPDATES on the Students table, and failed login attempts. Then, you will configure logging settings, creating an Extended Events session named SchoolDBActivityLog to capture these activities, ensuring logs are stored securely.

Regular monitoring of SQL Server error logs and Extended Events logs will help you identify irregularities or suspicious activities, while log data analysis using SQL queries will assist in identifying patterns of failed logins or unauthorized actions.

You will set up a process to periodically archive log data for future analysis or audits, and if suspicious activities are detected, you will take corrective action such as adjusting user permissions or reviewing security settings.

On the auditing side, you will identify key data to be audited, such as login attempts, data modifications (INSERT, UPDATE, DELETE), and permission or schema changes. Using SSMS, you will configure audit settings by creating a SQL Server Audit with a target destination (e.g., file, Application Log), link it to a Server Audit Specification to track server-level events like FAILED_LOGIN_GROUP, and set up a Database Audit Specification for auditing SchoolDB-level activities such as SELECT, INSERT, UPDATE, and DELETE operations, ensuring that all critical data access and modifications are monitored effectively.

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	Database Logging is properly performed	1.Logging requirements identified.		
		2.Logging settings configured (error logs, Extended Events session).		
		3.Logs stored in a secure location.		
		4.Regular monitoring of log data performed.		
		5.Log data analysed for failed login attempts or unauthorized actions.		
		6.Log data archived periodically.		
		7.Corrective action taken for suspicious activities.		
2	Database Auditing is properly performed	1.Data to be audited identified.		
		2.SQL commands executed to configure audit settings.		
		3.SQL Server audit created.		
		4.Server audit specification created.		
		5.Database audit specification created.		



Indicative content 4.3: Implementation of Data Encryption



Duration: 4hrs



Theoretical Activity 4.3.1: Description of data encryption



Notes to the trainer:

- Trainer may use small groups to describe data Encryption



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- What is data encryption
- Give and explain data encryption techniques

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 4.3.1 in the trainee manual.



Points to Remember

- Encryption is the conversion of plaintext into ciphertext
- Types of data encryption are:
 - ✓ Symmetric Encryption
 - ✓ Asymmetric Encryption
 - ✓ Hashing



Practical Activity 4.3.2: Implementing Data Encryption in SQL Server



Notes to the trainer:

- This activity should be performed in computer lab and is individual
- Avail a created database with information and users



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

As the lead database developer at TechSolutions Inc., you are tasked with improving the security of the company's customer and financial data by applying various encryption techniques. The company handles sensitive data, including customer information and financial transactions, and requires strong data protection measures. First, you will implement **symmetric encryption** to secure large volumes of data at rest, such as customer records and transaction histories stored in the database. Using **AES (Advanced Encryption Standard)**, encrypt the data to ensure that only users with the correct key can access or decrypt the information.

Next, incorporate **asymmetric encryption** for secure communications and key exchange between the company's internal systems and external partners. Utilize **RSA encryption** to secure data transmission, allowing external partners to encrypt information using TechSolutions' public key, which can only be decrypted with the private key held securely by the company.

Finally, implement **hashing** for password storage and data integrity checks. Use a secure hashing algorithm like **SHA-256** to hash user passwords before storing them in the database, ensuring that even if the database is compromised, the original passwords remain protected. Additionally, apply hashing to verify the integrity of data files, ensuring that any unauthorized changes can be detected.

By applying these encryption techniques, you will help protect sensitive data from unauthorized access and ensure secure communications and data integrity across the organization

Step 2: Demonstrate how Encrypt data while explaining the procedures.

Step 3: Ask trainees to encrypt data as required

Step 4: Verify whether the data are properly encrypted



Points to Remember

- Describe Data Encryption Methods: Explain the importance of data encryption in SQL Server and describe symmetric, asymmetric, and hashing methods.
- Implement Symmetric Encryption: Use SSMS to create a master key, set up a symmetric key, and encrypt a column with the symmetric key.
- Implement Asymmetric Encryption: Create an asymmetric key in SSMS and encrypt data using the created asymmetric key.
- Apply Hashing for Data Integrity: Create a computed column using a hashing function to ensure data integrity.
- Monitor and Maintain Encryption: Backup encryption keys and certificates, review encryption configurations, and rotate keys and certificates regularly.



Application of learning 4.3

As the Database Administrator for "BrightFuture Academy," you need to ensure the confidentiality and integrity of sensitive data stored in the **SchoolDB** database, such as student personal information, grades, and staff details. To protect this data from unauthorized access and breaches, you must implement data encryption techniques using SQL Server Management Studio (SSMS).

Your task is to apply encryption methods to safeguard sensitive information within **SchoolDB** and ensure that encryption keys and certificates are managed securely.

Tasks to Perform:

1. **Symmetric Encryption**
2. **Asymmetric Encryption**
3. **Hashing**

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	Data encryption is well implemented	Symmetric Encryption		
		1.Symmetric encryption method applied.		
		2.Encryption key created and securely stored.		
		3.Sensitive data encrypted using symmetric encryption.		
		Asymmetric Encryption		
		4.Asymmetric encryption method applied.		
		5.Public and private key pair generated.		
		6.Sensitive data encrypted using asymmetric encryption.		
		Hashing		
		7.Hashing algorithm chosen.		
		8.Sensitive data hashed.		
		9.Hashes verified for integrity checks.		



Indicative content 4.4: Configuration of Database Backup and Restore



Duration: 6hrs



Theoretical Activity 4.4.1: Description of data backup and restore



Notes to the trainer:

- Trainer may use small groups to describe data backup and restore



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

1. Differentiate database backup from restore

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 4.4.1 in the trainee manual.



Points to Remember

- A **backup** is the process of creating a copy of the database, its data, and its configuration. While a **restore** is the process of retrieving data from a backup and applying it to a database, making it operational again.

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Practical Activity 4.4.2: Configuration of Database Backup and Restore



Notes to the trainer

- This activity should be individual
- Avail a created database with information



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to do the task described below:

The objective of this is to understand and demonstrate how to configure various types of database backups and perform restores in SQL Server using SQL Server Management Studio (SSMS), ensuring effective data recovery and minimizing data loss. First, you will provide a brief introduction to data backup and restore within SQL Server, highlighting the importance of backups for data protection and recovery. You will then explain different backup methods: full backups that capture the entire database, differential backups that record changes since the last full backup, and transaction log (incremental) backups that capture changes since the last incremental or full backup. Next, you will propose a backup schedule, recommending weekly full backups, daily differential backups, and hourly transaction log backups for databases using the Full recovery model. Using SSMS, you will perform a full backup, a differential backup, and a transaction log backup, walking through each process step-by-step. For recovery, you will demonstrate how to perform a full database recovery, rollback recovery using transaction logs, and point-in-time recovery to undo changes made after a certain point. To ensure the reliability of your backup and recovery strategy, you will regularly test restores in a test environment, verify the integrity of backup files using the "Verify Backup Integrity" option, and maintain detailed documentation of the backup schedules, types, and recovery procedures for consistency and accuracy during emergency recovery situations.

Step 2: Demonstrate how to perform database backup and recovery while explaining the procedures.

Step 3: Ask trainees to perform database backup and recovery.

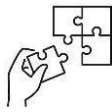
Step 4: Verify whether database backup and recovery are properly performed.



Points to Remember

- **Backup Importance:** Backups are crucial for protecting data and enabling recovery from accidental deletions, hardware failures, or other disasters.
- **Backup Methods:** Full backups capture the entire database, differential backups capture changes since the last full backup, and incremental backups capture changes since the last incremental or full backup.

- **Backup Schedule:** A recommended schedule includes weekly full backups, daily differential backups, and hourly transaction log backups for databases with the Full recovery model.
- **Backup Using SSMS:** Use SSMS to create full, differential, and transaction log backups.
- **Recovery Methods:** Restore databases from full backups, rollback changes using transaction log backups, and perform point-in-time recovery to restore to a specific point in time.
- **Testing and Documentation:** Regularly test backups and recovery plans, validate backup integrity, and document procedures for consistent and accurate recovery.



Application of learning 4.4

As the Database Administrator for BrightFuture Academy, you are responsible for setting up a reliable backup and recovery strategy for the SchoolDB database, ensuring that sensitive data, protected with encryption techniques, is regularly backed up and can be restored in the event of data loss or corruption. Your tasks involve configuring various backup methods such as full backups, which capture the entire database including tables, data, and schema, differential backups that record changes since the last full backup, and transaction log backups that capture incremental changes since the last backup. Additionally, you will propose and configure a backup schedule that includes weekly full backups, daily differential backups, and hourly transaction log backups using SQL Server Management Studio (SSMS). In terms of recovery, you will perform a full database recovery from a full backup, a rollback recovery to revert unwanted changes using transaction log backups, and a point-in-time recovery to restore the database to a specific time prior to unwanted modifications. To ensure the integrity and availability of the SchoolDB database, you will regularly test the backup and recovery plan by restoring backups in a test environment, verifying the integrity of backup files using the "Verify Backup Integrity" option in SSMS, and maintaining detailed documentation of the backup schedules, methods, and recovery procedures for consistent and reliable recovery during emergencies.

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	Database backup and restore are properly configured	Backup Methods		
		1.Database full back up is created		
		2. Differential backup is configured and performed.		
		3.Incremental (transaction log) backup is set up and performed.		
		Backup Schedule		
		4.Backup schedule is created (weekly full, daily differential, hourly transaction log backups).		
		5.Scheduled tasks for the backup plan in SSMS is configured.		
		Perform Recovery Methods		
		6.Full database recovery is performed		
		7.Rollback recovery using transaction log backups is completed		
		8.Point-in-time recovery performed		
		9.Backup and Recovery Plan is tested		
		10.Restores in a tested environment is performed		
		11.Backup integrity verified using "Verify Backup Integrity" in SSMS.		
		12.Backup and recovery procedures are documented.		



Learning outcome 4 end assessment

Theoretical assessment

Question1: Respond True /False to the following statements:

1. **Database security** involves only controlling physical access to the server.

Answer: False

2. **Access control policies** define the conditions under which user access is allowed or denied.

Answer: True

3. The **authentication system** in SQL Server is only concerned with creating user accounts.

Answer: False

4. **Authorization** involves assigning roles to users and granting them specific permissions.

Answer: True

5. **Hashing** is used for data encryption in SQL Server to provide confidentiality.

Answer: False

Question2: Read carefully the below statements and choose the correct answer based on the provided options (10 Marks)

1. What is the purpose of **data access control** in a database?

- A. To monitor server performance
- B. To define roles and permissions
- C. To provide high availability
- D. To compress data files

Answer: B. To define roles and permissions

2. Which type of **encryption** uses the same key for both encryption and decryption?

- A. Symmetric encryption
- B. Asymmetric encryption
- C. Hashing
- D. Data masking

Answer: A. Symmetric encryption

3. What is a **full back up**?

- A. A backup of only changed data since the last backup
- B. A complete copy of the entire database
- C. A backup of log files only
- D. A backup of user accounts

Answer: B. A complete copy of the entire database

4. **Auditing** helps in:

- A. Performance tuning of queries
- B. Tracking and recording database activities
- C. Creating database schemas
- D. Encrypting sensitive data

Answer: B. Tracking and recording database activities

5. What does **logging** in SQL Server involve?

- A. Configuring backup schedules
- B. Monitoring and analyzing server activities
- C. Creating user accounts
- D. Performing database normalization

Answer: D. Performing database normalization

Question3: Match the Columns (10 Marks)

Match the items in Column A with their appropriate descriptions in Column B.

Answer:	Column A	Column B
...D...	1. Symmetric Encryption	A. Uses different keys for encryption and decryption
...C...	2. Full Backup	B. Checks data integrity
...E...	3. Role-Based Access Control (RBAC)	C. Complete snapshot of the database
...B...	4. Auditing	D. Same key for encryption and decryption
...F...	5. Point-in-Time Recovery	E. Tracks and logs events
...G...	6. Incremental Backup	F. Restores to a specific point in time
...B...	7. Hashing	G. Tracks only changes since the last full

		or incremental backup
...H...	8. Authentication	H. Verifying user identities
...I...	9. Logging	I. Capturing and storing system events and actions
...J...	10. Discretionary Access Control (DAC)	J. Owner of the data decides who gets access

Question4: One-Word Response Questions (10 Marks)

1.is the process of verifying a user's identity in SQL Server called?

Answer: Authentication

2. Which backup type captures all the changes made since the last full backup?

Answer: Differential

3. What kind of policy allows access based on the discretion of the data owner?

Answer: Discretionary

4. Which method is used to ensure data integrity and is irreversible?

Answer: Hashing

5. Which component in SQL Server allows you to monitor server activities and detect unauthorized access?

Answer: Auditing

Practical assessment

As a newly hired Database Security Administrator for Secure Fin Solutions, a medium-sized financial company, your role focuses on setting up and configuring security features for their recently implemented SQL Server database that manages sensitive customer information, transaction records, employee data, and other critical information. Using SQL Server Management Studio (SSMS), you are required to complete various tasks, starting with a security overview and setup by identifying potential vulnerabilities such as SQL injection, unauthorized access, and data breaches, while ensuring access is restricted to authorized users and actions are logged. You will define roles such as FinanceManager and SupportStaff, assigning FinanceManager permissions to SELECT, INSERT, UPDATE, and DELETE on all tables, and SupportStaff permissions to SELECT on the Customers and Transactions tables. Next, you will establish access control policies based on these roles and classify data as Public, Confidential, or Highly Confidential.

In configuring authentication, you will create user accounts for the FinanceTeam and SupportTeam, assign roles, and test by logging in as these users to verify permissions,

while regularly reviewing authentication logs for unauthorized access. Authorization will involve creating server-level roles such as DatabaseAdmin, assigning permissions at server and database levels, and testing by logging in as a DatabaseAdmin user to ensure proper functionality. You will also configure logging settings to capture events like login attempts, data modifications, and permission changes, monitor and analyze logs for suspicious activity, and archive log data regularly. Further, you will configure auditing by setting up server and database audit specifications to track key activities. Data encryption techniques, including symmetric encryption for sensitive columns (e.g., CustomerSSN), asymmetric encryption for secure data transfer, and hashing for data integrity checks, will be applied.

Finally, the configuration of database backups will include performing full, differential, and transaction log backups, and you will test recovery methods such as full database recovery, rollback recovery, and point-in-time recovery to ensure data integrity and availability

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	Database is properly Authenticated	1.Authentication method is defined.		
		2.Login credentials are configured.		
		3.Strong password policies are enforced.		
		4.Login auditing is configured		
2	Database users are properly Authorised	1.Database users and roles are mapped.		
		2.Users are assigned to permissions.		
		3.Least privilege principle is applied.		
		4.Authorization is tested.		
		5.Changes of Transaction are applied to database		
3	Database Logging is properly performed	1.Logging requirements identified.		
		2.Logging settings configured (error logs, Extended Events session).		
		3.Logs stored in a secure location.		
		4.Regular monitoring of log data performed.		
		5.Log data analysed for failed login attempts or unauthorized actions.		

		6.Log data archived periodically.		
		7.Corrective action taken for suspicious activities.		
4	Database Auditing is properly performed	1.Data to be audited identified.		
		2.SQL commands executed to configure audit settings.		
		3 SQL Server audit created.		
		4 .Server audit specification created.		
		5 Database audit specification created.		
5	Data encryption is well implemented	Symmetric Encryption		
		1.Symmetric encryption method applied.		
		2.Encryption key created and securely stored.		
		3.Sensitive data encrypted using symmetric encryption.		
		Asymmetric Encryption		
		4.Asymmetric encryption method applied.		
		5.Public and private key pair generated.		
		6.Sensitive data encrypted using asymmetric encryption.		
		Hashing		
		7.Hashing algorithm chosen.		
		8.Sensitive data hashed.		
		9.Hashes verified for integrity checks.		
6	Database backup and restore are properly configured	Backup method		
		1.Database full back up is created		
		2 Differential backup is configured and performed.		
		3.Incremental (transaction log) backup is set up and performed.		
		Back up schedule		
		1.Backup schedule is created (weekly full, daily differential, hourly transaction log backups).		
		2.Scheduled tasks for the backup plan in SSMS is configured.		

		Perform recovery methods		
		1.Full database recovery is performed		
		2.Rollback recovery using transaction log backups is completed		
		3.Point-in-time recovery performed		
		4.Backup and Recovery Plan is tested		
		5.Restores in a tested environment is performed		
		6.Backup integrity verified using "Verify Backup Integrity" in SSMS.		
		7.Backup and recovery procedures are documented.		



Further information to the trainer

Books

Bhushan, B. (2024, 10 30). *Infosecurity Magazine*.

Raza, M. (2024, 10 30). *Audit Logging: A Comprehensive Guide*.

Satori. (2024, 10 30). *Access Control Policies: Definitions & Types*.

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Web links

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