# Blockchain-Based Education Data Management System

## Project Structure

```
blockchain-education-system/
├── app/
│   ├── __init__.py
│   ├── app.py
│   ├── models.py
│   ├── crypto.py
│   ├── merkle.py
│   ├── blockchain_adapter.py
│   └── config.py
├── chaincode/
│   └── education_contract.go
├── docker-compose.yml
├── requirements.txt
└── README.md

  Core Application Files:
1. requirements.txt - All Python dependencies
2. app/config.py - Configuration management
3. app/models.py - Database models (Student, Record, Transaction, VerifierRequest)
4. app/crypto.py - Encryption, decryption, and hashing functions
5. app/merkle.py - Merkle tree implementation for batch processing
6. app/blockchain_adapter.py
 - Interface to Hyperledger Fabric
7. app/app.py - Main Flask application with all API endpoints

     Blockchain:
8. chaincode/education_contract.go - Hyperledger Fabric smart contract

    Setup & Testing:
9. tests/test_crypto.py - Unit tests for cryptographic functions
10. docker-compose.yml - Docker configuration for Fabric network
11. Dockerfile - Container configuration for Flask app
12. setup.sh - Automated setup script
13. example_usage.py - Complete example demonstrating all features
14. README.md - Comprehensive documentation

Quick Start Guide:

1. **Make setup script executable:**
   ```bash
   chmod +x setup.sh
```

2. **Run setup:**
   ```
   ./setup.sh
   ```
4. **Update .env file** with the generated Fernet key
5. **Start the application:**
   ```
   python app/app.py
   ```
7. **Test with example script:**
   ```
   python example_usage.py
   ```

The system runs in **mock mode** by default (without requiring Hyperledger Fabric), which is perfect for development and testing. When you're ready for production, you can deploy the Fabric network using the provided docker-compose file.

All the features from your paper are implemented:
   ```

- ☑ Encrypted off-chain storage
- ☑ Blockchain anchoring with hashes
- ☑ Merkle tree for batch operations
- ☑ Record issuance and verification
- ☑ Transaction logging
- ☑ RESTful API

Good luck with your project! Let me know if you need any clarifications or modifications.