GIS TEST BANK

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GIS Test Bank

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DEDICATION

I would like to dedicate this thesis to my parents, sisters and my husband who have been very supportive throughout my education.
At San Diego State University about 10 years ago a certificate in GIS was established requiring 27 units distributed almost equally between Geography and Computer Science.

A few years later a San Diego Consortium made up of SDSU, Mesa College and San Diego city schools was awarded a grant by NSF-ATE (National Science Foundation-Advanced Technological Education) to develop a scalable skills certification program, articulate curriculum between institutions, and increase community awareness of GIS as a discipline and as a career.

The GIS Test Bank is developed primarily to promote GIS education and career advancement. It is a web based application which can be accessed anywhere with an internet facility. It consists of various essay type and multiple choice questions with graphics from different GIS categories. The user has to provide login information in order to access the application. Once authenticated, based on the role as an administrator, faculty, teaching assistant or student, the user will be able to use the application based on the permissions given to them. Test bank can be used to prepare class tests, prepare for exams, give tests online whose scores will be automatically reported to the faculty, upload or access class lectures or handouts etc. The test bank initially emphasizes a class articulated between SDSU and community colleges.
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And of course, Thanks go to my family for their invaluable support through all times and also for test running the application.
CHAPTER 1

INTRODUCTION

1.1 NSF-ATE PROGRAM

San Diego GIS Consortium comprising of San Diego State University, San Diego Mesa College and San Diego City schools was awarded a grant by the NSF-ATE (National Science Foundation-Advanced Technological Education) to develop a scalable skills certification program which could help students in the field of GIS to prepare for jobs and career advancement. The Objective of the National Science Foundation-Advanced Technological Education is to provide technological education by supporting curriculum development, preparation and professional development, internships, field works and other activities for faculty, teachers and students. This program includes collaboration between academic institutions and employers to promote improvement in the education of science and engineering technicians at the undergraduate and secondary school levels [4, 12].

The certificate in GIS at San Diego State University can be achieved by enrolling in 27 units distributed between the Department of Geography and the Department of Computer Science as follows:

Department of Geography:

- Geog 104 - Geographic Information Science and Spatial Reasoning
- Geog 381 - Computerized Map Design
- Geog 484 - Geographic Information Systems (Required)
- Geog 581 - Cartographic Design
- Geog 583 - Internet Mapping and Distributed GIServices
- Geog 584 - Geographic Information Systems Applications
- Geog 585 - Quantitative Methods in Geographic Research
- Geog 587 - Remote Sensing of the Environment
- Geog 588 - Intermediate Remote Sensing of the Environment
- Geog 589 - GIS-Based Decision Support Methods
- Geog 596 - Advanced Topics in GIScience
Department of Computer Science:

- CS 105 - Visual Basic Programming
- CS 107 - Introduction to Computer Programming (Required)
- CS 108 - Intermediate Computer Programming (Required)
- CS 220 - UNIX and the C Programming Language
- CS 310 - Data Structures
- CS 320 - Programming Languages
- CS 503 - Scientific Database Techniques
- CS 514 - Database Theory and Implementation
- CS 520 - Advanced Programming Languages
- CS 535 - Object-Oriented Programming and Design
- CS 537 - Component GIS Architecture
- CS 551 - User Interface Environments
- CS 575 - Super Computing for the Sciences
- CS 596 - Advanced Topics in Geocomputation
- CS 615 - Spatial Databases

The certificate program is independent of the NSF-ATE grant but shares the goal of preparing trained workers in GIS. Certificate earners complete four classes in one department, and five in the other.

1.2 GIS TEST BANK

The title of my project is GIS test bank. It is a web based application designed with the purpose for GIS users of helping them improve their GIS skills and knowledge. Different question categories of GIS like projections, GPS, remote sensing etc. from Geog 104 class are covered in this application [20]. Administrators, faculty members, appointed teaching assistants and registered students can use this application. Each of these roles has a predefined set of permissions. This application contains two types of questions, namely multiple choice and essay type questions. Multiple choice questions are divided into three levels: beginner, intermediate and advanced. Student users can take a test consisting of multiple choice questions with one or more than one correct answer. The questions of the test are selected randomly by the application. The scores obtained by each student while taking the test can be viewed by faculty members at any time. Faculty members can also generate
class tests consisting of essay type questions for each category. The number of questions on
the test is decided by the faculty. Different sets of question papers can be created in order to
prevent plagiarism. Apart from testing features like uploading lectures online, self-study help
for students etc. are also included in this application. The test bank is created using Ruby on
Rails which follows the Model View Controller (MVC) paradigm. The MVC architecture
allows clean separation of business logic (the controller), data (the model) and the formatting
of data for display and user interaction (the view). This test bank has a feature of role based
authentication which allows a user to access the system as an administrator, faculty, teaching
assistant or a student user. Each role has a predefined set of permissions, access and control
over the application. MySQL is used as a database though Rails works with many other
databases like PostgreSQL, Oracle, SQLite 3 etc.

1.3 ARCHITECTURE OF GIS TEST BANK

GIS test bank is created using Ruby on Rails and all Rails applications are
implemented using the Model-View-Controller (MVC) architecture (see Figure 1.1). In the
MVC pattern, the model represents the data, the view represents the user interface, and the
controller directs all the action. Each entity of the MVC—the model, view, and controller—is
separate and is capable of being developed and tested individually [3]. The model can be
changed without affecting the views; likewise, a view can be changed without affecting the
model. This means the changes in each part of an MVC application are local and have low
impact on other parts, which helps in easing the maintenance considerably, while increasing
the level of reusability among components [3]. Rails is a collection of libraries which are
assembled together [1]. Each library had a specific task associated with it. Among several
libraries, three libraries mapped directly to the MVC pattern which can be used
independently [1]. The three libraries are given below:

- ActiveRecord: It handles database interaction [1].
- ActionView: It generates the HTML documents that the user receives as response
  based on the request to a Rails application [1].
- ApplicationController: It manipulates the flow of an application along with the data
  received from the database that is displayed in a view [1].
These libraries together make up the Rails Model-View-Controller development stack. In Rails all the components are integrated together without any need to set up a manual bridge between them. This makes Rails a “full-stack” framework [1].

1.4 APPLICATION FLOW

The GIS Skill test bank application follows the Model-View-Controller Paradigm. The MVC paradigm allows clean separation of business logic (the controller), data (the model) and the formatting of data for display and user interaction (the view). The application begins with the login page where the user has to enter his login id and password. Based on the login information, the application finds out the role of the user and the user will automatically be redirected to the welcome page with predefined permissions. Each user can have one of the roles: administrator, faculty, teaching assistant or student. An administrator user has all the administrative powers of the application. These users can add/edit/remove any user. An administrator can also add/edit/remove all the essay type and multiple choice questions and answers, upload and delete a lecture, generate an essay type question class test, view each student user score sheet and can also change any user’s password. Faculty users can add/edit/remove a TA or a student user. A faculty member can also add/edit/remove all the essay type and multiple choice questions and answers, upload and delete a lecture, generate subjective question based class tests, view each student user score sheet. Teaching Assistants can add or view only student’s information. They can view a list of all questions, answer keys, upload documents, and delete documents. Student users can take an online quiz consisting of multiple choice questions. They can also prepare for tests using the self-study.

Figure 1.1. Model-View-Controller architecture diagram.
option from given GIS categories. Students have access to all the lectures and class handouts uploaded by the faculty and can view all the scores attained by them.

1.5 Challenges Faced

A web application framework is a rapidly growing technology. Some of the challenges faced during the development of the Test Bank are mentioned in the following sections.

1.5.1 Keeping Up with Rails

Rails is a continuously evolving technology. It is important to keep updated with the latest announcements. Hence it is necessary to follow new Rails documents and software releases. Some Rails articles explore what is coming in the future and if that actually turns into the next release.

1.5.2 Choosing a Database

Rails works with MySQL, Oracle, PostgreSQL, SQL Server and SQLite databases. For all databases other than MySQL, a database driver and a library that Rails can use to connect and use the database engine need to be installed. As each of the databases has its pros and cons, it was crucial to choose a database which could meet all the requirements with the least amount of time being consumed in database setup and connection with Rails. I have used MySQL as it is easy to install and Rails comes with a built in driver for MySQL databases [8, 9].

1.5.3 Database Creation

This test bank is a database driven application. As a database is one of the most important phases of any software development life cycle, it was important for me to properly design/plan and perform normalization of the database while considering all the functionalities to be included in the application.

1.5.4 Plug-ins

Rails provide one of the fastest ways to add functionality in an application using Plug-ins. Plug-ins are easy to install and easy to use. As Rails is growing rapidly, many different kinds of plug-ins can be used to do same kind of function. For example, to add an
authentication feature in an application there are many plug-ins available like restful_authentication, act_as_authenticated, Authlogic etc. As each of the available plug-ins has some advantages and disadvantages it is difficult to choose the best plug-in in a given situation.
CHAPTER 2

GEOGRAPHIC INFORMATION SCIENCE

2.1 Definition

Geographical information systems are used to explore the fundamentals of Geography. Geographic information science is a system created to work with geographical referenced information i.e. information based on location. This geo-referenced data is captured, stored, analyzed and displayed by a GIS system. GIS allows us to explore the data in the form of maps, globes, charts etc. to find the relationships and patterns in the data [7, 24].

2.2 Components of GIS

GIS can be divided into five components: Application, Data, Hardware, Software, and People (see Figure 2.1 [7]).

- **Application**: Applications include how the data will be inputted, stored, analyzed and presented as a final output. Application examples include water quality monitoring, land use planning etc [6].

- **Data**: Data is one of the most important components of GIS. Geographic and tabular data can be collected or purchased from a data provider. A DBMS is used to create and maintain a database and help organize and maintain data [6].

- **Hardware**: Hardware is equipment like computers, scanners, digitizer, and plotters on which GIS operates. The software runs on various hardware types including centralized servers to desktop computers [23].

- **Software**: Software provides functions and tools to store, analyze and display geographic data [23].

- **People**: GIS users are the people who design and maintain the system.

### 2.3 Applications of GIS

Geographic Information Systems are being used in variety of ways in our daily lives. Lot of organizations are also using GIS to perform various tasks.

#### 2.3.1 Government

GIS is helpful in planning and organizing geographic data for many government organizations. GIS is being used by various government bodies which helps them to keep track of description and ownership of properties, public works, roads, and more within their jurisdiction. It also helps military defense for terrain analysis and many other critical planning and operations [11, 2].

#### 2.3.2 Business

GIS is beneficial to various businesses in a variety of ways. GIS can be used to track properties, property value, tax information etc. for real estate agents and bankers. Health care professionals use GIS to track the spread of disease [2].

#### 2.3.3 Emergency Services

Various emergency departments like police departments, fire departments etc have started using GIS to help in their daily operations. GIS software can assist them to track crime, find the shortest route to emergencies and more [11].
2.3.4 Environment and Conservation

GIS is very helpful in managing and protecting species and their habitats. It also helps in the study of animal populations in various areas. Marine GIS uses data from oceans and seas to represent shores and phenomena like current, temperatures etc [2].

2.3.5 Education and Science

GIS helps many researchers to observe various phenomena and changes that have taken place over time. GIS can also be used to create interactive maps for various places which can help visitors to explore new places, events etc.
CHAPTER 3

GIS TEST BANK

3.1 ADVANTAGES OF THE TEST BANK

Test bank contains various features which are helpful for both students and faculty members. Among these features, some are listed below:

   a. It is independent of a particular teacher or even a particular campus, and thus:
   b. It can more fairly be used as a requirement for certificates in the area or areas being tested.

Test bank can be easily accessed from anyplace having an internet facility. The components required for the application are available for free and can be easily downloaded and installed. Test bank uses MySQL as its database which is an open source database [8].

Use of the application is very easy and does not require any tutorial. Anybody can use it without any guidelines. Various tasks can be performed by just selecting any of the given menu options.

One of the most important features of test bank is the online test [16]. Students can take tests online consisting of multiple choice questions. Since the correct answer can be one or more than one it increases the difficulty for students and helps them have a thorough understanding of the subject. The scores obtained by each student can be viewed by faculty whenever needed along with the date and time the test was taken by the student.

Faculty can generate surprise or class tests easily consisting of long answer type questions. The number of questions to be included on the test is decided by the faculty. Faculty can also use this feature more than once to have many different sets in order to prevent plagiarism.

Students can also use the application to prepare for tests. They can view questions on different topics and try to answer them. Scores of these tests are not recorded.

Faculty can upload documents, assignments, notes etc. just at one place which can be used by all the students.
It should be noted that test banks of this kind are used for certification tests for Java, Oracle, Microsoft (Certified Engineer), A +, Cisco etc.

### 3.2 What the Test Bank Covers?

GIS Test Bank contains various multiple choice and essay type questions based on different categories.

#### 3.2.1 Multiple Choice Questions

Test bank contains multiple choice questions for different categories and levels. Each multiple choice question has four answer choices. More answer choices can also be added later if needed. The format of multiple choice questions used to the test bank is shown in Figure 3.1.

<table>
<thead>
<tr>
<th>Category:</th>
<th>Level:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 2: Mapping the Earth</td>
<td>Beginner</td>
</tr>
</tbody>
</table>

What is the decimal conversion of the binary number 100101?

Choices are:

- 36.
- 37
- 38
- 39

![Figure 3.1. Format of multiple choice questions used in the test bank.](image1)

Each multiple choice question can have one or more correct answers. In this test bank, students have to select all correct answers for each question. An example to show the select all correct answers in a multiple choice question is shown in Figure 3.2. There are 50 multiple choice questions in the database so far and more can be added whenever needed.

#### 3.2.2 Multiple Choice Questions with Image

As this is a geography based application, sometimes it is necessary to represent any information with the help of graphical images (e.g. maps). Therefore, this application contains many multiple choice questions with graphical images as shown in the Figure 3.3 [10].
### Figure 3.2. Example of a select all correct answers in a multiple choice question.

**Category:** Unit 3: Network of Geographic Information, Georeference and Projection  
**Level:** Intermediate

Which of the following is true about a great circle?

Choices are:

- It divide the earth into two equal hemisphere.
- Is the path with smallest curvature.
- On the earth, equator is a great circle.
- The center of great circle coincides with center of the earth.

### Figure 3.3. Example of a multiple choice questions with image.  
**Category:** Unit 3: Network of Geographic Information, Georeference and Projection  
**Level:** Medium

What type of projection is shown in the image below?

Choices are:

- Peter projection
- Mercator projection
- Azimuthal distance projection
- Robinson projection

Answer to these kinds of questions can be answered only after carefully examining the respective image.

### 3.2.3 Essay Type Questions

For any course work it is necessary for a student to answer any question in detail rather than just choosing correct answers from few given choices. Test Bank contains essay type questions as shown in Figure 3.4 for each category and level. There are 50 essay type questions in the database so far and can be used to generate such a test for the students.

<table>
<thead>
<tr>
<th>Category:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 2: Mapping the Earth</td>
</tr>
</tbody>
</table>

**What is the first law of Geography?**

**Figure 3.4. Example of an essay type question.**

### 3.2.4 List of Categories

This test bank contains multiple choice and essay type questions from the Geog 104 - Geographic Information Science and Spatial Reasoning class [20]. The lists of categories are based on the lectures covered in that class. All Admin users of this application can add or remove a category. List of categories in the initial database is given below:

- Unit 1: Overview of GIScience
- Unit 2: Mapping the Earth
- Unit 3: Network of Geographic Information, Georeference and Projection
- Unit 4: GIS Software and Data Format
- Unit 5: GPS Introduction and Mobile GIS
- Unit 6: GIS Data Collection and Processing
- Unit 7: Internet and Mobile GIS
- Remote Sensing
- Unit 10: Geospatial Visualization
- Spatial Analysis
- GIS and Society
3.3 Usage

This test bank application can be used as one of the exercises during lab work in order to help prepare students for exams. This will also help testing this application by geography students.
CHAPTER 4

RUBY ON RAILS

4.1 INTRODUCTION

Rails is a web development framework written in the Ruby language. A web framework is used to develop web applications and web services with ease. The overhead associated with common activities of web development can be reduced by libraries, templates, session management and other software tools provided by a web framework [25]. In the Rails framework all the layers are built to work together with less code and promote “don’t repeat yourself” (DRY).

Rails is organized around the Model, View and Controller architecture, usually called MVC. The MVC paradigm provides clean separation of business logic (the controller), data (the model), and the data display format and user interaction (the view). This helps to maintain, debug and extend web applications with ease.

Some of the other useful features of Ruby on Rails framework used in the GIS Skills Certificate Test Bank are listed below.

4.2 DEVISE

An interactive application like test bank needs to use an authentication mechanism to keep track of users. This can be achieved in Rails using a gem known as Devise. Devise is a full featured Rack-based authentication solution based on Warden [5, 13].

Devise can be used by adding the devise gem in the Gemfile and installing the gem by running the bundler. Devise Modules are generated using the following command:

```
rails generate devise_install
```

The authentication system requires User Model, view and controller which was generated using:

```
rails generate devise User
```
A successful authentication routes the user to a welcome page while a failed login brings back the user to the login page. The user session starts as soon as the authentication is done.

Sometimes, successful authorization is required by some action with the controller or all the action in the controller in order to be accessed. Filters like before_filter can be used to implement such features.

### 4.3 Migrations

Database migrations can be defined using rails. Each migration represents a change that has to be made to the database. These changes can update both the database schema and the data in the database tables. You can also roll back to the previous database.

When a new model is created using a generator, rails automatically creates migration in the db/migrate folder that can be used to create the corresponding table. Blank migration can be created using the following command:

`script/generate migration MigrationName`

The class name is the same as that of the ruby migration file name. Methods like `self.up` and `self.down` are used to migrate any new changes and roll back to previous respectively [23].

Rails supports eleven data types, namely string, text, integer, float, decimal, datetime, timestamp, time, date, binary and Boolean. An example of table creation is:

```ruby
class CreateUsers < ActiveRecord::Migration
  def self.up
    create_table "users", :force => true do |t|
      t.column :firstname, :string
      t.column :lastname, :string
      t.column :email, :string
      t.column :login, :string
      t.column :crypted_password, :string, :limit => 40
      t.column :salt, :string, :limit => 40
      t.column :created_at, :datetime
      t.column :updated_at, :datetime
    end
  end
end
```
t.column :remember_token, :string
  t.column :remember_token_expires_at, :datetime
end
end

def self.down
  drop_table "users"
end
end

To run migration on the rails application, the following command is used:
Rake db:migrate [15, 17, 22].

4.4 VALIDATIONS

Validations help to ensure that only valid data is saved into your database. This includes database constraints, client-side validations, controller-level validations, and model-level validations [14]. For example, it is important to this application to ensure that every user provides a valid email address, a certain field should not be blank, password is within a certain range etc [14]. An example of how validation can be used in rails application is shown below:

- To validate that the specified attributes are not empty:
  
  validates_presence_of :user_name, :password

- To validate the uniqueness of a field:
  
  validates_uniqueness_of :email

- To validate length of a field:
  
  validates_length_of :name, :minimum => 4
CHAPTER 5

TEST BANK DEPLOYMENT

The GIS test bank application requires a Ruby interpreter, Rails framework and MySQL as a database. Any version of Ruby later than 1.8.6 can be used. Ruby 1.8.6 and earlier are not supported and neither is version 1.9.1. Ruby Gems are a standard package manager for Ruby and will also need to be installed [18]. Bundler is used to install and include the gems needed by the application. Once we have Gems, Rails and its dependencies can easily be installed by executing the following command:

gem install rails

The database is used to store the different data used in the application which will be used by rails to display on screen to the user. I have used MySQL database though other databases like SQLite, PostgreSQL and Oracle can also be used.

- MySQL adapter is needed to use MySQL in Rails greater than 2.1:
  
  $ gem install mysql

- To create a new Rails application using the MySQL adapter:
  
  $ rails new gis_thesis -d mysql

Next, config/database.yml also needs to be edited accordingly. Example is given below [26]:

- development:
  
  - adapter: mysql
  
  - database: gis_thesis
  
  - username: root
  
  - password: cheena
  
  - host: localhost

It is also easy to use other databases like PostgreSQL, SQLite, and Oracle with Rails.

Creation of skeleton, controllers, and model is done only once. This gis_thesis folder can be copied in ruby/bin folder on the server and is now ready to use.

5.1 GENERATING SKELETON

In order to create an entire blank Rails project skeleton, the following line is used:
rails new gis_thesis

Once we have a skeleton, we need to create a controller, models and views.

### 5.2 Generating Controllers

Controllers contain the main business logic. Controllers receive events from the user input, interact with the model, and display an appropriate view to the user [19].

Syntax to generate a controller is given below:

- rails generate controller controller_name
- rails generate controller controller_name method_name(s)

The controllers created for this application are:

- Answers Controller
- Categories Controller
- Documents Controller
- Images Controller
- Levels Controller
- Questions Controller
- Roles Controller
- Scores Controller
- Subquestions Controller
- User Controller
- Welcome Controller

The controllers created by Devise gem are:

- Passwords Controller
- Registrations Controller
- Sessions Controller

### 5.3 Generating Models

Model is responsible for maintaining the state of the application. A model is not just data but it enforces all the business rules that apply to that data [21, 19].

Syntax to generate a model is given below:

- rails generate model model_name
- rails generate model user name:string hashed_password:string salt:string
The models created for this application are:

- Answer
- Category
- Document
- Image
- Question
- Level
- Role
- Score
- Subquestion
- User

5.4 CONNECTION WITH DATABASE

GIS test bank uses MySQL as its database. The Migrations feature of Rails was used to create the database. I created a database named gis_thesis. Then, I edited the config/database.yml file to establish the connection in the following way [26]:

- development:
  - adapter: mysql
  - database: gis_thesis
  - username: root
  - password: password
  - host: localhost

5.5 DATABASE DESIGN

When models were created using a generator, the corresponding create table files were created in the db/migrate folder. Here is the way we created the Users table:

class DeviseCreateUsers < ActiveRecord::Migration
  def self.up
    create_table(:users) do |t|
      t.database_authenticatable :null => false
      t.recoverable
      t.rememberable
t.trackable

t.column :email, :string

t.column :login, :string

t.column :firstname, :string

t.column :lastname, :string

t.timestamps

drop_table :users

def self.down

drop_table :users
end

add_index :users, :login, :unique => true

add_index :users, :email, :unique => true

add_index :users, :reset_password_token, :unique => true

def self.up

drop_table :users
end

end

The corresponding table created in the database is shown in Figure 5.1. Each User has an ID, first name, last name, email address, login name and password (at least 4 characters) fields.

Figure 5.1. Users table.
Each Role has an ID, role name and role description field. There are only four entries in the table namely administrator, faculty, teaching assistant and student. The role table is shown in Figure 5.2 and 5.3.

```
mysql> desc roles;
+-------------+--------------+------+----------+-------------+-----------+-------------+
| Field       | Type         | Null | Key      | Default     | Extra     |
+-------------+--------------+------+----------+-------------+-----------+-------------+
| id          | int(11)      | NO   | PRI      | NULL        | auto increment |
| name        | varchar(255) | YES  |(NULL     | NULL        |           |
| description | text         | YES  | NULL     | NULL        |           |
+-------------+--------------+------+----------+-------------+-----------+-------------+
3 rows in set (0.02 sec)
```

Figure 5.2. Roles table.

```
mysql> select * from roles;
+----+---------+--------------------------------+---------------------------------+
| id | name    | description                     |
+----+---------+--------------------------------+---------------------------------+
| 1  | Admin   | Admin Role                      |
| 2  | Faculty | Faculty Role Description        |
| 3  | TA      | TA Role Description             |
| 4  | Student | Student Role Description        |
+----+---------+--------------------------------+---------------------------------+
4 rows in set (0.09 sec)
```

Figure 5.3. Entries in roles table.

The Roles_Users table contains role ID and User ID fields. This table maps the roles that are assigned to each user. The Roles_users table is shown in Figure 5.4.

```
mysql> desc roles_users;
+-------------+--------------+------+----------+-------------+-----------+-------------+
| Field       | Type         | Null | Key      | Default     | Extra     |
+-------------+--------------+------+----------+-------------+-----------+-------------+
| role_id     | int(11)      | YES  | MUL      | NULL        |           |
| user_id     | int(11)      | YES  | MUL      | NULL        |           |
+-------------+--------------+------+----------+-------------+-----------+-------------+
2 rows in set (0.02 sec)
```

Figure 5.4. Roles_Users table.

The Category table has ID and category name field as shown in Figure 5.5. Category name fields consists of GIS topics covered in the test bank.

The Level table has ID and level name field. Level table have three entries of beginner, intermediate and advanced. Description of level table is shown in Figure 5.6 and 5.7.
The Questions table consists of four fields namely ID, question, category ID and level ID. Category ID and Level ID shows the category and level a particular question belongs to. Figure 5.8 shows the question table.

The Answers table consists of four fields namely ID, answer, question ID and isCorrect. Question ID field indicates the question to which that answer belongs to while
isCorrect fields tells whether that answer choice is correct or not. Figure 5.9 shows the answer table.

<table>
<thead>
<tr>
<th>Field</th>
<th>Type</th>
<th>Null</th>
<th>Key</th>
<th>Default</th>
<th>Extra</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>int(11)</td>
<td>NO</td>
<td>PRI</td>
<td>NULL</td>
<td>auto_increment</td>
</tr>
<tr>
<td>answer</td>
<td>varchar</td>
<td>YES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>question_id</td>
<td>int(11)</td>
<td>YES</td>
<td>NULL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>isCorrect</td>
<td>tinyint(1)</td>
<td>YES</td>
<td></td>
<td>NULL</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5.9. Answers table.

The Images table contains the image associated with multiple choice questions. This table has an ID, title, content and question ID field. Images table is shown in Figure 5.10.

<table>
<thead>
<tr>
<th>Field</th>
<th>Type</th>
<th>Null</th>
<th>Key</th>
<th>Default</th>
<th>Extra</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>int(11)</td>
<td>NO</td>
<td>PRI</td>
<td>NULL</td>
<td>auto_increment</td>
</tr>
<tr>
<td>title</td>
<td>varchar(255)</td>
<td>YES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>content</td>
<td>blob</td>
<td>YES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>question_id</td>
<td>int(11)</td>
<td>YES</td>
<td></td>
<td>NULL</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5.10. Image table.

Subquestion table records essay type questions. This table has an ID, subquestion and category ID field. Category ID fields records the category to which it belongs. Description of Subquestion table is shown in Figure 5.11.

<table>
<thead>
<tr>
<th>Field</th>
<th>Type</th>
<th>Null</th>
<th>Key</th>
<th>Default</th>
<th>Extra</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>int(11)</td>
<td>NO</td>
<td>PRI</td>
<td>NULL</td>
<td>auto_increment</td>
</tr>
<tr>
<td>subquestion</td>
<td>varchar(255)</td>
<td>YES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>category_id</td>
<td>int(11)</td>
<td>YES</td>
<td></td>
<td>NULL</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5.11. Subquestions table.
The Documents table is created to store the documents or lectures uploaded by the admin or faculty member. Document table consists of an ID, title and content field as shown in the Figure 5.12.

```
mysql> desc documents;
+-------+-------------+-------+-------+--------+----------+--------+
| Field | Type        | Null  | Key   | Default | Extra    |
|-------+-------------+-------+-------+--------+----------+--------|
| id    | int(11)     | NO    | PRI   | NULL   | auto_increment |
| title | varchar(255)| YES   |       | NULL   |           |
| content | longblob   | YES   |       | NULL   |           |
+-------+-------------+-------+-------+--------+----------+--------+
0 rows in set (0.02 sec)
```

Figure 5.12. Documents table.

The Scores table records the scores achieved by all the students during online test. Score table contains an ID, User ID, total questions, correct answers, incorrect answers, total number of correct answers, percentage, and date and time test taken fields. Description of scores table is shown in Figure 5.13.

```
mysql> desc scores;
+-------+-------------+-------+-------+--------+-------------+----------+----------------------------------+
| Field | Type        | Null  | Key   | Default | Extra       |
|-------+-------------+-------+-------+--------+-------------+----------+----------------------------------|
| id    | int(11)     | NO    | PRI   | NULL   | auto_increment |
| user_id | int(11)   | YES   |       | NULL   |              |
| totalques | int(11)  | YES   |       | NULL   |              |
| correctans | int(11)  | YES   |       | NULL   |              |
| incorrectans | int(11) | YES   |       | NULL   |              |
| notanswered | int(11) | YES   |       | NULL   |              |
| created_at | datetime | YES   |       | NULL   |              |
| updated_at | datetime | YES   |       | NULL   |              |
+-------+-------------+-------+-------+--------+-------------+----------+----------------------------------+
8 rows in set (0.02 sec)
```

Figure 5.13. Scores table.
CHAPTER 6

APPLICATION FLOW CONTROL

The application begins with the login page. Only registered users can access this application. Each user has to enter their login information.

6.1 AUTHENTICATION

Each user who wishes to access the application has to enter their login ID and password (see Figure 6.1). Once the user information is authenticated, the user will be redirected to the respective home page based on their role. If a user forgets his/her password, he can contact the application administrator to reset it to another password. There are four types of users who can use this application, namely administrator, faculty, teaching assistant (TA) and student.

![Image of GIS Test Bank login page]

Figure 6.1. Login page of GIS Test Bank.
6.2 LIST OF PERMISSIONS FOR AN ADMINISTRATOR, FACULTY, TEACHING ASSISTANT AND STUDENT

The homepage of the user indicates the set of permissions assigned to them. Figures 6.2, 6.3, 6.4, & Figure 6.5 shows the homepages of an administrator, faculty, TA and student respectively.

![Figure 6.2. Homepage of an admin user.](image)

![Figure 6.3. Homepage of a faculty user.](image)
Figure 6.4. Homepage of a teaching assistant user.

Figure 6.5. Homepage of a student user.

6.3 USERS

Test Bank contains various users based on role assigned to them. Based on the type of role, a user can add, edit, remove or list all the users. An admin or a faculty user can also view students scoresheet.
6.3.1 Add New User

An administrator has the power to add another administrator, faculty, teaching assistant and student user while a faculty member can add TA and student users. To create a new user account, the admin or faculty has to enter the user information like first name, last name, login name, email, password and role to be assigned. A user can be assigned only one role at a time (see Figure 6.6).

Figure 6.6. New user form.

6.3.2 Editing and Listing Details

The difference between an administrator and faculty permission here is that an admin user can edit the information, remove and view details of all the registered users while a faulty user can edit, remove and view details of a teaching assistant and student user (see Figure 6.7).

6.3.3 View Student Score Sheet

Administrators and faculty members can view scores history of all the student users along with the date and time at which they gave the test (see Figure 6.8 and 6.9).
6.3.4 Change User Password

The administrator has the capability to change or reset the password of any existing user. So, in case any user forgets his/her password, they can contact the administrator (see Figure 6.10).
### Figure 6.9. Score details of a student user.

### Figure 6.10. Change user password form.

#### 6.4 Questions

Test Bank contains two types of questions: questions namely multiple choice and essay type. Add, edit, delete, or search capabilities can be performed on questions based on the user role.
6.4.1 Add New Question

An administrator or a faculty member can add two types of questions namely multiple choice and essay type. Essay type question can be added by entering the question statement along with the category to which it belongs. To add a multiple choice question, user must provide the question statement, category, level, answer choices and the correct answer(s) among them. User can also upload an image with the multiple choice question (see Figure 6.11).

![Figure 6.11. New question form.](image)

6.4.2 Edit, Remove and Search Question

Both administrator and faculty have permissions to edit, remove and view a list of all questions. They can also search for a question from the database (see Figures 6.12 and 6.13).

6.5 Answers

The administrator or a faculty member can add a new answer to an existing question in the database. They can also edit, remove or change the answer choices. Print key option is also available to them, where they can view all the questions of a category with their correct answers (see Figure 6.14).
6.6 CATEGORY

Administrator and faculty member can add, edit details and view all categories in the system. An admin has a power to remove a category (see Figure 6.15).

6.7 LECTURE

Lectures, handouts, class notes can be uploaded by an admin or a faculty member. Students have access to these documents (see Figure 6.16).
6.8 Class Test

An administrator or a faculty member can generate a class test consisting of essay type questions. The number of questions on the test is decided by the admin or faculty but the questions are randomly selected by the application. Admin or faculty can create many different sets of same number of questions to be distributed in the class to avoid plagiarism (see Figure 6.17).
**6.9 STUDENT FEATURES**

GIS Test Bank provides various functionalities to the students. They can take the test online, access the uploaded documents or use self study feature to prepare themselves for exams.
6.9.1. Online Test

Any student user can take a test consisting of multiple choice questions. Each question can have one or more than one correct answer choice. Negative marking is enabled with every incorrect answer or missed answer. Student can view all the questions with correct answers at the end along with their grades. This grade will also be reported to the faculty member (see Figures 6.18 and 6.19).

Figure 6.18. Snapshot of question displayed during online test.

Figure 6.19. Snapshot of result is displayed after the online test.
6.9.2 Self Study

This feature helps students to prepare for an exam. A student can decide a category on which they want to practice. However, correct answers will not be shown to them. The scores of this test will not be reported to the faculty (see Figures 6.20 and 6.21).

![Figure 6.20. Snapshot of choosing a category for self-study.](image1)

![Figure 6.21. Snapshot of questions displayed during self-study.](image2)

6.9.3 Access Lectures

Student users can view all the lectures, handouts, class notes or assignments uploaded by the faculty members.
6.9.4 Student Profile Details

All student users can view their own profile details and change their existing password. A student can also view all the scores history (see Figures 6.22 and 6.23).

Figure 6.22. Snapshot of student profile information.

Figure 6.23. Snapshot of change password form available to all the users.
CHAPTER 7

FUTURE DEVELOPMENT

The Test Bank can be further developed which may include the enhancements given below.

Test Bank can be extended to cover all the courses of Department of Geography and Department of Computer Science necessary for GIS certificate. These courses can then be accessed by the student based on their registered courses.

Test bank can be further enhanced by using essay type questions not only to produce class test but online test as well. Grading of essay type questions can also be provided based on matching keyword.

Timers can be introduced for online test in which certain time limit will be given to students to answer all the questions in one test.

Features where student can also upload their assignments online can be implemented.

Format of online test can be enhanced by displaying radio buttons for unique answer question to enforce students to give only one answer where as displaying check boxes for select all correct answer questions.
REFERENCES


