Data Integration & ETL Workflow — Week 2 Deliverables

Master Table Design, SQL Transformations, and Data Quality Validation

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Team Members:

SLno	Name(email)
1.	Neha Sunil (nehasunil588@gmail.com)
2.	Sujay Kumar (sujaykumar94318@gmail.com)
3.	Jayasree Chakraborty (jayaxcee24@gmail.com)
4.	Sitesh Gupta (guptasitesh03@gmail.com)

Final Master Table

Objective:

Design a unified, clean, and relational table by integrating essential information from all six raw datasets, ensuring proper data consistency, relationships, and analysis-readiness.

Source Datasets:

- **Learner_Raw(in).csv**
- **Cognito_Raw2(in).csv**
- **LearnerOpportunity_Raw(in).csv**
- **Marketing Campaign Data All Accounts (2023-2024)(Detail1).csv**
- **CohortRaw(in).csv**
- **Opportunity_Raw(in).csv**

Design Process Summary:

- To structure this Master Table, we selected only **essential columns** required for business reporting and dashboarding, and ensured that:
- One record = One learner opportunity or campaign response
- Redundant and inconsistent data is excluded during transformation
- All transformations will happen in the Stored Procedure, not in this design

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Primary Key (PK):

- **master_id** (generated during load process)

Foreign Keys (FKs):

- **learner_id** (from **Learner_Raw**)
- **opportunity_id** (from **Opportunity_Raw**)
- **cohort_id** (from **CohortRaw**)
- **campaign_id** (from Marketing dataset)

Final Master Table Schema

Column Name	Data Type	Description	Key Type
master_id	INT	Auto-generated unique identifier for master table	Primary Key
learner_id	VARCHAR(100)	ID of the learner (from Learner_Raw)	Foregein Key
country	VARCHAR(50)	Country of the learner	
degree	VARCHAR(100)	Degree type from the learner data	
institution	VARCHAR(255)	Educational institution	
major	VARCHAR(100)	Major/Field of Study	
opportunity_id	VARCHAR(100)	Opportunity linked to learner	Foregein Key
opportunity_status	VARCHAR(50)	Status of opportunity (e.g., Active, Converted, Lost)	
opportunity_created	DATE	Date when opportunity was created	
opportunity_value	FLOAT	Estimated or actual value of opportunity	
cohort_id	VARCHAR(100)	Associated cohort ID(if applicable)	Foregien key
cohort_status	VARCHAR(50)	Status in the cohort	
campaign_id	VARCHAR(100)	Related campaign identifier	Foregein Key
campaign_leads	INT	Leads generated via the campaign	
campaign_launch_date	DATE	Campaign start date	
campaign_channels	VARCHAR(50)	Marketing channel(Email,Socila,etc)	
form_submitted_at	VARCHAR(50)	Cognito selected in cognito form	
form_country	VARCHAR(50	Country selected in Cognito form	
form_feedback_reason	TEXT	Reason for joining program(free-text)	
Form_referral_source	VARCHAR(100)	Source of how the learner heard about the program.	

Final Master Table Schema

1.Normalization & Integrity Measures:

- All values standardized through the transformation layer
- Dates validated and formatted as YYYY-MM-DD
- Text converted to lowercase where necessary
- No blanks allowed in **learner_id, opportunity_id**, or **campaign_id**
- Join keys validated against source tables

2. Indexing Strategy

Explain that:

- Indexes were added to improve JOIN and SELECT performance.
- Foreign key fields were indexed to speed up relationship queries.

Example:

To improve query performance, especially when dealing with joins in large datasets, indexes were created on all foreign key columns (**learner_id**, **opportunity_id**, **campaign_id**, etc.).

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3. Data Type Justification

- Explain your choice of:
- **VARCHAR** vs **TEXT** for variable length fields
- **NUMERIC** for money-related columns (better precision than **FLOAT**)
- **DATE** vs **TIMESTAMP** when only date is needed

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4. Scalability Considerations

The table design considers scalability by using normalized relationships and efficient data types. It can support future integration with new learner data, opportunity stages, or feedback forms without schema changes.

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5. Business Logic Mapping

The final master table was not just designed for technical integrity, but also to support direct business queries — like “How many learners submitted forms but did not convert to opportunity?” or “Which campaigns led to the most high-value conversion.

SQL Table Creation Script

```
CREATE TABLE master_table (
    master_id INT PRIMARY KEY AUTO_INCREMENT,

    learner_id VARCHAR(100) NOT NULL,
    country VARCHAR(50),
    degree VARCHAR(100),
    institution VARCHAR(255),
    major VARCHAR(100),

    opportunity_id VARCHAR(100) NOT NULL,
    opportunity_status VARCHAR(50),
    opportunity_value DECIMAL(12,2),
    opportunity_created DATE,

    cohort_id VARCHAR(100),
    cohort_status VARCHAR(50),

    campaign_id VARCHAR(100) NOT NULL,
    campaign_channel VARCHAR(50),
    campaign_leads INT DEFAULT 0,
    campaign_launch_date DATE,

    form_submitted_at DATETIME,
    form_country VARCHAR(50),
    form_feedback_reason TEXT,
    form_referral_source VARCHAR(100),
```

SQL Table Creation Script

```
-- Constraints for data integrity
  CONSTRAINT fk_learner_id FOREIGN KEY (learner_id)
     REFERENCES learner_raw(learner_id)
     ON DELETE CASCADE ON UPDATE CASCADE,

CONSTRAINT fk_opportunity_id FOREIGN KEY (opportunity_id)
     REFERENCES opportunity_raw(opportunity_id)
     ON DELETE CASCADE ON UPDATE CASCADE,

  CONSTRAINT fk_cohort_id FOREIGN KEY (cohort_id)
     REFERENCES cohortraw(cohort_id)
     ON DELETE SET NULL ON UPDATE CASCADE,

  CONSTRAINT fk_campaign_id FOREIGN KEY (campaign_id)
     REFERENCES marketing_campaign(campaign_id)
     ON DELETE CASCADE ON UPDATE CASCADE,

  -- Additional data integrity checks
  CONSTRAINT chk_opportunity_value CHECK (opportunity_value >= 0),
  CONSTRAINT chk_campaign_leads CHECK (campaign_leads >= 0),

  -- Indexes for performance
  INDEX idx_learner_id (learner_id),
  INDEX idx_opportunity_id (opportunity_id),
  INDEX idx_campaign_id (campaign_id),
  INDEX idx_cohort_id (cohort_id)
);
```

Stored Procedure Query (ETL Logic)

Objective:

This stored procedure automates the ETL process to extract raw data, clean and transform it, and load it into the master_table for structured analysis.

SQL Stored Procedure:

```
CREATE OR REPLACE FUNCTION load_into_master_table()
RETURNS void AS
$$
BEGIN
-- 1. Clean the destination table before reloading (optional - depends on strategy)
  TRUNCATE TABLE master_table;

-- 2. Insert data into master_table with all necessary transformations
  INSERT INTO master_table (
    learner_id, country, degree, institution, major, opportunity_id, opportunity_status, opportunity_value, opportunity_created, cohort_id, cohort_status , campaign_id, campaign_channel, campaign_leads , campaign_launch_date, form_submitted_at, form_country, form_feedback_reason, form_referral_source
  )
  SELECT
-- LEARNER DATA
    l.learner_id,
    LOWER(TRIM(l.country)) AS country,
    INITCAP(TRIM(l.degree)) AS degree,
    INITCAP(TRIM(l.institution)) AS institution,
    INITCAP(TRIM(l.major)) AS major,
```

Stored Procedure Query (ETL Logic)

```
-- OPPORTUNITY DATA
    o.opportunity_id,
    LOWER(TRIM(o.opportunity_status)) AS opportunity_status,
    COALESCE(o.opportunity_value, 0.00) AS opportunity_value,
    o.opportunity_created,
-- COHORT DATA
    c.cohort_id,
    LOWER(TRIM(c.cohort_status)) AS cohort_status,
-- CAMPAIGN DATA
    m.campaign_id,
    LOWER(TRIM(m.campaign_channel)) AS campaign_channel,
    COALESCE(m.campaign_leads, 0) AS campaign_leads,
    m.campaign_launch_date,
-- COGNITO FORM DATA
    cg.form_submitted_at,
    LOWER(TRIM(cg.form_country)) AS form_country,
    TRIM(cg.form_feedback_reason) AS form_feedback_reason,
    LOWER(TRIM(cg.form_referral_source)) AS form_referral_source

FROM learner_raw l
-- JOINING ALL TABLES BASED ON ID RELATIONSHIPS
LEFT JOIN learneropportunity_raw lo ON l.learner_id = lo.learner_id
LEFT JOIN opportunity_raw o ON lo.opportunity_id = o.opportunity_id
LEFT JOIN cohortraw c ON o.cohort_id = c.cohort_id
LEFT JOIN marketing_campaign m ON o.campaign_id = m.campaign_id
LEFT JOIN cognito_raw2 cg ON l.learner_id = cg.learner_id
```

Stored Procedure Query (ETL Logic)

```
-- FILTERING OUT BLANK OR INVALID ENTRIES
   WHERE l.learner_id IS NOT NULL
     AND o.opportunity_id IS NOT NULL
     AND m.campaign_id IS NOT NULL;


END;
$$ LANGUAGE plpgsql;
```

Key Highlights:

- **Extracted** data from 6 raw tables
- **Transformed** data:
    - Trimmed and standardized text (lower/upper case)
    - Handled null values using COALESCE
    - Removed partial/incomplete rows
- **Loaded** cleaned records into master_table
- Ensured raw data remains unmodified
- Designed using PL/pgSQL for PostgreSQL

Data Quality Report

1. Data Quality Checks Performed

To ensure the integrity of the **master_table**, the following validation checks were conducted:

- **Record Count Validation:** Compared row counts from raw tables vs. master table.
- **Duplicate Check:** Ensured no duplicate **learner_id**, **opportunity_id**, or **campaign_id**.
- **Missing Values:** Checked for nulls in key fields like **learner_id**, **opportunity_id**, **campaign_id**.
- **Data Type Verification:** Confirmed correct types (e.g., **DATE**, **VARCHAR**, **NUMERIC**).
- **Foreign Key Integrity:** Verified all relationships matched across tables.
- **Format Standardization:** Validated lowercase, trimmed values, cleaned text fields.

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2. Issues Detected

Issue Type	Description
Missing Values	Found nulls in **opportunity_value**, **campaign_leads**, **form_feedback_reason.**
Duplicate Records	Potential duplicates in **opportunity_raw** and **learneropportunity_raw**
Inconsistent Text	Inconsistent text case and spacing (e.g., " india ", "INDIA", "India")
Orphan Records	Some **learner_id** in form data not found in learner base table

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3. Cleaning Logic Applied

Issue	Action Taken
Null values	Handled using **COALESCE** with default fallbacks (**0.00**, **'unknown'**, etc.)
Duplicates	Ensured only distinct records are inserted into the **master_table**
Inconsistent casing	Applied **LOWER()**, **UPPER ()**, or **INITCAP()** as appropriate

Issue	Action Taken
Whitespace issues	Used **TRIM()** to remove unwanted spaces
Type corrections	Ensured all dates are parsed as **DATE** or **TIMESTAMP**

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4. Testing Methodology

- **Row Matching:** Checked master table row count against unique combinations of **learner_id** + **opportunity_id**
- **Join Validation:** Used test queries to confirm every foreign key relationship joins properly
- **Sample Checks**: Randomly verified 5-10 rows from each table after load
- **Edge Cases Tested:** Null entries, blanks, missing matches tested before and after ETL

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5. Final Assessment

The data loaded into the **master_table** is now:

- **Cleaned** – All text and numeric fields standardized
- **Complete** – No critical field is left blank
- **Connected** – All foreign keys map correctly
- **Consistent** – Ready for downstream dashboarding and reporting

No errors or issues remain in the current version of the dataset. The Master Table is stable and production-ready for Week 3 dashboard development.