Code Pocket: Development of Interactive Online Learning of STEM's Subject

Nurul Azma Zakaria, Muhammad Shamil Saharudin, Robiah Yusof, and Zaheera Zainal Abidin

Abstract*: *As to promote and develop STEM education in Malaysia, various approaches have been taken, including improving the curriculum of secondary school by enhancing the contents of the Technology subjects. In this paper, we are concentrating on the issues raised in learning and teaching the computer science subject specifically in supporting the students to understand the syllabus. We propose an interactive online learning application (Code Pocket) using Waterfall model to assist students in learning the subject and enables teachers to monitor the performance of the students. Code Pocket is a web-based application which acts as e-learning platform that consists of many modules such as notes, quiz and reporting. A dashboard menu panel is provided to enable easy navigation. This application provides alternative learning and teaching mechanisms by providing flexible learning environment that promotes online and mobile learning which can be accessed at anytime and anywhere. With interactive features, the learning experience will be better and interesting.

Index Terms*: *Interactive learning, Online learning, Teaching and learning, STEM.

I. INTRODUCTION

In this era of globalization, Information and Communication Technology (ICT) has become a common thing among young generation. They have been exposed to technology in their early ages and accessing online information have become popular among them. With increasing general ICT skills and knowledge, Technology subject in Science, Technology, Engineering and Mathematics (STEM) education which was introduced in 2001 [1] can be further improved and benefits the country in the future. Due to this aspiration, in 2017 the Ministry of Education Malaysia (KPM) has introduced the Curriculum of Secondary Schools (KSSM) through Malaysia Education Strategic Planning Development (2013-2025) [2]. In this new curriculum, a new subject named Basic of Computer Science (ASK) with additional technical contents is replacing the general ICT Literacy (ICTL) subject. It is an important subject for Form 1 students. The syllabus is more challenging as the aim is to develop a computational minded student. ASK focuses more on concept of computer science and creativity. Students is introduced to the basic of programming as for preparation for more advanced programming in the following years.

However, a number of challenges and issues exist in teaching and learning areas of STEM education and various studies have been carried out by previous researches [3]-[9]. One of the key problem is the difficulty face by the students, especially for those who have very minimal knowledge in the subject, in this case is ICT knowledge, to understand the syllabus. They might be having trouble to understand as the syllabus introduces the basic of programming. Moreover, there are lack of resources related to this subject, other than the textbooks and modules given by the teachers and most of these are offline resources. There are also shortage of interesting and interactive medium to attract and keep the students' interest and focus during learning session.

As most of the youngsters have been exposed to gadgets like laptops, smartphones and tabs, the use of E-learning and online materials have become an attractive solution to the issue as studies done by [10], [11]. In this paper, we propose an interactive online learning application, named Code Pocket which assists students in their learning and provides flexible mechanism for the teachers to manage the learning session and monitor students' performance. With E-learning platform, the productivity can be increased as the subject can be accessed at anytime and anywhere. Code Pocket serves as a new medium that is highly intuitive and interactive for students and teachers in supporting the government's vision in STEM education.

The rest of this paper is organized as follows. Section II laid out detailed explanation on the design and methodology of Code Pocket. This paper continues with Section III that describes the implementation and ends with a conclusion in Section IV.

II. DESIGN

Code Pocket consists of four (4) modules and two (2) user types. Table 1 and 2 show the details of modules and user types.

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Table 1. Code pocket modules

Module Name	Description
Online Notes	There are four (4) chapters based on the syllabus
Online Quiz	Each of the chapters consists of quiz to test the students' understanding
Report Analysis	Teachers able to generate report and graph for every completed quiz
Student Record	Teachers able to add new student, delete, update the record and search the details of the students

Table 2. Code pocket user types

User Type	Description of Activities
Student	Student able to login into the system using student's password, view the notes, answer the quizzes.
Teacher	Teachers able to login into the system using teacher's password, register other users (student/teacher), add, edit, update or delete the quizzes and notes, generate report and graph, and view the notes.

The software development life cycle (SDLC) used in this application is Waterfall model [12]. Waterfall model is a sequence of seven (7) non-overlapping stages in which the output of each stage becomes the input for the next. The progress is seen as flowing steadily downwards through the phases of requirement, analysis, design, development, testing, implementation and maintenance.

The following subsections elaborates on structure chart, flow chart, pseudocode, entity-relation-diagram (ERD) and application interface of the Code Pocket application.

A. Structure Chart

Structure chart as depicted in Fig. 1, shows the overall connections between system modules and user types of Code Pocket. Each user types has its own modules as tabulated in Table 1 and 2. For example for user type *Students*, there are two (2) modules exist in this user type and for each module there is an activity allowed to be performed such as *View Notes* and *Answer quiz*.

B. Flow Chart

A flow chart is a diagram that represent the flow of the system, steps and also connections. There are three (3) main flow charts which illustrate the overall flow of the Code Pocket application. Fig. 2 demonstrations the flow chart of the Code Pocket's *Main* page. At the *Main* page, users are able to view the information about the system, and login as *Teachers* or *Students*. Both user types have different level of access and functions.

Fig. 3 shows the flow chart of the user type *Teacher*s. In this user type, the teacher serve as admin where the admin have full access of the modules in the system. There are four (4) modules which are Notes, Quiz, Manage Student, and Reporting.

Fig. 4 shows the flow chart of the user type *Students*. In *Students* login account, the student serve as user where the user has limited access to the system based on the module. The user can view the notes uploaded by the teacher and answer the quiz available in the application.

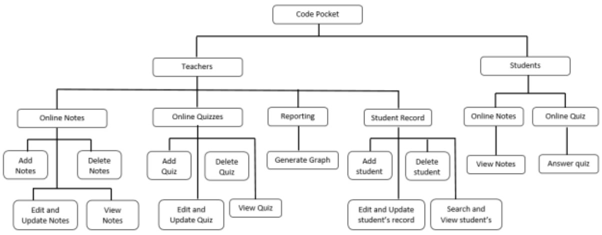
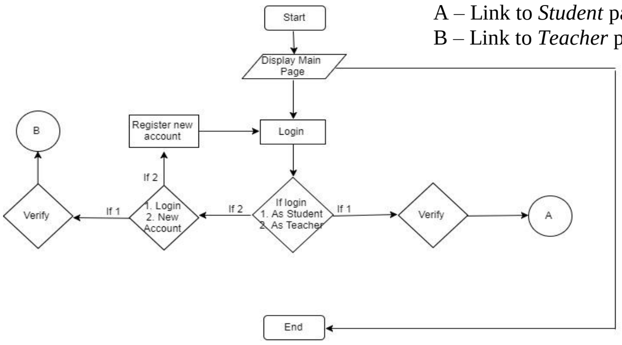


Fig. 1. Structure chart of Code Pocket

Fig. 2. Flow chart of the *Main* page.



A – Link to *Student* page
B – Link to *Teacher* page

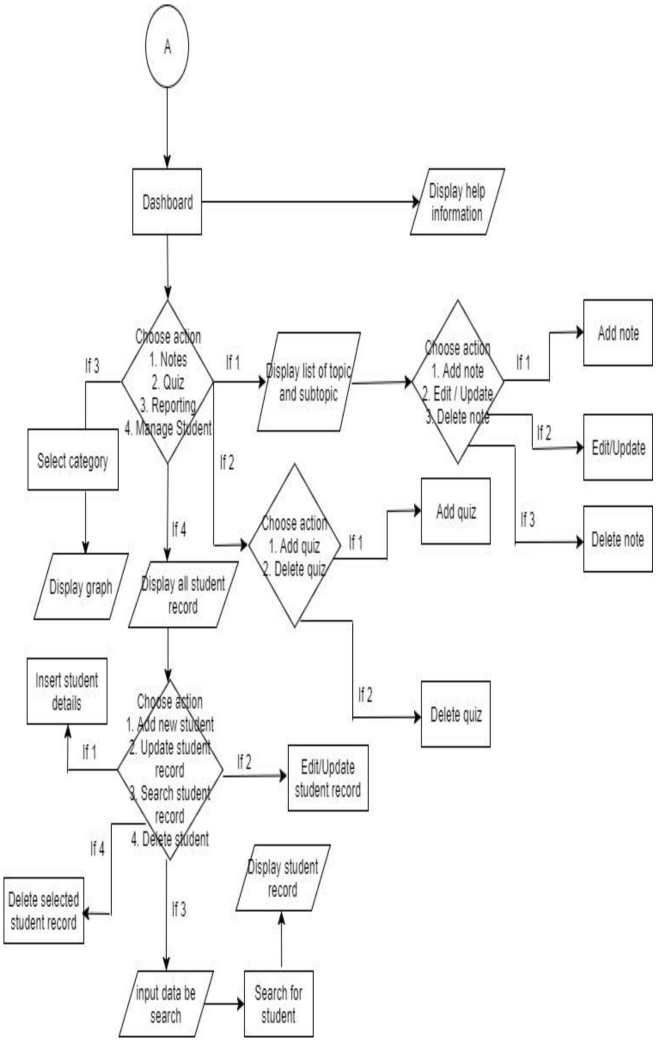


Fig. 3. Flow chart of the user type *Teachers* page.

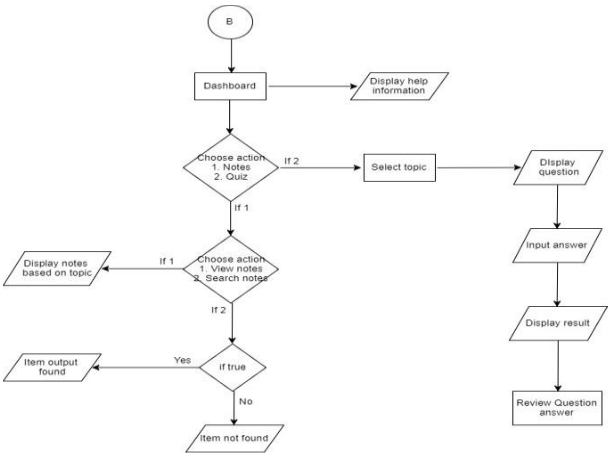
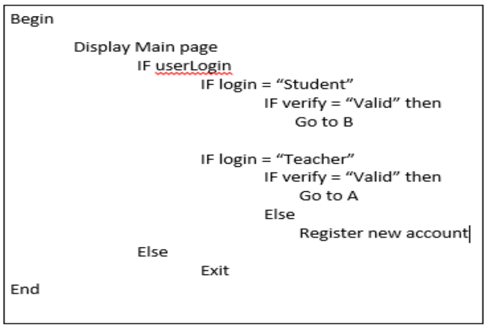


Fig. 4. Flow chart of the user type *Students* page.

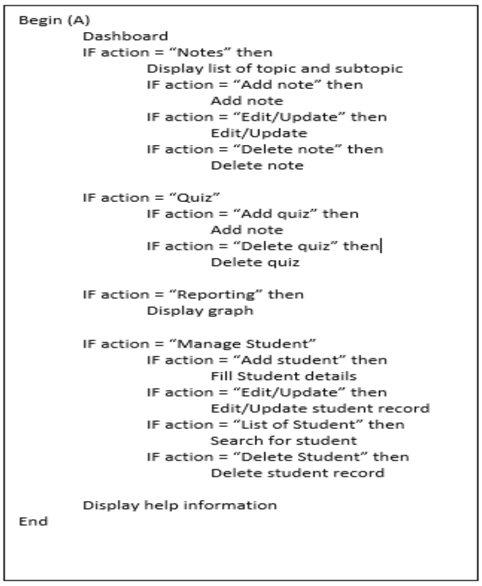
C. Pseudocode

Pseudocode shows the details and flow of the system in the form of algorithm where the statement are in human reading form rather than programming code. Fig. 5, 6 and 7 represents the samples of pseudocode for the flow of process illustrated in Fig. 2, 3 and 4.



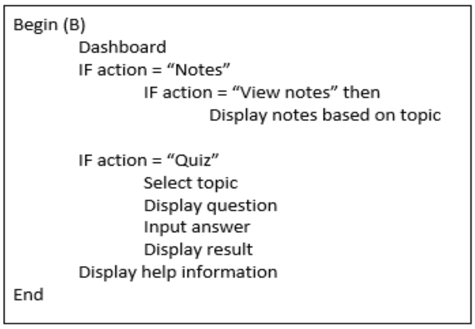
```
Begin
        Display Main page
                IF userLogin
                        IF login = "Student"
                                IF verify = "Valid" then
                                    Go to B

                        IF login = "Teacher"
                                IF verify = "Valid" then
                                    Go to A
                                Else
                                    Register new account
                Else
                        Exit
End
```

Fig. 5. Pseudocode of the *Main* page.



```
Begin (A)
        Dashboard
        IF action = "Notes" then
                Display list of topic and subtopic
                IF action = "Add note" then
                        Add note
                IF action = "Edit/Update" then
                        Edit/Update
                IF action = "Delete note" then
                        Delete note

        IF action = "Quiz"
                IF action = "Add quiz" then
                        Add note
                IF action = "Delete quiz" then
                        Delete quiz

        IF action = "Reporting" then
                Display graph

        IF action = "Manage Student"
                IF action = "Add student" then
                        Fill Student details
                IF action = "Edit/Update" then
                        Edit/Update student record
                IF action = "List of Student" then
                        Search for student
                IF action = "Delete Student" then
                        Delete student record

        Display help information
End
```

Fig. 6. Pseudocode of the Teachers page.



```
Begin (B)
        Dashboard
        IF action = "Notes"
                IF action = "View notes" then
                        Display notes based on topic

        IF action = "Quiz"
                Select topic
                Display question
                Input answer
                Display result
        Display help information
End
```

Fig. 7. Pseudocode of the Students page.

D. Entity-Relationship Diagram

This subsection describes the entity-relationship diagram (ERD) which focuses on the relationship among tables in the database. Fig. 8 shows the ERD of the Code Pocket and Table 3 lists the business rule applied in this application. In total there are eight (8) tables namely *teachers*, *students*, *notes*, *notes_has_quiz*, *kuiz*, *kuiz_has_students*, *results* and *category*. Each table contains various attributes related to the table, primary and foreign keys, and types of the attributes such as integer (*INT*).

E. Interface Design

Interface designs illustrate in this subsection are the actual system interface design of the Code Pocket application. In general, the design of the interface is similar for both user types. However, there are slight differences which based on the modules and activities of the user types as illustrated in Figure 1.

Fig. 9 depicts the *Main* page of the Code Pocket application which provides the overview of the system and serves as the introduction to the subject for both user types account (*Teachers* and *Students*). Initially, the user types *Teachers* and *Students* were registered in the *Signup* page as presented in Fig. 10. The registration is required in order to record access details such as *username* and *password* and user's information like *name*, *e-mail* and *ID* in the system. In order to access the application, *username* and *password* are required in the *Login* page of both user types for the authentication process, as shown in Fig. 11 and 12 respectively.

Table 3. ERD Business Rule

Business Rule
One teacher can have many students *Many students can have many quiz* *Many notes can have many quiz* *One quiz can only have one result* *One quiz can only have one category*

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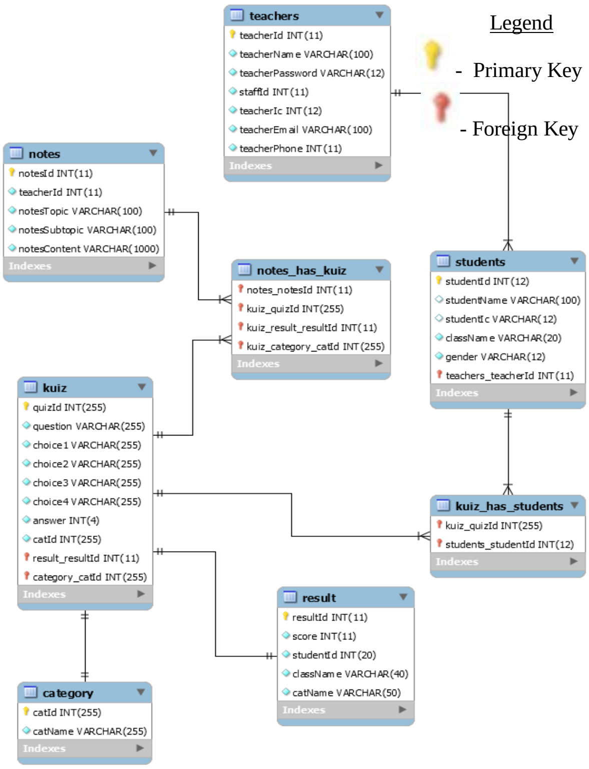


Fig. 8. ERD of Code Pocket

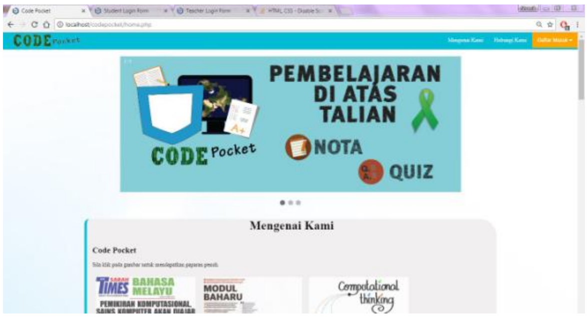
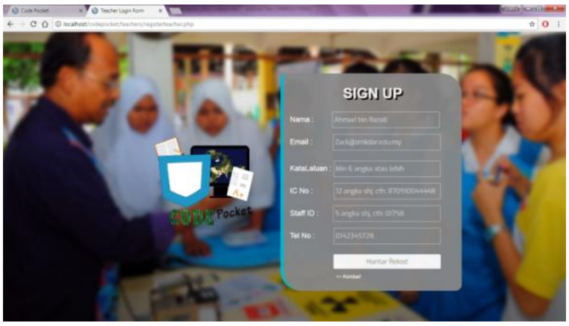


Fig. 9. Main page



SIGN UP

Nama : Ahmad bin Razali

Email : Zack@smkdar.edu.my

KataLaluan : Min 6 angka atau lebih

IC No : 12 angka shj, cth: 870910044448

Staff ID : 5 angka shj, cth: 01758

Tel No : 0142345728

Hantar Rekod

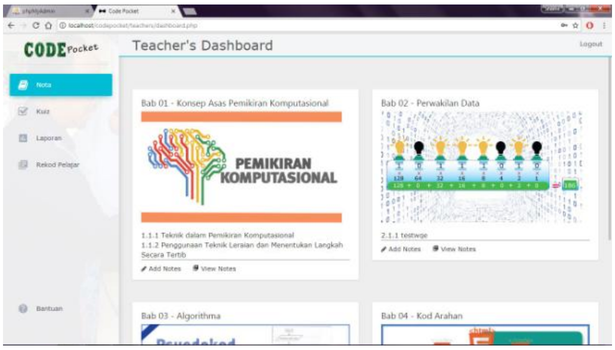
← Kembali

Fig. 10. Signup page.

Fig. 11. Login page for Teachers.

Fig. 12. Login page for Students.

Once the user was able to login into the application, the user's *Dashboard* was displayed as the *Main* page of the specified user either *Teachers* or *Students*. Fig. 13 represents the example of *Dashboard* for user type *Teachers*. Elements on the left panel of the *Dashboard* page for both user types indicates the permitted activities for them as listed in Table 2. Elements on the right panel displays all contents such as *notes* and *quiz* related to the subject, where user type *Teachers* has full access (add, edit/update and delete) in this environment. User type *Students* is able to interact with the material available in this panel. For example, in *Quiz* section as shown in Fig. 14, *Students* was able to attempt the quiz by choosing the correct answer and at the end of the session, the summary result of the quiz was displayed. Fig. 15 displays the sample of *Quiz Result* interface. In addition, Fig. 16 shows the interface of students' record that were managed by the *Teachers*. The details of the student was searched by using *Name* string.



Bab 01 - Konsep Asas Pemikiran Komputasional

1.1.1 Teknik dalam Pemikiran Komputasional

1.1.2 Penggunaan Teknik Leraian dan Menentukan Langkah Secara Tertib

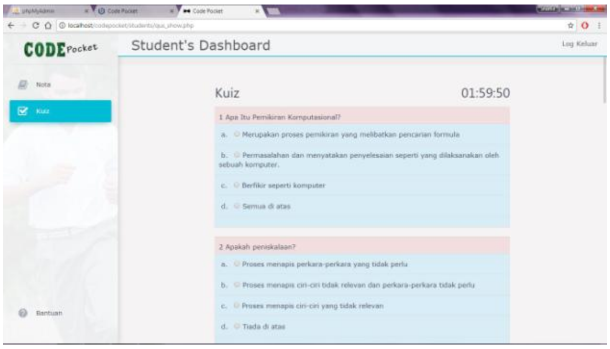
Bab 02 - Perwakilan Data

2.1.1 testwqe

Bab 03 - Algorithma

Bab 04 - Kod Arahan

Fig. 13. Dashboard page for Teachers.



Kuiz 01:59:50

1 Apa Itu Pemikiran Komputasional?

a. ○ Merupakan proses pemikiran yang melibatkan pencarian formula

b. ○ Permasalahan dan menyatakan penyelesaian seperti yang dilaksanakan oleh sebuah komputer.

c. ○ Berfikir seperti komputer

d. ○ Semua di atas

2 Apakah peniskalaan?

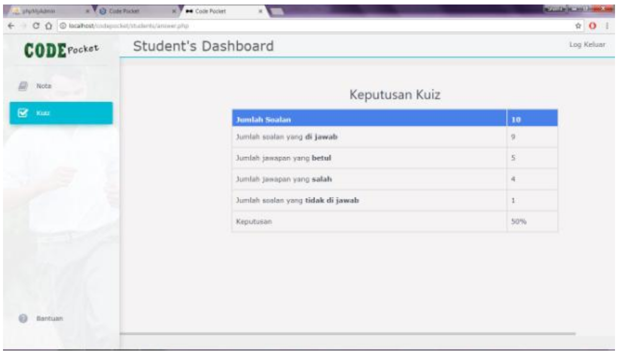
a. ○ Proses menapis perkara-perkara yang tidak perlu

b. ○ Proses menapis ciri-ciri tidak relevan dan perkara-perkara tidak perlu

c. ○ Proses menapis ciri-ciri yang tidak relevan

d. ○ Tiada di atas

Fig. 14. Quiz page for Students.



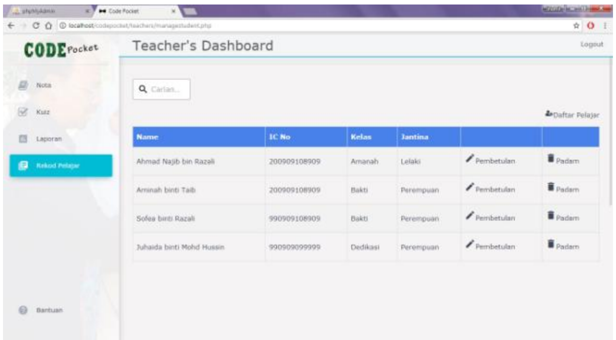
localhost/codepocket/students/answer.php

Student's Dashboard

Keputusan Kuiz

Jumlah Soalan	**10**
Jumlah soalan yang **di jawab**	9
Jumlah jawapan yang **betul**	5
Jumlah jawapan yang **salah**	4
Jumlah soalan yang **tidak di jawab**	1
Keputusan	50%

Fig. 15. Quiz Result interface.



localhost/codepocket/teachers/managestudent.php

Teacher's Dashboard

Name	IC No	Kelas	Jantina		
Ahmad Najib bin Razali	200909108909	Amanah	Lelaki	Pembetulan	Padam
Aminah binti Taib	200909108909	Bakti	Perempuan	Pembetulan	Padam
Sofea binti Razali	990909108909	Bakti	Perempuan	Pembetulan	Padam
Juhaida binti Mohd Hussin	990909099999	Dedikasi	Perempuan	Pembetulan	Padam

Fig. 16. Students' record page from Teachers view.

III. IMPLEMENTATION

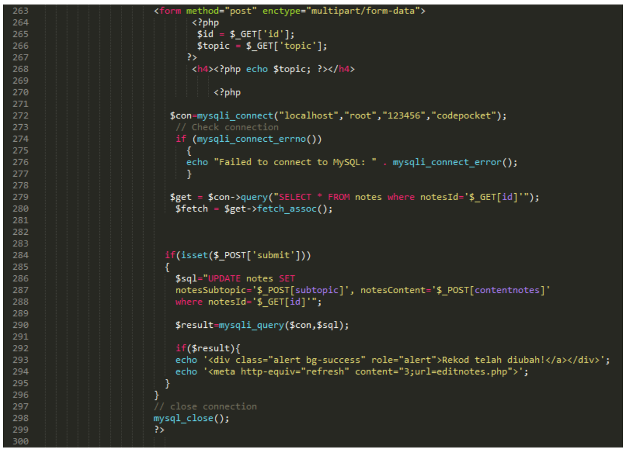
This section explains about the system implementation in terms of programming technique and error handling involve in the development of Code Pocket.

The programming language used to develop the function of the application is Hypertext Preprocessor (PHP) [13] and the web interface runs on HyperText Transfer Protocol (HTTP). Moreover, JavaScript [10] is used to make sure the flow and the process loaded run smoothly and Cascading Style Sheets (CSS) is used to design the presentation of the application so as to make it attractive. The following figures demonstrate the code snippets of the Code Pocket.

Fig. 17 shows the usage of *IF* statements that check the condition and generate the output once the requirement is fulfilled. For example, in line 272, the variables were used to connect to the database and line 274 checked the condition for database connection. After that, in line 284, when the user clicked the submit button, the data was updated and then the result was displayed as stated in line 292.

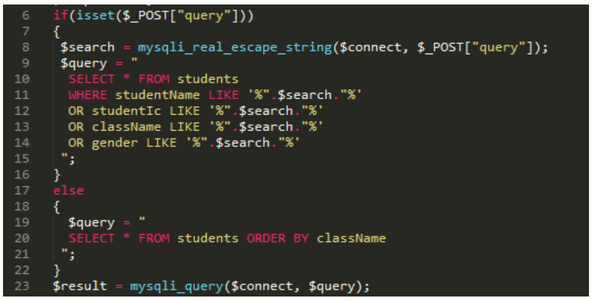
Fig. 18 describes sample code to search a record in the data listed. If the condition is fulfilled, the related record that have been fetched was displayed in the interface as requested. In this case, the search was performed in *students* table.

Error handling refers to the response and recovery procedures from error conditions present in the system. A pop-up message which describes the error message from the system is displayed for assisting further action from the user. It also helps in maintaining the normal flow of program execution. Examples of error handling are shown in Fig. 19 and 20 which are related to login credentials and 12-digit identification card (IC) number respectively.



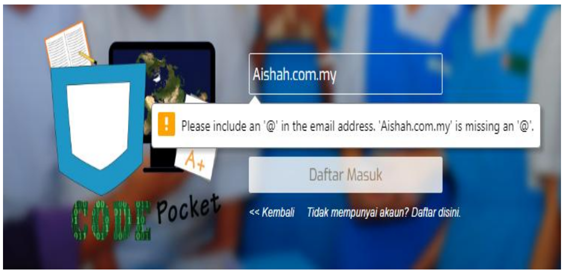
```
263                 <form method="post" enctype="multipart/form-data">
264                       <?php
265                        $id = $_GET['id'];
266                        $topic = $_GET['topic'];
267                      ?>
268                       <h4><?php echo $topic; ?></h4>
269
270                           <?php
271
272                    $con=mysqli_connect("localhost","root","123456","codepocket");
273                     // Check connection
274                     if (mysqli_connect_errno())
275                       {
276                       echo "Failed to connect to MySQL: " . mysqli_connect_error();
277                       }
278
279                    $get = $con->query("SELECT * FROM notes where notesId='$_GET[id]'");
280                     $fetch = $get->fetch_assoc();
281
282
283
284                   if(isset($_POST['submit']))
285                   {
286                     $sql="UPDATE notes SET
287                     notesSubtopic='$_POST[subtopic]', notesContent='$_POST[contentnotes]'
288                     where notesId='$_GET[id]'";
289
290                     $result=mysqli_query($con,$sql);
291
292                     if($result){
293                     echo '<div class="alert bg-success" role="alert">Rekod telah diubah!</a></div>';
294                     echo '<meta http-equiv="refresh" content="3;url=editnotes.php">';
295                   }
296                 }
297                 // close connection
298                 mysql_close();
299                 ?>
300
```

Fig. 17. Code snippet of database connection using IF statement.



```
if(isset($_POST["query"]))
{
 $search = mysqli_real_escape_string($connect, $_POST["query"]);
 $query = "
  SELECT * FROM students
  WHERE studentName LIKE '%".$search."%'
  OR studentIc LIKE '%".$search."%'
  OR className LIKE '%".$search."%'
  OR gender LIKE '%".$search."%'
 ";
}
else
{
  $query = "
  SELECT * FROM students ORDER BY className
 ";
}
$result = mysqli_query($connect, $query);
```

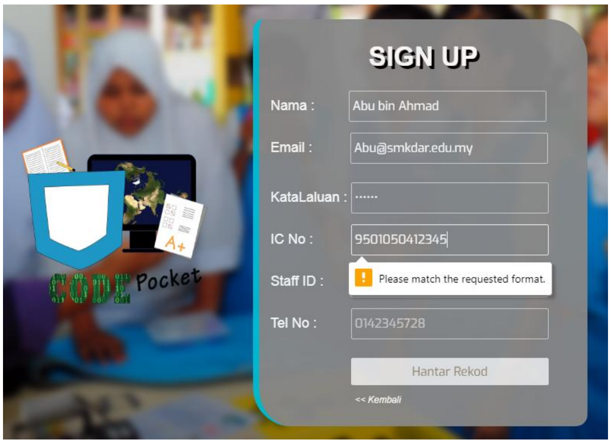
Fig. 18. Code snippet to search record from the students table.



Aishah.com.my

Please include an '@' in the email address. 'Aishah.com.my' is missing an '@'.

Fig. 19. Error handling for e-mail address format.



SIGN UP

Nama : Abu bin Ahmad

Email : Abu@smkdar.edu.my

KataLaluan : ······

IC No : 9501050412345

Staff ID :

Please match the requested format.

Tel No : 0142345728

Fig. 20. Error handling in Signup IC number format.

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DOI: 10.35940/ijrte.B3297.078219
Journal Website: www.ijrte.org

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IV. CONCLUSION

Overall, the Code Pocket application was successfully developed for supporting the teaching and learning session of a newly introduced STEM's subject, Basic of Computer Science (ASK). This work provides an online learning platform for improving the learning experience. With interactive design and user friendly application, Code Pocket becomes a good alternative from traditional learning method using printed materials. The subject's contents can be accessed easily and the students' performance can be monitored in real-time by the teachers. However, as Code Pocket is a type of online learning tool, thus the dependency to the network connectivity is very high. Without the Internet connection, Code Pocket is unable to function. Nevertheless, this development acts as an example for other implementation in STEM's subjects such as Science and Mathematics. In the future, the contents and function of Code Pocket application can be extended and improved, and a mobile version of Code Pocket is able increase the portability and usability of the application.

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