# TEACHING-LEARNING-BASED OPTIMIZATION (TLBO) ALGORITHM FOR ENHANCED CURRICULUM EVALUATION: A FEASIBILITY STUDY

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## Abstract
*In this paper, a feasibility study towards the development of a curriculum evaluation model using Teaching-Learning-Based Optimization (TLBO) was presented. Based on the successes of Computation Intelligence techniques, especially the metaheuristic optimization algorithms in solving complex optimization problems, the application of TLBO for curriculum evaluation was proposed. The teacher-learner process of the algorithm and its performance evaluation function will be harnessed to evaluate the effectiveness of a curriculum. When developed, the algorithm is expected to enhance curriculum development process.*

**Keyword:** Curriculum; Curriculum Evaluation; Computation intelligence; Metaheuristic Optimization Algorithms; Teaching-Learning-Based Optimization

## Introduction
Curriculum has been defined as “all the learning which is planned and guided by the school, whether it is carried on in groups or individually, inside or outside the school” (Hassan, 2013). Curriculum can also be viewed as a the practical activities carried out by teachers in order to pass knowledge to learners, or as knowledge that is needed to be transferred or the process of knowledge transfer (Hassan, 2013). Curriculum has been viewed as the set of courses that are intended to deliver knowledge, values, principles and skills which are consequences of formal education (William & William, 1993). Another view is that curriculum is “what is taught” (Arthur, 1981) while it is viewed as the total active life of each person in college (Harold, 1950). Any curriculum contains an aim, properly arranged contents, guidelines for dealing with the contents, an evaluation system to determine the effectiveness of the curriculum.

Curriculum development is the step-by-step process employed to enhance the courses offered by an educational body such as schools, colleges or universities. The evolving world brings daily changes which must be integrated into the education curricula. Innovative teaching techniques and strategies are constantly being checked in order to improve the student’s learning experience. As a result, institution have to be able to put plans in place for acknowledging shifts and then be able to implement them in the school curriculum (Stutt, 2018) . There are two curriculum development models:

a. **The Product Model:** This type of model is result oriented. It focuses mostly on things like grade; it focuses on the results rather than the students learning process (Stutt, 2018).
b. **The Process Model:** This model focuses on the learning process and how it improves overtime (Stutt, 2018).

There are several approaches to curriculum development, one commonly used approach is shown in Figure 1.

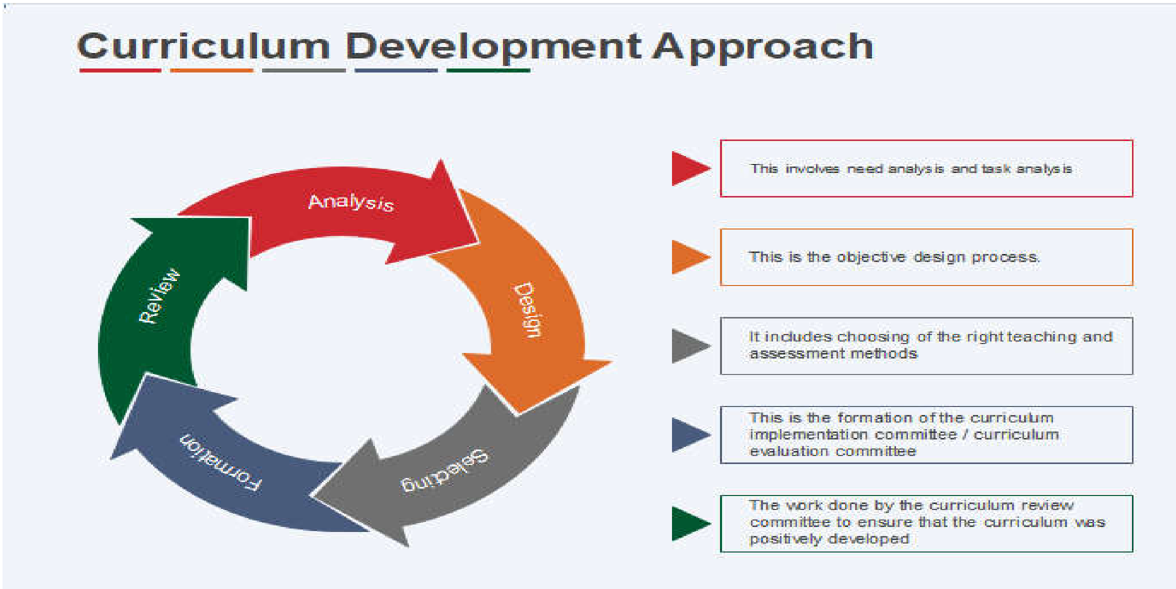


Figure 1; Curriculum development Approach

Curriculum evaluation is an essential part of the whole process of curriculum development. It is a continuous activity and not just performed at the end of the development process. Evaluation essentially is making information available for the sake of influencing decision making at the different stages of curriculum development. This information may involve the whole program or a part of the program. Curriculum evaluation helps in determining the outcome of a program, a programs plausibility, revision of the course/program content and it also gives insight on ways to further develop the course or program. There are three major roles of curriculum evaluation, these are the formative evaluation and summative evaluation. The formative evaluation occurs while the curriculum is being developed while summative evaluation occurs at the end of the evaluation process. Finally, diagnostic evaluation is directed towards two purposes; it can be used to fix students in the correct outset of an instructional level, or to find out the hidden cause of deviancies in student's learning (Farooq, 2018). From these roles of curriculum evaluation, it is evident that to evaluate a curriculum, it has to be administered either during the process or at the end of the process. Improvement and modifications can also be suggested after the initial evaluation process.

This paper proposes the evaluation of a curriculum before it is administered using computational intelligence framework. Computational Intelligence (CI) techniques comprises of algorithms that are inspired by different natural phenomena to solve real-world optimization problems (Xing & Gao, 2013). The curriculum evaluation objective function will be formulated and teaching and learning process will be modelled and simulated. Metaheuristic Optimization Algorithms (MOA) which are one of the most successful CI technique have been successful in solving complex optimization problems (Yang, 2013). One of the key characteristic of population-based MOA is their ability to use multiple search agents which prevent the search agents from getting stuck in local optima. With robust communication among agents inspired by several nature-inspirations, MOA are able balancing between exploitation and exploration which is the key determinant of how successful they are on optimization problem (Abdullahi I. M., Mu'azu, Olaniyi, & Agajo, 2019). MOA are inspired by some nature characteristics like animal behaviors, evolution, ecology and culture, controlled by high level strategies (Bronlee, 2011).

several MOA have been developed to solve several problems optimally, they include; Pastoralist Optimization Algorithm (POA) inspired the nomadic pastoralist herding strategies (Abdullahi I. M., Mu'azu, Olaniyi, & Agajo, 2018), Teaching Learning Based Optimization (TLBO) inspired by teaching-learning process (Rao, Savsani, & Vakharia, 2011) and Imperialist Competitive Algorithm (ICA) inspired by the colonization of empires (Atashpaz-Gargari & Lucas, 2007). MOA are generally classified as Biology-Based Algorithm (BBA), Physics-Based Algorithm (PBA), Chemistry-Based Algorithm (CBA) and Mathematics-Based Algorithm (MBA) (Xing & Gao, 2013.

## 1. Curriculum Evaluation Models.

Some popular curriculum evaluation models which have been widely applied in educational evaluation include the following (Anh, 2018):

### a. Tyler's Objective Model

This model was developed to evaluate student's progress towards some instructional objectives. This was achieved by specifying instructional objectives, collection of performance data and validation of the performance data against the specified objectives. It however ignores process and could not be used to specify the reason a curriculum was not successful (Tyler, 1949).

### b. Stake's Responsive Model

Stake's model focuses on responsive evaluation that focuses more on describing and judging audience information. It place less emphasis on results and more emphasis on program activities. This is done by recording antecedents (existing conditions prior to curriculum evaluation), transactions between teachers and students, students and students, students and curriculum material and finally, students and educational environment. Finally, the outcomes are measured (Stake, 2011).

### c. Scriven's Goal-Free Model

In Scriven's model, the intended and unintended effects of a curriculum are evaluated based on some set needs or objectives (Scriven, 1974). Scriven's identified two roles curriculum evaluation plays:

i. **Formative Evaluation**:

A formative type of evaluation judges the curriculum as it is being used. Using a formative evaluation allows check the progress or impact of the curriculum on a consistent basis, instead of waiting until the end of the school year. Examples of formative evaluation include midterm course evaluations or reviewing summaries (Loop, 2017).

ii. **Summative Evaluation**:

In summative evaluation, the final result of the curriculum are assessed with respect to its stated objectives. It takes place after the curriculum has been fully developed and put into operations (Farooq, 2018).

### d. CIPP Model

CIPP model of evaluation focuses on Context, Input, Process and Product (CIPP) of the programme (Stufflebeam, 2014). The model focuses on decision making which include context evaluation (the what?), Input evaluation (the how?), the process evaluation (the who?) and the product evaluation (the outcome?). The model is very sensitive to feedbacks and provide good alternatives, however, it under-values students input and over-values efficiency.

## 2. Teaching Learning-Based Optimization (TLBO)

TLBO is a nature-inspired population-based MOA that is inspired by the teaching and learning process in a classroom. TLBO mimics the behavior of learners when influence by teachers and the interaction between the learners themselves (Rao, Savsani, & Vakharia, 2011). Being a population-based MOA, a group of learners makes up the population of the algorithm or potential solutions. The variables of the population are represented by the different subjects offered to the learners while the performance of each learner represents the fitness of the optimization problem. TLBO is implemented in two phases:

### 3.1Teacher Phase

In this phase, the teacher tries to bring the learners to his or her knowledge level by raising the mean level of all the learners towards its own level. The best solution or learner becomes the teacher. Given an N number of learners and D size of the search problem, the position of a learner$(X)$, is represented as: $X = (X_i^1, \ldots, X_i^d, \ldots, X_N^D)$ where $X_i^d$ is the position of the i$^{th}$ learner at the d$^{th}$ variable. Let the teacher be represented as $(T)$, and the mean of a class with N learners be represented as:

$$\mu_i = \frac{1}{N}\left(\sum_{i=1}^{N} X_i\right) \quad (1)$$

As the teacher tries to move the mean of the learners from $\mu$ towards its own level $\mu_{new}$, the mean difference is given as:

$$\Delta_i = r_i(\mu_{new} - T_F \mu_i) \quad (2)$$

Where, $r_i$ is a random number in the range [0,1] and $T_F$ is the teaching factor that determines the value of mean to be changed. $T_F$ is heuristically varied between 1 and 2 and is calculated from:

$$T_F = round[1 + rand(0,1)\{2-1\}] \quad (3)$$

The new position of the learners are updated according to:

$$X_{new,i} = X_{old,i} + \Delta_i \quad (4)$$

### 3.2Learner Phase

The learners learns through two processes. First, through the teachers influence and secondly, through the interaction with other learners (Rao, Savsani, & Vakharia, 2011). This is achieved using the pseudocode as shown in Figure 2:

i. ***For*** *i=1: N*
   *Randomly selects two learners* $X_i$ *and* $X_j$: $i \neq j$
   i. ***If*** $f(X_j) > f(X_i)$
      $X_{new,i} = X_{old,i} + r_i(X_i - X_j)$
   ii. ***Else***
      $X_{new,i} = X_{old,i} + r_i(X_j - X_i)$
   iii. ***End if***
ii. ***End for***
iii. *Accepts* $X_{new}$ *if it gives a better result*

Figure 2: Learning from Learners Pseudocode

Figure 3 shows the flowchart of the TLBO algorithm where each of the steps taken on the implementation of TLBO was highlighted.

## 3. Proposed TLBO Curriculum Evaluation Model

In developing the TLBO curriculum evaluation framework, the problem is formulated as an optimization problem where group of students or learners were thought with different curriculum with a view of obtaining the best students or curriculum. The model is shown in Figure 4 and the steps are summarized as follows:

### 4.1 Problem Formulation

The curriculum evaluation problem is formulated as a maximization optimization problem where the fitness function is defined as:

$$F = \max\left(f\left(X_{i,j} * C_{i,j}\right)\right), \qquad (5)$$

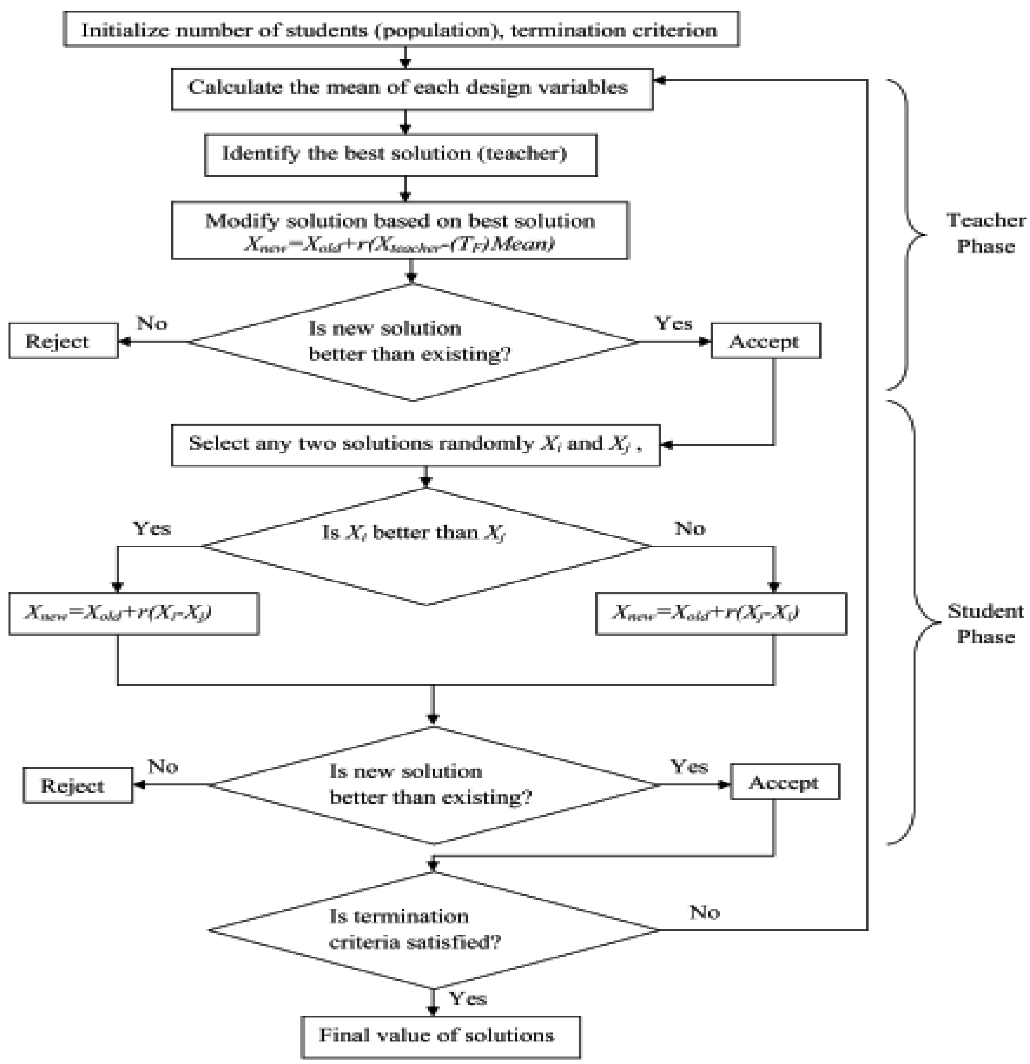


Figure 3: TLBO Flowchart (Rao, Savsani, & Vakharia, 2011)

Subject to:

$$\sum_{j=1}^{M} X_{i,j} = \mathrm{M} \qquad (6)$$

$$\mathrm{Q}_{min} \leq \mathrm{C_j} \leq \mathrm{Q}_{max} \qquad (7)$$

Where, $\mathrm{i} \in \mathrm{N}, \mathrm{j} \in \mathrm{M}$, $C_{i,j} \in \{0,1\}$, N is the total number of students, M is the number of courses for any considered curriculum, $C_{i,j}$ is the course/subject offered by student $i$. Equation (6) is the equality constraint that ensures that all students take a maximum of M courses, while Equation (7) is the inequality constraint that ensures that each course is within a minimum and maximum limit for a given curriculum.

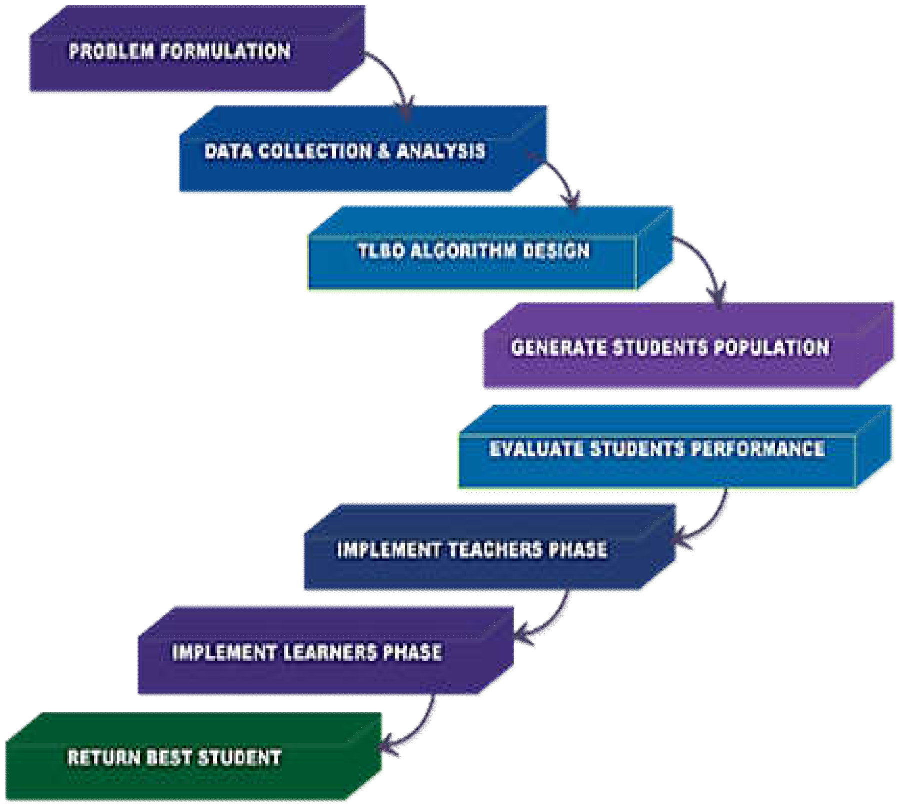


Figure 4: Proposed Curriculum Evaluation Framework

### 4.2 Data Collection & Analysis

The curriculum of different courses at tertiary level will be collected and used for the experiments. Each curriculum will be analyzed to identify the range of changes it can be subjected to and mapped to their respective expected outcome.

### 4.3TLBO Algorithm Design

Here, the algorithm parameters like the population size, maximum iteration and other parameters will be set. This parameters act as a control to guide the convergence of the algorithm towards the best solution. This will be followed by generation and evaluation of each student Performance and the implement teachers and learners phases. The global best solution will then be returned as the best curriculum.

### Conclusion

In this paper, a feasibility study towards the development of a Teaching-Learning-Based Optimization (TLBO) algorithm for enhanced curriculum evaluation was presented. The teaching-learning process of the algorithm will be modelled to suite a given curriculum evaluation process and in turn evaluates the curriculum effectiveness. Different students will be thought with different curriculum and the fitness function will be used to evaluate the fitness of each student. This will likely help in obtaining the best curriculum.

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