# Ceylon Chronicles Game based Education Application for Interactive Learning on History Subject

Isuru Ashinshana, Pawantha Chathuranga, Manoga Wickramarachchi, Dileka Dhanushi
Sri Lanka Institute of Information Technology,
Sri Lanka

*Abstract -* **"Ceylon Chronicles" is a game-based education application developed based on Sri Lankan History in order to enlighten users on history subject in an interactive and digitally mediated learning environment. This application is aimed for students who are in grade ten and eleven to prepare them for the Sri Lankan General Certification of Examination in Ordinary Level (G.C.E O/L). Ceylon chronicles is equipped to provide guidance and information required by both teachers and students to learn history efficiently in the form of a decision-based game. For the past few years examination results for history issued by the department of examination shows a drastic decrease in marks, that contributed to a rise in the number of students who have failed G.C.E O/L in History. With this application students can learn the subject by interacting with the levels that are based on the content of each lesson covered by the syllabus. Immersive learning-based environment of this application has the ability to enhance the learning experience. Teachers can always add new questions directly to the game levels by using the feature called "Question library". With the prediction system, teachers can find the weak students accordingto their marks they score in the game and arrange more work to prepare them to the exam.**

*Keywords - Education, Gamification, Game-based learning, Mix reality.*

## I. INTRODUCTION

Game-based learning applications have become an integrated tool in most of the education systems in developed countries [10]. However, in Sri Lanka the luxury of taking advantage of cutting-edge technologies in our education system is yet to be utilized. "Ceylon Chronicles" is a game-based learning application introduced to learn History subject for students who are bracing to face the G.C.E Ordinary Level examinations. There are plenty of famous education applications on the internet like Byjus's the gaming app, White hat junior and many more. [1] This paper exhibits the unique capabilities of "Ceylon Chronicles" as an acceptable game-based education application different to the already existing game-based education applications. This application is the first ever game-based education application developed to learn History subject based on Sri Lankan history.

This paper reflects the steps and strategies taken to develop "Ceylon Chronicles" in detail under methodology, which distinguish the concepts taken to develop this immersive game-based environment, reaching a millstone in Sri Lankan education system. As mentioned at the beginning, this application consists of a decision-based game flowing from the pre-historic civilization to the modern civilization allowing students to experience the different cultural ethics, kingdoms and rulers, and invasions and how Sri Lanka has drastically changed from each invasion varying from clothing, to language differences to trading systems. The application allows two types of users categorized as students and teachers that provides different capabilities and facilities to fulfill each of their requirements.

Furthermore, this paper discusses on the integration of the theoretical content into the game in an approach that allows students to refer to their relevant textbooks in order to achieve goals in each level in a decision-based approach. Students are categorized based on their initial knowledge in History as beginner, intermediate, expert through a questionnaire. In methodology the paper elaborates further on the prediction algorithm that benefits each student to identify their potential and to work hard towards their goals.

Apart from that, students have the opportunity to learn further on historical concepts and artifacts in an immersive learning-based environment due to the integration of Mix Reality technologies in this application. This feature will be helpful for students to observe our noble history in a realistic manner. Developed application consist of a section that allows teachers to collaborate and to add additional materials, quizzes based on the lessons integrated using Sinhala language and adhered to the syllabus. Furthermore, teachers are also able to analyze student progress and the application is able to provide teachers and students on future progress by the prediction algorithms used by the application that is detailed thoroughly. Therefore, teachers can refer the progress of the students and they can identify the students who requires more engagement to preparation for the exam. High-level diagram of the application is illustrated below (Figure 1.0) that depicts the interaction of each segment.
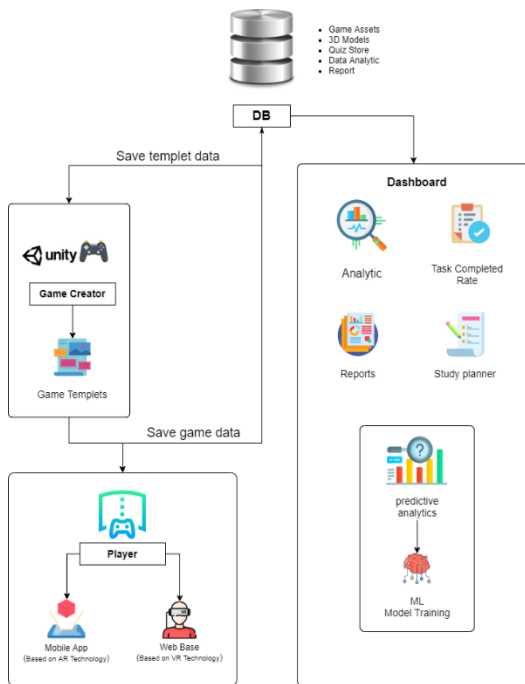
Figure 1.0

## II. BACKGROUND STUDY

Nowadays, technology has become an essential in our daily activities that rose into much formation along with Covid-19 pandemic since 2020[11]. Education is an area that is affected the most with the Covid-19 pandemic [9]. All essential tasks which are carried out, such as: going to school, universities, or going to work, etc. has changed drastically, for currently most of these activities are not able to be caried out the way they have been as such activities has been restricted to online mediums.

Compared to most developed countries, Sri Lanka has had plenty of barriers in fully integrating cutting-edge technologies to the education system [10]. As the government and companies have tried to introduce and implement different varieties of new mechanisms to education systems, but with various issues in the country these mechanisms cannot be implemented effectively. All the areas in the country does not have proper internet coverages, all schools don't have proper facilities, schools require more teachers, and some schools do not even have computer labs and many more. Hence, most of these new methodologies introduced by the government or companies has not gone forward as expected [15]. Therefore, in integrating "Ceylon Chronicles" these challenges are taken into consideration to provide an efficient, uncomplicated learning environment for Sri Lankan students [16].

As per research conducted by the National Research Council on Unites States of America, they have identified for fundamental characteristics that e-learning applications can improve both inside and outside the classroom [17]. According to this article, the first fundamental characteristic 1) is to use engaging production features to motivate children to learn. In

"Ceylon Chronicles" this characteristic is already integrated to the game-based learning application in the form of a strategy-based game; 2) Second characteristic is teaching children to construct their own learning paths with information, this characteristic can be identified in "Ceylon Chronicles" in each student dashboard that allows them to choose their comfortable option in learning history (Story-based game levels, game level-based quiz system, Mix reality based Museum); 3) Encouraging collaborations that facilitate both cognitive and social aspects of learning, by allowing students to engage in quizzes "Ceylon Chronicles" is able to provide students sufficient cognitive based training skills in history and by allowing students to form communities and trough leaderboards social aspects are also integrated in this application; 4) Using storytelling and entertainment features to foster learning outside the classroom, within the game students will be given the opportunity to have an immersive experience based on different time periods in history for each level.

Unlike other theoretical subjects, History has the capacity to provide an immersive learning environment that does not bore students easily and theoretical concepts and facts can be submerged within a story in a game-based learning environment. Game-based learning environments has proven to be effective and ensure that the learners will acquire the specific knowledge and skills the game has intended. Game design elements are able to Conway cognitive, motivational, affective, and social cultural foundations that are integrated with theories from education and psychology. Computer games have also proven to have a positive effect in enhancing students' visual selective attention. [18][19][20]

## III. METHODOLOGY

Ceylon Chronicles is a game created based on Ordinary Level History subject to prepare grade ten and eleven students for the exam. When we are creating this game, we researched about the challenges that teachers and students in Sri Lanka are facing currently, while they are teaching/learning the subject. Following are some key points we have identified.

A. Challenges for teachers:

- In a classroom, there are students with different mindsets. All students cannot understand and memorize the lesson in the same way. Some students can grab them in the very first attempt andsome need more guidance and time. Other problemis they have very limited time but more theories to cover. Covering a large syllabus in a short amount of time for students who are in different knowledgemindsets is a major difficulty they are facing.

- Some theory parts contain more advanced things and teachers require a better way to teach them. Asan example, there is a lesson to teach about parts ofthe lake, by drawing a sketch on the blackboard and teaching referring to it is very hard and cannot be provided with a good explanation.

B.   Challenges for Students:
- Students have nine subjects to study before the Ordinary Level examination and they have less than two years to prepare for the exam. Reading books and memorizing the lessons will not be theeasiest way. Therefore, students require some easy ways to learn the subjects thoroughly.

- Subjects like History have so many theories to cover and so many things to memorize. Due to this reason, students will ignore learning the history subject and as a reason for that, most of the students will fail history examination and it drastically portrays that history subject is one ofthe most failed subjects in Ordinary Level examination for many years.

With all these requirements, we planned our solutions and tried toprovide the best solution we can.

1.   Identify the knowledge level.
As we discussed earlier, students are not in the same intelligence level. Therefore, identifying the rational and irrational students are very important. To solve this problem,we created an entry level exam before the game starts. We provided some general questions regarding the history, and students must face the quiz before they start the game. With thescore they are getting to the quiz, the game will divide them into three categories. Good, Normal and Weak are the three categories. The students are divided in to those three groups according to their marks. Then they can start learning with the game. Inside the game, there are quizzes and other learning materials. The students who are in weak category will have more work and support in the game than Normal and the Good category. The reason for that is, to get those students in the weak category into the same level before the exam. With this method, teachers can teach the lesson to everyone, and assign work separately for the student categories.

2.   Decision based learning system:
By only playing a game, students cannot interpret the elements. We need to implement component to teach them while playing the game. The solution we proposed is to create the game as a decision-based game. With this, students must get different kinds of decision to complete tasks and finish levels. Students must find solutions by reading relevant lessons in the textbooks. Due to this, we can combine both technology and books together. Some parents don't like their children to play games. However, this game would be different. To complete levels, students must read the lesson on the textbooks therefore, the parents does not have to  worry about their children's education.

3.   Editable templates for teachers:
Most of the games do not have the feature to add our content tothe game. But in this game, there is a feature called "Question Library". Question library is a section that provide editable templates for teachers to create their own questions and tasks and add them in to the game. With this feature, teachers can update the game with new questions and tasks.

4.   AR and VR Museum:
In the history textbook, there are so many pictures to describehistorical things. By looking at those images, students cannot get the realistic idea about it, and teachers will also struggle toteach those elements in an easier way to remember. Hence, what is a way for students to see them in a realistic way?
Augmented and Virtual Reality usage is the solution for this question. We implement a museum with historical elements thatstudents can see in a realistic way. This will help them to see the historical elements in a more interactive way and they can get a good idea about those and remember them.

5.   More descriptions:
While playing the game, we provide audio descriptions about each stage they are passing. Therefore, students can learn andunderstand while they are playing the game. This will be a better way to teach the lesson than in a classroom.

6.   Predict student's progress before the exam:
In this game, we provided a machine learning prediction system to predict the student's progress with the marks theyhave gained in the game. With this method, teachers can identify the student's current knowledge level and the studentswho need more assistance before the exam. Thus, they can make revision classes or tutorials to make students more confident and well prepared to the exam.
Multivariate Regression is a supervised machine learning approach that allows for the study of multiple data variables. Multivariate regression is a subset of multiple regression in which the dependent variable is one. We attempt to predict the result based on the number of independent variables.
Machine learning relies on lots of data and cannot function without it. Without a sufficient amount of understanding of this principle, algorithm training is impossible. Regardless of the scale of how strong our artificial intelligence team or database might be, if your data collection is incomplete, the whole ML project will fall short.
Our research wants to estimate the O/L exam result of the students. We've collected details such as the ID of each student, term test results (4 school terms), O/L exam results. Basis these details O/L exam result of the students can be predicted and how each variables are interrelated.
- Implementation
for the implementation, used three main libraries written in the Python.
1.Numpy
2.Pandas
3.Matplolib

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```
data_set.drop(data_set.columns[range(7, 23)], axis = 1, inplace = True)
data_set.head()
```

|   | Student ID | 1st Term | 2nd Term | 3rd Term | 1st Term.1 | AVG | O/L Results |
|---|---|---|---|---|---|---|---|
| 0 | CC0001 | 58.0 | 65.0 | 60.0 | 75.0 | 64.50 | B |
| 1 | CC0002 | 62.0 | 78.0 | 70.0 | 68.0 | 69.50 | A |
| 2 | CC0003 | 40.0 | 43.0 | 40.0 | 52.0 | 43.75 | C |
| 3 | CC0004 | 25.0 | 32.0 | 34.0 | 31.0 | 30.50 | F |
| 4 | CC0005 | 55.0 | 64.0 | 70.0 | 65.0 | 63.50 | B |

*Figure 2.1 - Drop columns with NAN*

If the date column is null or space in the dataset, it is not useful for model training. So, such columns have been removed using the 'drop()' method.

Pandas describe() method is used to view some basic statistical details like percentile, mean, std etc.

Our next task is to separate features and labels from our dataset. Our dataset contains 5 columns.

```
[34] # Fitting Multiple Linear Regression to the Training set
     from sklearn.linear_model import LinearRegression
     regressor = LinearRegression()
     regressor.fit(X_train, y_train)

     LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None, normalize=False)
```

*Figure 2.2 - Model training*

The multi-linear regression model allows an analyst to predict an outcome based on information provided by the multiple explanatory variables.

learn provides the best function for partitioning data into training tests and testing tests. We provide a certain proportion of data to use as a test set and we can provide the parameter random_state to ensure repeatable results. We split 80% of the data to the training set while 20% of data to the test using the below code. The test_size variable is where specify the proposition of the test set.

```
[25] import seaborn as sns

     mtp.figure(figsize = (5,5))
     mtp.tight_layout()
     sns.distplot(data_set['AVG'])
```
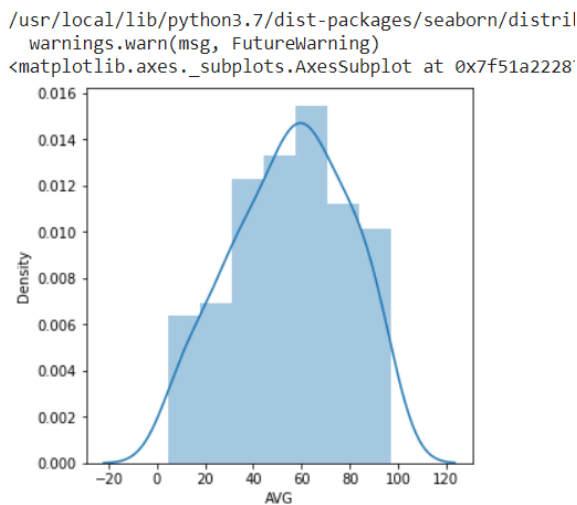
```
/usr/local/lib/python3.7/dist-packages/seaborn/distri
  warnings.warn(msg, FutureWarning)
<matplotlib.axes._subplots.AxesSubplot at 0x7f51a2228
```

*Figure 2.3*

After splitting data into train set and test set, now our job is to train our algorithm. For that, we need to import Linear

Regression to minimize the residual error of squares between the observed target in the dataset and the target predicted by the linear approximation.

Now, call the fit() method along with our training data. After training our algorithm, now time to make some predictions. For this, we are going to use our test data and see how correctly our algorithms predict the percentage score.

```
df1.plot(kind = 'bar', figsize = (8,8))
mtp.grid(which='major', linestyle='-', linewidth='0.5', color='green')
mtp.grid(which='minor', linestyle=':', linewidth='0.5', color='black')
mtp.show()
```
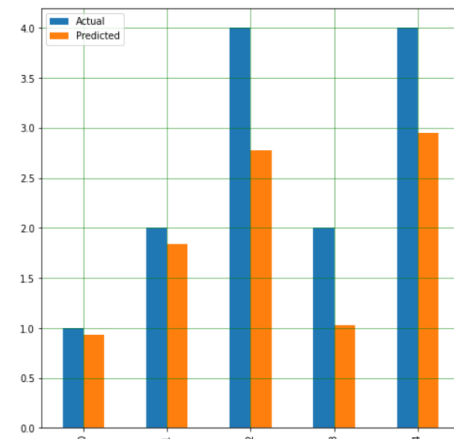
*Figure 2.4 - results between the actual and predicted results*

The bar graph to compare the results between the actual and predicted results. Since the number of record in the database is high, for the visualization, it only shows the data of 5 records.

```
from sklearn import metrics
print('Mean Squared Error:', metrics.mean_squared_error(y_test, y_pred))

Mean Squared Error: 0.47192169883734386
```

*Figure 2.5 - Split data to train and test*

Mean Squared Error: It is the mean of the squared errors which are calculated as:

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(Y_i - y_i)^2$$

## IV. RESULTS AND DISCUSSION

*Figure 3.1*

*Figure 3.3*

*Figure 3.2*

*Figure 3.4*
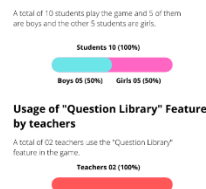
According to the focus group of 10 students (5 Boys and 5 Girls), these are the generated results for; 1) Gameplay accorind to the gender; 2) Game-based vs book-based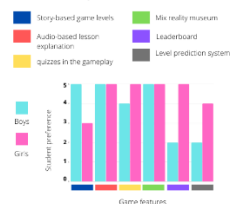 education preference by the students; 3) Interaction with questions; 4) Game feature preference. In Figure 3.1 it delivers the detials about the focus group of 10 students (5 Boys and 5 Girls). In the Figure 3.2 it identifies what is the prefered educated method between game-based education and book-based education. From the focus group of 10 students (100%), 6 students (60%) including 4 boys (40%) and 2 girls (20%) preffers game-based education. Remaining group of 4 students (40%) includes 1 boy (10%) and 3 girls (30%) still preffer book-based education. According to the statistics, game-based education has a clear winner with 60% of student preferance. In the Figure 3.3 it identifies how students are scored for the quizzes in the game. In the first game level, it contain a total of 6 questions. And the same quiz given to the students to answer in the book-based method after the game quiz. According to the results proven by the graph,
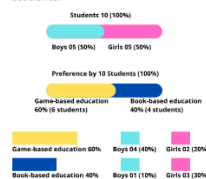
| Question Number | No of students answered correctly (boys) (game-based quiz) | No of students answered correctly (girls) (game-based quiz) | Success rate | No of stuts answered correctly (boys) (book-based quiz) | No of stuts answered correctly (girls) (book-based quiz) | Success Rate |
|---|---|---|---|---|---|---|
| Question 01 | 05/05 (100%) | 05/05 (100%) | 100% | 02/05 (40%) | 03/05 (60%) | 50% |
| Question 02 | 04/05 (80%) | 05/05 (100%) | 90% | 01/05 (20%) | 02/05 (40%) | 30% |
| Question 03 | 04/05 (80%) | 05/05 (100%) | 90% | 01/05 (20%) | 01/05 (20%) | 20% |
| Question 04 | 04/05 (80%) | 04/05 (80%) | 80% | 03/05 (60%) | 04/05 (80%) | 70% |
| Question 05 | 03/05 (60%) | 05/05 (100%) | 80% | 04/05 (80%) | 05/05 (100%) | 90% |
| Question 06 | 04/05 (80%) | 04/05 (80%) | 80% | 02/05 (40%) | 03/05 (60%) | 50% |

Figure 3.5

In game-based quiz session, all the questions have a high successful rate above 80% and both female students (Avg success rate: 93.33%) and male students (Avg success rate: 80%). In book-based traditional quiz session, it provides that how students weak in the book-based method. 4 out of 6 questions have less success rate below 50%. Both female students (Avg success rate: 60%) and male students (Avg success rate: 43.33%) scored in the quizzes. With this results, it conserve game-based quiz system introduce high success rate than book-based quiz system. And graph clearly clarify how male students are weak in book-based education.

Figure 3.4 contains the game feature preference results. According to the results proven by the graph,

| Game Feature | No of female students prefers the feature | No of male students prefers the feature | Preference rate |
|---|---|---|---|
| Story-based game levels | 03/05 (60%) | 05/05 (100%) | 80% |
| Audio-based lesson explain | 05/05 (100%) | 05/05 (100%) | 100% |
| Quizzes in the gameplay | 04/05 (80%) | 05/05 (100%) | 90% |
| Mix reality museum | 05/05 (100%) | 05/05 (100%) | 100% |
| Leaderboard | 03/05 (60%) | 05/05 (100%) | 80% |
| Level Prediction system | 03/05 (60%) | 04/05 (80%) | 70% |

Figure 3.6

Most of the students (both female and male students) existed about the features provided by "Ceylon Chronicles". Female students (Avg preference rate:

76.66%) and Male students (96.66%) are confirming their preference on "Ceylon Chronicles".

## V. CONCLUSION

By gathering all the user results and referring the graphs created with the results of student's interaction with the game, "Ceylon Chronicles" is a successful project and it helps both students and teachers to do the education work in an interactive way on learning History subject.

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