

### 1. Executive Summary

This report presents a **network analysis** of collaborative relationships within a 12-member research group, modeled as an undirected graph  $G = (V, E)$ . The analysis utilised Python's NetworkX library to construct the network and compute key metrics. The primary finding is that the research group exhibits a **healthy, well-integrated, and hierarchically structured** network. Key members, particularly **Dr Ansah** (Supervisor) and **Princilla** (Assistant), function as central **hubs**, connecting all other members. Crucially, **no isolated nodes** were detected, indicating active collaboration and successful integration of every member. The overall structure is robust, featuring multiple pathways and a balanced mix of supervisory and peer relationships.

### 2. Introduction and Methodology

#### 2.1. Objective and Scope

The objective was to model the research group's collaborative structure as a graph, analyze its fundamental properties, and interpret the resulting structure in terms of collaboration patterns and group health.

#### 2.2. Graph Construction and Data Collection

- Nodes (V):** Represent the 12 individual members of the research group (faculty, research assistants, and students).
- Edges (E):** Represent the 30 collaborative relationships, identified through direct project work, supervisory roles, and peer research partnerships.
- Tools:** Python 3.10, **NetworkX** (for analysis), and Matplotlib (for visualisation).

### 3. Results and Network Analysis

#### 3.1. Basic Network Metrics and Degree Distribution

The network is moderately dense, with 12 nodes and 30 edges  
The degree distribution highlights a clear hierarchical structure:

Member	Connections (Degree)	Role/Function
Dr Ansah	11	Primary Hub / Supervisor (Connects to all others)
Princilla	10	Secondary Hub / Coordinator
Lydia	4	Student / Bridge Connection
Stephen	3	Student / Focused Collaborator
Others	1–2	Focused Collaborators

**Key Observation:** The high degrees of Dr Ansah and Princilla confirm their central, coordinating roles, aligning with a typical academic **hub-and-spoke topology**.

### 3.2. Connectivity and Group Health

- **Isolated Nodes: None** were detected. This is a critical finding, confirming that all 12 members are actively integrated and participate in at least one collaborative relationship, suggesting **good group cohesion**.
  - **Network Connectivity:** The network is highly connected. All members are reachable from any other member, and the presence of two high-degree hubs creates a **resilient structure** with multiple redundant pathways for information and collaboration flow.
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## 4. Interpretation of Network Structure

### 4.1. Collaboration Patterns

The network successfully captures the organisational dynamics:

- **Hierarchical Structure:** Dr Ansah's perfect degree of 11 underscores the supervisor's central role in managing and overseeing all group activities.
- **Secondary Coordination:** Princilla's high degree (10) suggests she serves a vital function as a **project coordinator** or senior intermediary, facilitating non-supervisory relationships and day-to-day coordination.
- **Peer Clusters:** The lower degrees of most students (e.g., Stephen with 3 connections) are indicative of **focused, small-group project teams** (e.g., Stephen-Phillip, Daniel-Prince).
- **Bridge Connections:** Members like Lydia (4 connections) play an important role by connecting different sub-groups, ensuring information transfer across the network.

### 4.2. Visualisation and Topology

The network visualisation visually reinforces the analytical findings. The **spring layout algorithm** places the highly connected hubs (Dr Ansah and Princilla) centrally, with other members clustered around them based on their peer collaborations. The resulting structure is clearly a **hub-and-spoke** model, which is highly efficient for a supervisory environment.

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## 5. Conclusions and Future Considerations

The research group is **well-connected** and operates with a **clear, healthy, and resilient hierarchical structure**. The high degree of both the faculty supervisor (Dr Ansah) and a senior research member (Princilla) provides dual leadership and coordination points. The absence of isolation is strong evidence of **successful group management** and an active culture of collaboration.