

An E-Learning Tool for The Self-Study of Mathematics for the CPE Examination

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Abstract—In this paper, we give an overview of an online e-learning tool which has been developed for kids aged from nine to eleven years old in Mauritius for the self-study of Mathematics in order to prepare them for the CPE examination. The software does not intend to render obsolete the existing pedagogical approaches. Nowadays, the teaching-learning process is mainly focused towards the class-room model. Moreover, most of the e-learning platforms that exist are simply static ways of delivering resources using the internet. There is nearly no interaction between the learner and the tool. Our application will enable students to practice exercises online and also work out sample examination papers. Another interesting feature is that the kid will not have to wait for someone to correct the work as the correction will be done online and on the spot. Additional feedback is also provided for some exercises.

Keywords—CPE, e-learning, Mauritius, primary education

I. INTRODUCTION

E-LEARNING (electronic learning) may be referred as a component of flexible learning that uses Information and Communication Technologies (ICT), as a communication and delivery tool, to support students, or to improve the management of learning [1]. Many researchers still believe e-learning is still in its infancy. Mauritius can benefit a lot from e-learning as it provides the acquisition of knowledge and skills, and flexible learning opportunities to students.

In the world of today, students are mostly opting for online learning which contributes tremendously in the success of distance learning. Online e-learning facilities are bringing many changes that the Ministry of Education has struggled to enforce in our curricula for the past 25 years. It is acknowledged that e-learning can help improve the performance of less talented students [2]. Moreover, e-learning promotes self-learning such that students can learn at the pace they are capable of, and often without the need for a teacher.

The aim of this paper has been the implementation of an e-learning tool that can be used by primary students to improve their mathematical skills. The platform will provide a personalised learning experience and at the same time, the pupils will grasp necessary technology skills.

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Mauritius cannot be metamorphosed into a cyber-island without inculcating competent skills in its new generation. Therefore, this system will present some ways in alleviating some of the IT problems faced in the primary schools. Furthermore, this project may also provide solution to the major existing problems faced by our educational system like high failure rate of students at the CPE examinations and private tuition.

The paper is organised as follows: Section 2 talks about the primary education in Mauritius. In Section 3, the operation of the system is outlined. Testing is carried out in Section 4 and the results are also presented there while Section 5 presents a brief conclusion on our work.

II. BACKGROUND STUDY

A. Competitive Primary Education

Due to the lack of cut-throat competition at primary level, there is a high pressure on the students to secure a seat in one of the few 'star' secondary schools. Based on such a system, the parents have to ensure that their child gets the edge rather than trailing at the bottom. They are forced to do the best for their child and they have no other choice than opting for private tuition.

As long as our educational system promotes a bookish aspect of education leading to a highly competitive CPE examination, the demand for after school tuition is there. The teachers purposely create a lack of knowledge in class such that whatever is missing is covered in tuition. They are fighting so that the educational system remains the same which means no extension of class hours in the afternoon and school holidays should not be reduced so as to cram the students more during the holidays to justify the wages obtained from it.

B. The Overloaded Syllabus

Another drawback of the Primary Education in Mauritius is that the syllabus exerts a huge pressure on the students. The primary school curriculum has been criticised on the ground that it is overcrowded with a host of subject areas clamouring for more recognition, more time and more resource allocation. Many teachers have complained that the curriculum of the primary curriculum and that the subject syllabi are too

overloaded. As a result, the needs of the developing child are sacrificed on the altar of a congested syllabus. Also, rote learning is emphasised at the expense of problem solving.

C. Status of ICT in Mauritius

According to the White Paper – Pre Primary and Secondary Education (n.d.), the current educational system is becoming outdated. We do accept that it has been of great help to Mauritius to complete its first phase of industrialisation. However, as per the White Paper, failure to reform the educational system may seriously endanger our economy.

Following the Global Information Technology Report (2008) on ICT published by the World Economic Forum, Mauritius has lost six ranks and is actually at the 51st position in the use of ICT in its development. This clearly indicates that Mauritius is losing ground in its attempt to develop ICT skills in its population compared to other countries. Since the aim of Mauritius is to become a cyber-island, this is not acceptable. Nowadays, technology literacy has become a must. To be able to cope and contribute in this ever-growing technological world, the new generation must definitely develop excellent competencies and skills in technology at an early age.

D. ICT in Primary Schools in Mauritius

In 2001, for the first time Information and Communication Technology (ICT) was introduced as a subject in the primary schools. However, it is noted that the ministry took a long time to implement his decision. Even during the implementation phase, some problems arose, thus delaying the introduction of ICT in primary schools.

In many countries, ICT has been implemented for more than twenty years in primary schools and studies have been carried out in order to evaluate its impact on teaching and learning (A. Bork, 1995; G. Dawson, 2002). The extent to which resources are available can help learning (G. Gordon & A. Siamek, 2002) among pupils in the primary schools.

The Action Plan for a New Education System in Mauritius (1998) highlights the importance of Information Technology (IT) in schools. Mauritius cannot be left behind in the IT field. Therefore, for the third millennium the educational system must make necessary provision for IT training at all levels.

One of the objectives of the introduction of ICT in schools was that it would attempt to reduce the digital divide among the population of the 21st century. So, besides teacher training, it was also suggested that schools would be provided with access to the internet with a view to giving our children the opportunity of accessing the global village.

III. DESCRIPTION OF THE SYSTEM

The application will be an e-learning platform for the primary students where children aged from 9 to 11 years old and primary teachers will access the website. The application will consist of three types of users which are: students, teachers and administrators. The role of each user is different and they do not have the same functionalities in the system.

A. Student Section

To access the student corner, the user must register and activate his account. When registration is completed, after logging into the system, the student will be able to access the student's homepage. Apart from the homepage, a forum will be developed where anyone accessing this particular site can view the reviews about chapters from a very subject but only registered members can post comments in the forum.

The student will be able to comment on the forum as well as download the notes or exercises uploaded by the teacher. Finally, the most challenging part in this e-learning website is the implementation of some of the chapters from different subjects of standard IV, V and VI syllabuses and various exercises based on the chapters. The students will work out the exercises online and they will be corrected on the spot.

B. Teacher Section

An account for the teacher will be created by the system administrator. The teacher will make use of the account to access the site where he will be able to modify the username, password or e-mail address. He will also post comments on the forum or even start a topic for discussion. Moreover, the teacher can upload notes and exercises in the .pdf format.

C. Administrator Section

The system administrator will update the site whenever there is a change in the education sector. In the educational news section, the administrator will add or delete news with respect to what is being done in the education field in Mauritius. Moreover, He/she will also manage the student and teacher registrations. Whenever the teacher or the student will post something on the forum, the post will be sent for approval to the administrator.

Additionally, if it is relevant to the forum, the administrator will post in on the forum otherwise he/she will delete it. Any user viewing this site will be able to contact the system administrator for any kind of information he/she requires. The users will also be able to access the forum.

D. Generation of Mathematics Test Papers

To implement this part, examination questions have been stored in the table question. PHP provides objects to generate flash files with Ming. For instance, generating a dynamic abacus has been possible by making use of the object in Ming. Moreover, for drawing shapes like rectangle, square and triangle to a particular scale, the GD Library in PHP has been used. Therefore, every time the page loads, the questions vary and so do the figures. The paper includes both structured (questions 1 to 15) and multiple choice (questions 16 to 45) questions as shown below.

E. Learning Tools for Mathematics

Everything that has been implemented in this section will permit the student for self-learning. At the same time, they will be grasping some ICT skills.

F. CPE Mathematics

For Mathematics, some of the chapters have been implemented. They include:

1. Numbers: Whole Numbers, Numeration and Notation, Addition, Subtraction, Multiplication, Division, Number Problems, Factors and Multiples, Types of Numbers, Powers.

2. Measures: Length, Units of Length, Conversion of Units of Length, Arithmetic Operations on length, word Problems on Length, Perimeter, Surface Area, Units of Area, Conversions of Units of Area, Arithmetic Operations on Area, word Problems on area.

The above chapters have been explained such that they meet the aims and objectives of the mathematics syllabus. After the explanation, interesting and dynamic exercises will be provided that the student can practice. The number of exercises is unlimited as every time a page is refreshed, the user is presented with a different set of exercises.

The students can keep on practicing to improve their skills as “practice makes perfect”. The more interesting part is when the user completes an exercise, the latter is corrected on the spot, using AJAX and PHP, and if the result is incorrect, he/she is has three more chances to correct it.

If the answer is still incorrect after the three tries, the user is given the correct answer. Nearly all the mathematic exercises will have the same format but they will only differ in the way the result is generated.

A PHP script called “calculations.php” has been implemented where there are 12 classes each having their own functionalities that will return the calculated result of the dynamic exercises.

IV. TESTING AND RESULTS

All exercises generated use random numbers, i.e, each time a page is loaded, the exercises are presented with a new set of random numbers. A student can try an exercise up to three times if the answer is incorrect, the fourth time he/she is given the correct one and in some cases an explanation also is given of how the exercise can be carried out. All exercises start from 3-digits to 6-digits numbers. This is to start with easy calculations and then increase the difficulty gradually.

A. Exercise for Writing in Words and Numbers

1. Words

716: seven hundred and 16	<input type="text"/>	✗ Answer = seven hundred and sixteen
1853: one thousand eight hundred and fifty-three	<input type="text"/>	✓
50259: fifty thousand two hundred and forty nine	<input type="text"/>	✗ Answer = fifty thousand two hundred and fifty nine
293006: two hundred and ninety-three thousand six hundred and six	<input type="text"/>	✓

2. Figures

nine hundred and ninety:	<input type="text" value="990"/>	✓
six thousand one hundred and fifty six:	<input type="text" value="6115"/>	✗ Answer = 6156
eighty one thousand nine hundred and eighty seven:	<input type="text" value="8987"/>	✗ Answer = 81987
one hundred and twenty two thousand two hundred and nineteen:	<input type="text" value="122219"/>	✓

3. Expanded Notation

913:	<input type="text" value="3x1"/>	+	<input type="text" value="1x10"/>	+	<input type="text" value="9x100"/>	✓
214:	<input type="text" value="1x10"/>	+	<input type="text" value="2x100"/>	+	<input type="text" value="4x1"/>	✓

B. Basic Arithmetic Operations

1. Addition

Two to four random numbers are generated and the user performs the addition of these numbers. If the answer is correct, a tick is displayed otherwise the student has got 2 chances to put the correct answer. If after the three trials the user is still unable to provide the correct answer, the system displays the correct answer.

6885 + 4084	→	6885 + 4084
<input type="text" value="96910"/>		<input type="text" value="10969"/>
<input type="button" value="Retry"/>		✓

2. Subtraction

Two random numbers were generated and the user carries out the subtraction of the numbers.

3. Multiplication

Two random numbers were generated and the user carries out the subtraction of the numbers.

4. Division

Two random numbers were generated and the user carries out the subtraction of the numbers.

C. Factors of a Number

In this exercise, the user must input a number. The program will then write down all the factors of this number.

In this example, the number 26 has four factors namely 1, 2, 13 and 26. If the number 25 was input, the output would have been 1, 5 and 25.

D. Word problems Involving Arithmetic Operations

A question is taken at random from an array of questions and the values in the question are always random.

E. Types of Numbers

Three types of exercises have been implemented to verify whether the user has understood even, odd, prime, composite, square and triangular numbers.

1. Here the word prime is a variable. Next time page is refreshed, the word prime may change to square, odd or even and the numbers as well will change.

2. Here as well, prime is a variable, as well as the starting and ending number.

3. Triangular is the variable and the rank as well. Next time the program is run, you can have something like, "The fourth square number = ".

The fifth triangular number = $1+2+3+4+5$ = 111 ✗ Incorrect Addition ∴ answer = 15

The third triangular number = $1+2$ = 3 ✗ $1+2+3=6$

4. Here the word even is a variable. The number of numbers to be output is also a variable though here it has been constraint to three.

9. Find the sum of 2 consecutive even numbers is 854. Find the two numbers.

Consecutive numbers = 426, 428 ✓

F. Highest Common Factor

2. 60 and 150

60 = $2 \times 2 \times 3 \times 5$

150 = $2 \times 3 \times 5 \times 5$ Retry

∴ H.C.F of 60 and 150 = 5

↓

2. 60 and 150

60 = $2 \times 2 \times 3 \times 5$

150 = $2 \times 3 \times 5 \times 5$ ✓

∴ H.C.F of 60 and 150 = 30

In this example, the program needs to evaluate the HCF of 60 and 150. The user initially enters 5 which is not correct. He is then given another change. The correct is 30.

G. Powers

$11^2 = 11 \times 11 = 121$ ✓

$22 \times 22 \times 22 \times 22 \times 22 = 22^5$ ✗ Answer = 22^5

$32 = 2^5$ ✓

$9^2 \times 9^4 = 9^6$ ✗ Answer = 9^6

$10^8 + 10^4 = 10^8$ ✓

$6 \times (10^5 + 10^3) = 600$ ✓

$10^3 - 8^2 = 936$ ✓

This power topics covers different types of exercises dealing with powers and this will surely allow the student to understand this topic in a much better way than having only kind of exercises with static values. Each time this module is entered, new values appear.

H. Exercises Involving Length Measurement

1. Conversion of Units Length

The aim of this exercise is to test whether a student can convert between different units of length.

$7 \frac{3}{4} \text{ m} = 775 \text{ cm}$ ✓

$1175 \text{ cm} = 11 \frac{3}{4} \text{ m}$ ✓

$5 \frac{1}{2} \text{ cm} = 55 \text{ mm}$ ✓

$169 \text{ mm} = 16.9 \text{ cm}$ ✓

$7 \frac{1}{4} \text{ km} = 7200$ ✗ $7 \frac{1}{4} \text{ km} = 7250 \text{ m}$

$11309 \text{ m} = 11.309 \text{ km}$ ✓

2. Arithmetic Operations on Length

Addition

$\begin{array}{r} 3 \text{ km } 642 \text{ m} \\ 7 \text{ km } 054 \text{ m} \\ + 4 \text{ km } 876 \text{ m} \\ \hline 14 \text{ km } 572 \text{ m} \end{array}$	→	$\begin{array}{r} 3 \text{ km } 642 \text{ m} \\ 7 \text{ km } 054 \text{ m} \\ + 4 \text{ km } 876 \text{ m} \\ \hline 15 \text{ km } 572 \text{ m} \end{array}$
Retry		✓

Subtraction

$\begin{array}{r} 7 \text{ m } 06 \text{ cm} \\ - 2 \text{ m } 39 \text{ cm} \\ \hline 4 \text{ m } 77 \text{ cm} \end{array}$	→	$\begin{array}{r} 7 \text{ m } 06 \text{ cm} \\ - 2 \text{ m } 39 \text{ cm} \\ \hline 4 \text{ m } 77 \text{ cm} \end{array}$
Retry		✗ Answer = 4 m 67 cm

Division

$\begin{array}{r} 4 \overline{) 3 \text{ m } 08 \text{ cm}} \\ \underline{1 \text{ m } 77 \text{ cm}} \\ \hline \end{array}$	→	$\begin{array}{r} 4 \overline{) 3 \text{ m } 08 \text{ cm}} \\ \underline{1 \text{ m } 67 \text{ cm}} \\ \hline \end{array}$
Retry		✗ Answer = 77 cm

3. Word Problems on Length

A question is taken at random from an array of questions and its values are also random. Thus, next time the module is called, another question with different values will appear. It is possible that the same question will come again later but the values will be different.

Shapes like squares, rectangles, triangles and parallelograms are generated from two random numbers and they are then drawn according to a scale. Students then have to enter the correct area. Answers are provided immediately. If the answer is not correct, the correct results are shown.

1. Simla lives 68 m 44 cm away from school. She walks this distance twice a day. Find the distance she walks during 1 school week. Retry

∴ Distance during 1 school week =

↓

1. Simla lives 68 m 44 cm away from school. She walks this distance twice a day. Find the distance she walks during 1 school week.

∴ Distance during 1 school week =

✗

∴ Distance during 1 school week = $68\text{ m }44\text{ cm} \times 2 \times 7 = 958\text{ m }16\text{ cm}$

V. CONCLUSIONS

The aim of this e-learning platform for upper primary students was to present an interactive e-learning tool for students aged from nine to eleven. The system has been made available through a website mainly because online education has become more accessible due to the fact that nowadays most primary schools have a computer laboratory with an internet connection. The interface has been kept intentionally very simple, neat, clear and thus very easy to understand and use.

The unlimited exercises that have been generated in the website will definitely help the students achieve better results. Using this system, we believe that the need for after school tuition will be reduced, such that students will have more time to learn at their own pace and in their own way. We firmly believe that this tool will improve the mathematical skills of our primary students and thus they will fare better at the CPE examination.

Simultaneously, they will also grasp some basic ICT skills. The forum will be used for sharing learning materials among the students and teachers. Many of the exercises have been developed in an innovative. To our knowledge, this is the first interactive tool in Mauritius to cater for the education of primary students. Even on the international scene, there are no free mathematical tools of this nature.

In the future, we intend to broaden the range of exercises available and try to address the whole syllabus. We also intend to work on a similar tool for other subjects like History, Geography and Science.

4. Perimeter

This example shows a situation where a student has entered the incorrect perimeter value. The program provides the answer in some considerable detail.

3. The perimeter of a square garden is 128 m. Find the length of one side of the garden. Retry

∴ Length of 1 side of garden =

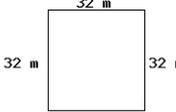
↓

3. The perimeter of a square garden is 128 m. Find the length of one side of the garden.

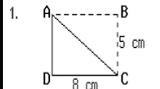
∴ Length of 1 side of garden =

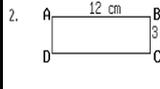
✗

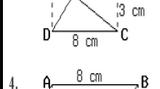
∴ Length of 1 side of garden = $128 / 4 = 32\text{ m}$

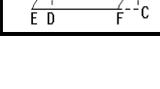


5. Area

1.  Area of triangle = cm² ✓

2.  Area of rectangle = cm² ✓

3.  Area of triangle = cm² ✗ Area = 12 cm²

4.  Area of parallelogram = cm² ✗ Area = 24 cm²

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