

USING STATISTICAL ANALYSIS ALGORITHM IN ARTIFICIAL INTELLIGENCE FOR ONLINE LEARNING

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ABSTRACT

The assessment outcome for many online learning methods are based on the number of correct answers and then convert it into one final mark or grade. We discovered that when using online learning, we can extract more detail information from the learning process and these information are useful for the assessor to plan an effective and efficient learning model for the learner. Statistical analysis is an important part of an assessment when performing the online learning outcome. The assessment indicators include the difficulty level of the question, time spend in answering and the variation in choosing answer. In this paper we will present the findings of these assessment indicators and how it can improve the way the learner being assessed when using online learning system. We developed a statistical analysis algorithm which can assess the online learning outcomes more effectively using quantifiable measurements. A number of examples of using this statistical analysis algorithm are presented.

KEYWORDS

Artificial Intelligence, Assessment Indicator, Online Learning, Statistical Analysis Algorithm

1. INTRODUCTION

Many online learning assessment systems that use multiple choice approach is based on the correct answers to judge a learner on their understanding of what they have learned [1]. We have carry out various experiments on these quantifiable measurements (assessment indicators) on Mathematics and English subject on different learner groups. With these assessment indicators, assessors and learners can easily assess the online learning performance [2].

We carry out experiments from 100 online voluntary learners from 8 different countries: USA, Canada, United Kingdom, Malaysia, Singapore, Philippines, Thailand and Indonesia. The experiments involved learners from the age between 9 and 10. The experiment questions we have used is the UK National Mathematics Curriculum, Year 5, Geometry topic, multiple choice questions. All 100 online voluntary learners, speak and write fluent English and have knowledge in this Geometry topic.

2. ASSESSMENT INDICATORS AND STATISTICAL ANALYSIS

In this research, we have identified 3 critical assessment indicators which can influence the learners' learning progress and understanding. These 3 assessment indicators have inter-relationships with the underlying final mark from the assessment [3]. At the end of the assessment, the artificial intelligence (AI) engine will analyse all the statistical information from these 3 indicators and provide a recommendation for the assessor and learner.

(1). **Difficulty Level** (measure by the complexity of the questions [4]).

Each question will have the difficulty level embedded. For example, we take a topic in Addition from Mathematics subject. For an Addition topic, we can assign the Difficulty level to these 3 questions depending on the complexity, i.e. $4 + 3 = ?$ (Low Difficulty), $755 + 958 = ?$ (Medium Difficulty) and $7,431,398,214 + 32,883,295 = ?$ (High Difficulty).

Level Terms	Quantitative Measurement
<i>High (hardest)</i>	3
<i>Medium</i>	2
<i>Low (easiest)</i>	1

(2). **Understanding Level** (measure by the time from the question appear to submission).

Each question will have the understanding level embedded. For example, assuming there is a question with Level Term - High (from a to b) where “a = 3 seconds” and “b = 5 seconds”. In this example, if the learner can submit the answer between 3 to 5 seconds after the question appeared than the answer will be assigned 2 points for the Understanding indicator.

Level Terms	Quantitative Measurement
<i>High (from a to b) fastest</i>	2
<i>Medium (from b to c)</i>	1
<i>Low (from c onwards) slowest</i>	0

(3). **Confident Level** (variation in choosing an answer before submission).

For each question, we will capture the behaviour of the learner when choosing an answer before submission [5]. For example, for most learners if they are confident and prudent on choosing the correct answer, they will submit the answer once decided without making any changes. If the learner didn't make any changes when answer this example question, than this answer will be assigned 2 points for the Confident indicator.

Level Terms	Quantitative Measurement
<i>High (no change on first pick)</i>	2
<i>Medium (one change)</i>	1
<i>Low (two changes or more)</i>	0

In this research, we have carry out multiple experiments to evaluate the use of assessment indicators and the statistical information generated when the learner performing the assessment [6][7]. We have conducted 3 detail experiments and the outcomes generated show promising result on the learners' overall learning performance. Below are the 3 experiments summary which we have conducted on 100 online voluntary learners. All marks and indicators have been converted to percentage (%) prior for further analysis by the artificial intelligence engine.

2.1. Experiments

Experiment 1:

20 Multiple Choice Questions (Difficulty level : 1)

Type of questions : Year 5 - UK National Mathematics Curriculum (Topic: Geometry)

Standard marking scheme : Lowest (0 / 20) and Highest (20 / 20) {marks}

Understanding level : Lowest (0 / 40) and Highest (40 / 40) {20 questions x 2 points}

Confident level : Lowest (0 / 40) and Highest (40 / 40) {20 questions x 2 points}
Number of learners involved in this experiment : 100

Summary Results :

- 10% of the learners who cannot move on to Experiment 2 in the 1st attempt, majority of their Understanding level and/or Confident level are under 50%. And the learners are required to have a 2nd attempt.
- In the 2nd attempt, all the remaining 10% learners have successfully move on to Experiment 2 and both indicators show a major improvement and all indicators above 50%.
- 90% of the learners who achieve moving to Experiment 2 in the 1st attempt, have shown promising result of over 50% in both Understanding level and Confident level.

Experiment 2:

20 Multiple Choice Questions (Difficulty level : 2)

Type of questions : Year 5 - UK National Mathematics Curriculum (Topic: Geometry)

Standard marking scheme : Lowest (0 / 20) and Highest (20 / 20) {marks}

Understanding level : Lowest (0 / 40) and Highest (40 / 40) {20 questions x 2 points}

Confidence level : Lowest (0 / 40) and Highest (40 / 40) {20 questions x 2 points}

Number of learners involved in this experiment : 100

Summary Results :

- 23% of the learners who cannot move on to Experiment 3 in the 1st attempt, majority of their Understanding level and/or Confident level are under 50%. And the learners are required to have a 2nd attempt.
- In the 2nd attempt, 17% out of 23% learners have successfully move on to Experiment 3 and both indicators show a major improvement and all indicators above 50%.
- In the 3rd attempt, all the remaining 5% out of 23% learners have successfully move on to Experiment 3 and both indicators show a major improvement and all indicators above 50%.
- 77% of the learners who achieve moving to Experiment 3 in the 1st attempt, have shown promising result of over 50% in both Understanding level and Confident level.

Experiment 3:

20 Multiple Choice Questions (Difficulty level : 3)

Type of questions : Year 5 - UK National Mathematics Curriculum (Topic: Geometry)

Standard marking scheme : Lowest (0 / 20) and Highest (20 / 20) {marks}

Understanding level : Lowest (0 / 40) and Highest (40 / 40) {20 questions x 2 points}

Confidence level : Lowest (0 / 40) and Highest (40 / 40) {20 questions x 2 points}

Number of learners involved in this experiment : 100

Summary Results :

- 56% of the learners who cannot complete the Experiment 3 in the 1st attempt, majority of their Understanding level and/or Confident level are under 50%. And the learners are required to have a 2nd attempt.
- In the 2nd attempt, 19% out of 56% learners have successfully completed the Experiment 3 and both indicators show a major improvement and all indicators above 75%.

- In the 3rd attempt, all the remaining 15% out of 37% (56% - 19%) learners have successfully completed the Experiment 3 and both indicators show a major improvement and all indicators above 75%.
- In the 4th attempt, all the remaining 22% (37% - 15%) learners have successfully completed the Experiment 3 and both indicators show a major improvement and all indicators above 75%.
- 44% of the learners who completed the Experiment 3 in the 1st attempt, have shown promising result of over 75% in both Understanding level and Confident level.

Both the assessment indicators and statistical information stand alone do not have any representations and it is meaningless without others being analysed altogether [8]. Furthermore, in order to have an effective and efficient online learning outcome for the learner, the assessor requires to design and develop the curriculum, learning materials and Q&A using a hybrid integrated model [9]. The curriculum needs to be an all rounded learning blueprint, where learner can improve their understanding in a progressive manner and user-friendly approach.

3. AI RULES

The AI rules define the way the online learning system assigned learning materials and exercises for the learner to follow. These are the basic rules which we have carry out in our experiments, in which we find it effective in improving the learners understanding.

Rule number	Difficulty level	Correct answers (%)	Understanding level (%)	Confident level (%)	Recommendation (Response)
1	1	< 50	Nil	Nil	Repeat the same difficulty level = 1 exercise
2	1	≥ 50	< 50	< 50	Repeat the same difficulty level = 1 exercise
3	1	≥ 50	< 50	≥ 50	Repeat the same difficulty level = 1 exercise
4	1	≥ 50	≥ 50	< 50	Repeat the same difficulty level = 1 exercise
5	1	≥ 50	≥ 50	≥ 50	Move to next difficulty level = 2 exercise
6	2	< 50	Nil	Nil	Repeat the same difficulty level = 2 exercise
7	2	≥ 50	< 50	< 50	Repeat the same difficulty level = 2 exercise
8	2	≥ 50	< 50	≥ 50	Repeat the same difficulty level = 2 exercise
9	2	≥ 50	≥ 50	< 50	Repeat the same difficulty level = 2 exercise
10	2	≥ 50	≥ 50	≥ 50	Move to next difficulty level = 3 exercise
11	3	< 75	Nil	Nil	Repeat the same difficulty level = 3 exercise
12	3	≥ 75	< 50	< 50	Repeat the same difficulty level = 3 exercise
13	3	≥ 75	< 50	≥ 50	Repeat the same difficulty level = 3 exercise
14	3	≥ 75	≥ 50	< 50	Repeat the same difficulty level = 3 exercise
15	3	≥ 75	≥ 50	≥ 50	Move to next topic exercise

Table 1. The AI rules applied in the experiments.

Online learning assessor and learner can modify all the assessment indicators accordingly (depending on various conditions and overall standard requirements) [10].

4. ONLINE LEARNING USING AI SYSTEM

The online learning using AI system include several components which can be integrated as one complete artificial intelligence online learning system [11]. These are the standard components:-

1. Reasoning – It is the set of processes that empowers us to provide basis for judgement, making decisions, and prediction.
2. Learning – It is the activity of gaining information or skill by studying, practising, being educated, or experiencing something. Learning improves the awareness of the subjects of the study.
3. Problem Solving – It is the procedure in which one perceives and tries to arrive at a desired solution from a current situation by taking some path, which is obstructed by known or unknown hurdles.
4. Perception – It is the way of acquiring, interpreting, selecting, and organizing sensory information.
5. Linguistic Intelligence – It is one’s ability to use, comprehend, talk, and compose the verbal and written language. It is significant in interpersonal communication.

The potential of online learning system include 4 factors of accessibility, flexibility, interactivity, and collaboration of online learning afforded by the technology. In terms of the challenges to online learning, 6 are identified: defining online learning; proposing a new legacy of epistemology-social constructivism for all; quality assurance and standards; commitment versus innovation; copyright and intellectual property; and personal learning in social constructivism [12].

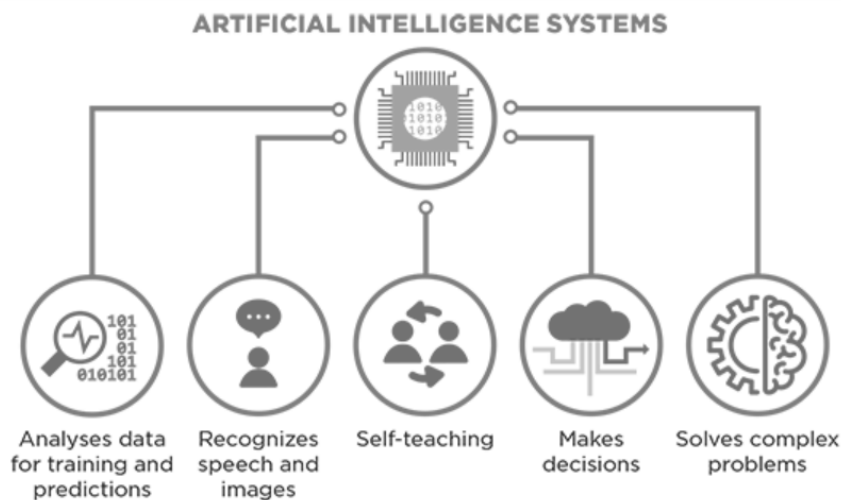


Figure 1. The AI online learning system components.

5. CONCLUSIONS

This paper proposed AI online learning involves 3 stages. Stage One involves design and development of the curriculum with learning materials, Q&A and other assessment indicators. Stage Two involves the implementation of a creative AI rules. And Stage Three involves the user-friendly learning process and analysis operation. This model can generates flexibility when designing and developing the online learning system. The new statistical analysis algorithm with various assessment indicators show promising results in AI online learning and further evaluation and research is in progress.

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