



**MwalimuPLUS**

**A Custom-made Intelligent  
Tutoring System  
for Kenyan Students  
and Teachers**

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# Contents

- Executive Summary . . . . .4
- The Teaching-Learning Process in the Digital Age. . . . .5
- An Overview of Our Solution . . . . .7
- Conclusion . . . . .11
- Works cited . . . . .12

# Executive Summary

## Introduction

Incorporating information and communication technology (ICT) in the teaching-learning process is crucial. An Intelligent Tutoring System (ITS) recognizes the learner's behavioural patterns and provides a suitable response to those patterns (Beck & Stern, 1996).

## MwalimuPlus Overview and Benefits

A solution that integrates teaching and technology to help students is MwalimuPlus, a human-like and economical solution that provides individualized learning support and adaptive learning environments.

Here are a few of the key benefits of the MwalimuPlus ITS:

- ✓ Designed with flexibility so it complements teachers and understands different learning styles.
- ✓ Guides and tutors the student with pre-test, post-test, and feedback steps.
- ✓ Improves student understanding with a dynamic problem-solving environment: offers guidance for decisions, while maintaining a record for each student

## Conclusion

MwalimuPlus is pedagogy and technology integrated, allowing teachers to adapt it seamlessly to the teaching-learning process. MwalimuPlus is an efficient and cost-effective solution for Kenyan teachers and students alike.

# The Teaching-Learning Process in the Digital Age

Incorporating information and communication technology (ICT) in the teaching-learning process resolves limitations, improves engagement, deepens knowledge acquisition, and accelerates learning, according to Michael Fullan in his book *Stratosphere* (Fullan, 2013).

A solution that integrates teaching and technology to help students is MwalimuPlus. MwalimuPlus is an economical solution that provides individualized learning support and adaptive learning environments. This system guides and tutors the student and lets teachers remain in control.

## MwalimuPlus, an Intelligent Tutoring System

An Intelligent Tutoring System (ITS) is an instructional procedure that recognizes the learner's behavioural patterns and provides a suitable response to those patterns (Beck & Stern, 1996). The MwalimuPlus ITS provides this support while maintaining the human approach to education. This approach enables the educator to provide the students with a computer-based problem-solving environment that can model learners' progress, track their knowledge and use this data to adapt the instructional session to their individual needs.

With these types of systems, understanding learners' differences is crucial. The MwalimuPlus ITS offers guidance for decisions, while maintaining a record for each student. Our ITS even improves understanding, similar to the effect of expert human tutors (VanLehn, 2011).

## Designed with Flexibility

ITSs are not only dynamic to learning styles but also flexible towards all kinds of learning types. Researchers have developed ITSs for numerous domains. They provide a dynamic problem-solving environment for students to practise and solve questions while the system guides them towards correct answers.

## Technology to Complement Teachers

While ITS-based technologies are effective learning assistants, they are not meant to replace teachers. Many reports in different countries indicate that teachers and teaching strategies should remain at the center of the educational system and no technology can substitute for them (Pil and Leana, 2009). Success of any technological tool in education depends on the attitude towards ICT and how teachers adapt. MwalimuPlus is a case of humans and technology working together.

# An Overview of Our Solution

Our solution for Kenyan students is an ITS tailored to Kenyan curriculum that provides levels of support for learners and teachers. The digital tutor provides numerous problem-solving opportunities for students. It also allows teachers to integrate the learning process with technology but still retain control. Mwalimuplus assist teachers by providing several reporting tools that can help them address concerns and set up students for success.

Mwalimuplus covers mathematical concepts from Grade 1 to Grade 8 based on the Kenyan 8-4-4 curriculum. Each grade contains three terms and the system allows parents or teachers to register students in one of the terms. For example, parents or schools can register students for Term 2 in Grade 7. Then, once students log in for the first time, the system gives a pre-test to evaluate the student's knowledge about concepts in Term 2 of Grade 7. Questions in the pre-test are randomly selected.

When the students solve a problem with a low assistance score, the system increases the complexity of the problem until the score indicates that the students have mastered the concept.

## Measuring Learning Gains

Pre-Test and Post-Tests are used to measure learning gains. Once the pre-test is completed, the system selects a concept and a question for students to solve. The MwalimuPlus system measure a student's performance in solving a problem and determines the types of feedback messages that students get (Najar, Mitrovic, & McLaren, 2016).

The post-test questions, similar to pre-test, are randomly selected from test questions throughout the term. This way, the system can measure students' gain and provide appropriate reports for the teachers and parents who would like to monitor learner's performance.

## Feedback

The system provides different levels of feedback messages:

- ✓ **Simple (positive/negative)**—The lowest level of assistance; informs learners whether their answer was correct or not.
- ✓ **Error flag** —Advises students about the error they made or draw learners attention to what exactly the problem statement is requesting.
- ✓ **Hint** —More explanation is provided to guide the learner.
- ✓ **Work-out example**—Provided once learners request an example. Work-out examples show:
  - ✓ **A complete solution**, which reveals final answers without explaining solutions. It's only available between 30 to 60 seconds after the learners see a problem and submits two incorrect solutions. The waiting time is randomly selected.
  - ✓ **A procedural explanation**, which explains step-by-step how students can reach the final answer. This figure shows a screenshot of a procedural explanation.



### FRACTIONS: Squares Roots of Fractions Involving Perfect Numbers

What is the square root of  $\frac{4}{9}$ ?

=

5

Submit

### Show Me How It's Done?

The numerator is 2.

I'm sure you can solve this problem. Try again!

Do you want to see how it was done?

$$\sqrt{\frac{4}{9}}$$

⇒ Work out the square root of the numerators and denominators separately.

⇒ Express in its prime factors:

$$\sqrt{\frac{4}{9}} = \frac{\sqrt{2 \times 2}}{\sqrt{3 \times 3}}$$

⇒ Pick one number from each pair:

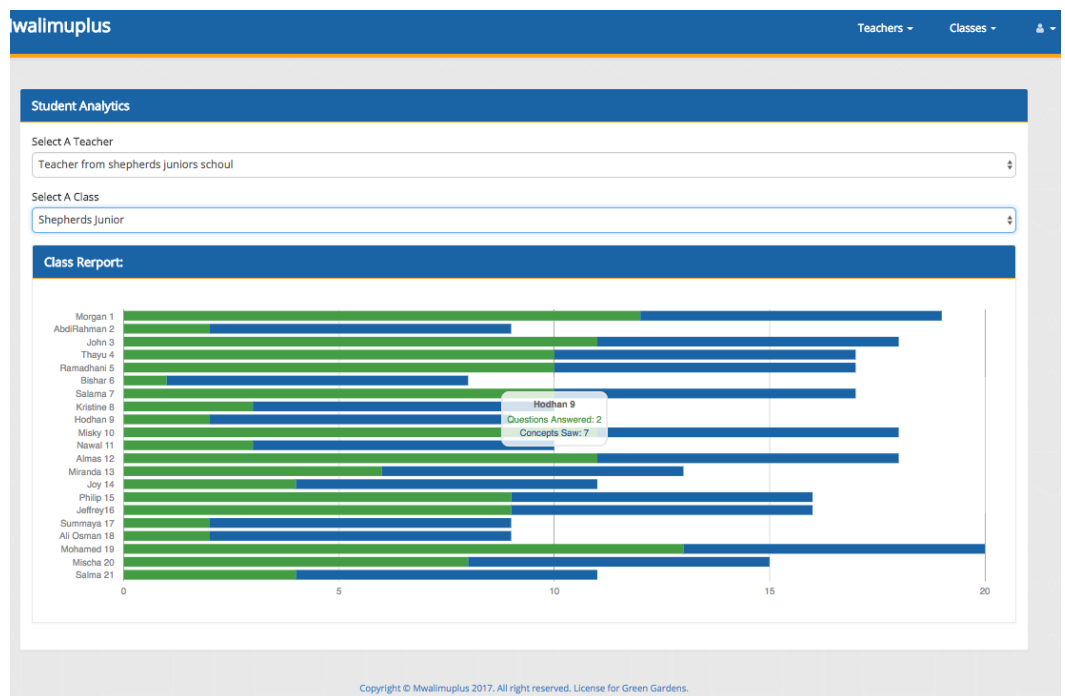
$$= \frac{\sqrt{(2 \times 2)}}{\sqrt{(3 \times 3)}}$$

$$= \frac{2}{3}$$

Show Me Another Hint

## Reports

The reports can assist teachers to spot strength areas in their class and identify areas that require more assistance. The following diagram shows a sample report that shows number of concepts and questions saw in a learning session.



Parents and learners can encourage the learners to repeat a term in the system if their post-test is below a threshold (defined by teachers or parents).

The system automatically selects the best questions and concepts for students to practice, but teachers can also remain in control by defining what students should practice. For instance, teachers can define concepts that students should rehearse between two lessons. The following screenshot shows how teachers can pick concepts associated to the students grade based on Kenyan curriculum.

The screenshot shows a user interface titled "Select the subconcepts available". It contains a list of ten mathematical subconcepts, each with a checkbox on the left. The checked items are highlighted in green, while the unchecked items are in grey. The checked items are: "Addition of Whole Numbers", "Area of Circles and Trapeziums", "Area of Parallelogram practically, Combined shapes and Borders", "Capacity of Cylinders", and "Combined Operation". The unchecked items are: "Addition", "Area of Cross-Section of Regular Solids", "Capacity of Cubes and Cuboids", and "Combined Operation Involving Fractions".

Subconcept	Selected
Addition	Not Selected
Addition	Not Selected
Addition of Whole Numbers	Selected
Area of Circles and Trapeziums	Selected
Area of Cross-Section of Regular Solids	Not Selected
Area of Parallelogram practically, Combined shapes and Borders	Selected
Capacity of Cubes and Cuboids	Not Selected
Capacity of Cylinders	Selected
Combined Operation	Selected
Combined Operation Involving Fractions	Not Selected

# Conclusion

Mwalimuplus is an Intelligent Tutoring System (ITS) designed for flexibility and integrated into Kenyan curriculum. The MwalimuPlus solution improves engagement, supports students by providing individualized feedback messages and an adaptive learning environment. It is pedagogy and technology integrated, allowing teachers to adapt it seamlessly to the teaching-learning process. Mwalimuplus is an efficient and cost-effective solution for Kenyan teachers and students alike

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