

# BUILDING AN AI MATH TUTOR FOR MALAYSIAN FORM 1-3 STUDENTS

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## INTRODUCTION

### Problem Statement

Existing research (Labadze et al., 2023; Moral-Sánchez et al., 2023) confirms that AI chatbots improve engagement and learning outcomes. However, most studies focus on Western curricula, neglecting localized needs. This project bridges the gap by developing CikguAiman, a Mistral-7B-based chatbot fine-tuned on KSSM textbooks, to provide syllabus-specific, step-by-step math assistance.

### Background & Motivation

Mathematics remains one of the most challenging subjects for Malaysian secondary school students. Studies indicate that large class sizes, limited access to personalized tutoring, and high anxiety levels contribute to poor performance (Khoo et al., 2024). While AI-powered tutoring tools (e.g., Photomath, Khan Academy) exist, they lack alignment with Malaysia's KSSM syllabus, leaving students without tailored support.

### Research Objectives

- Develop an AI chatbot trained on Form 1-3 KSSM math content.
- Evaluate its accuracy in solving problems across algebra, geometry, and arithmetic.
- Identify limitations (e.g., response time, conceptual errors) and propose improvements.

### Key Literature

- Labadze et al. (2023) - Chatbots enhance personalized learning and reduce anxiety.
- Cheng et al. (2024) - Step-by-step explanations improve problem-solving skills.
- Khoo et al. (2024) - Highlights math anxiety as a critical barrier in Malaysian students.

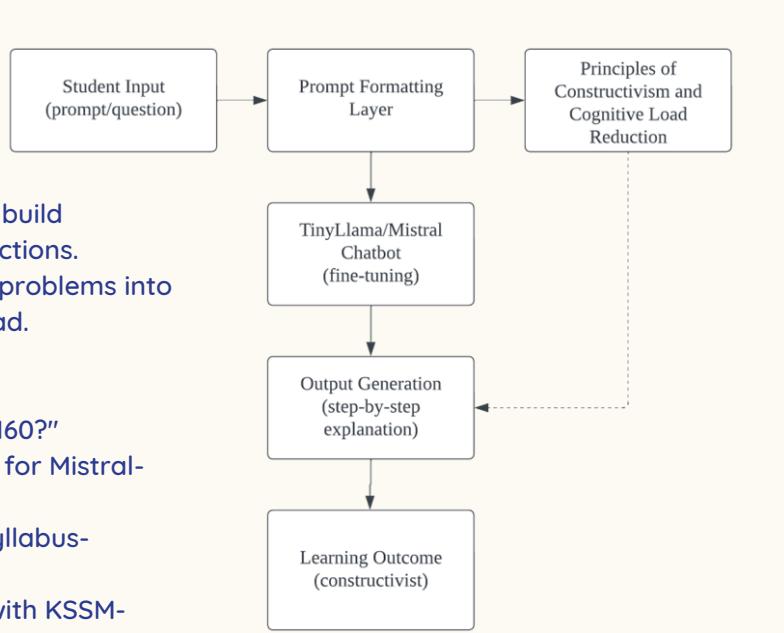
## FRAMEWORK

### Educational Theories

- Constructivism: Students actively build knowledge through guided interactions.
- Cognitive Load Theory: Breaking problems into sub-steps reduces mental overload.

### Technical Pipeline

- Student Input → "What is 25% of 160?"
- Prompt Formatting → Structured for Mistral-7B's fine-tuned dataset.
- Model Processing → Generates syllabus-aligned explanations.
- Output → Step-by-step solution with KSSM-relevant reasoning.



## RESEARCH METHODOLOGY

### 1. Data Collection & Preparation

- Source: KSSM Form 1-3 textbooks (1,000+ prompt-response pairs).
- Format: JSONL-structured

### 2. Model Development

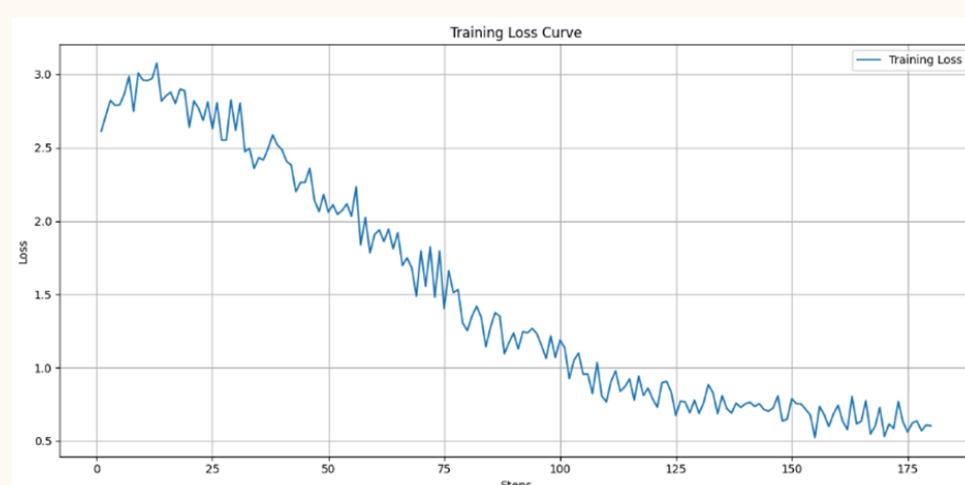
- Base Model: Mistral-7B-Instruct (7B parameters).
- Fine-Tuning: Unslot framework (Ubuntu 24.04, GTX 3050).
- Deployment: Local hosting via Ollama; interface with Open WebUI.

### 3. Testing & Evaluation

- 20 Test Questions: Algebra, geometry, statistics.
- Metrics: Accuracy, response clarity, latency.

NOTE: No human participants; only textbook-derived data.

## FINDINGS & RESULTS



Step Range	Min. Loss	Max. Loss	Average Loss (Mean)
1-30	2.5515	3.0759	2.804923
31-60	1.7823	2.8051	2.251666
61-90	1.0949	1.9444	1.532360
91-120	0.7673	1.2677	1.001966
121-150	0.6357	0.9065	0.755083
151-180	0.5234	0.8041	0.651256

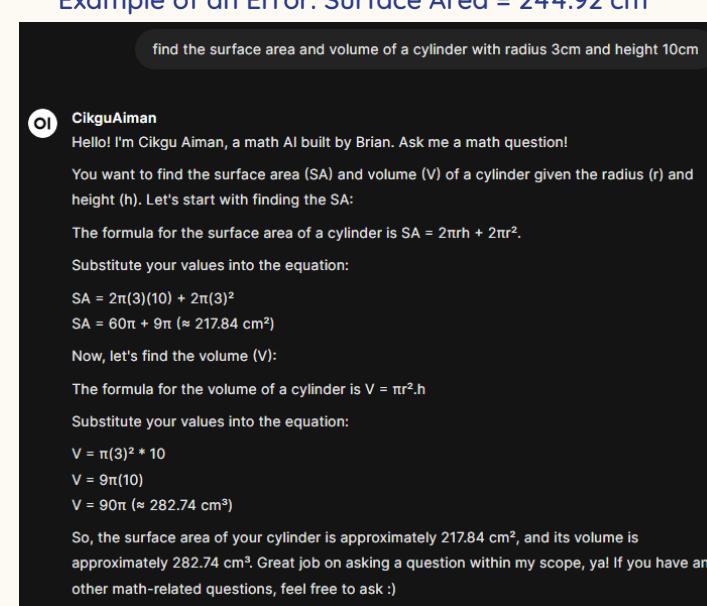
### METRIC

- Accurate Responses
- Partially Correct
- Errors (Incorrect Responses)
- Latency

### RESULTS

- 30% out of 20 curated questions
- 15% but overcomplicated
- 55% (Incorrect solutions; misunderstanding)
- 5-7 minutes per response (CPU overclocking)

### Example of an Error: Surface Area = 244.92 cm<sup>2</sup>



## DISCUSSION

### Performance Analysis

#### Accuracy Breakdown:

- 30% fully correct answers
- 15% partially correct but overly complex explanations
- 55% incorrect responses

#### Response Quality

- Strengths: Clear step-by-step solutions for straightforward problems
- Weaknesses: Tendency to overcomplicate simple questions and hallucinate on abstract topics

### Technical Challenges

#### Hardware Limitations:

- Local GPU constraints (GTX 3050, 4GB VRAM)
- Slow response times (5-7 minutes per query)
- Inability to track validation loss during training

## CONCLUSION

This study confirms that while AI tutors like 'CikguAiman' can supplement classroom learning for basic KSSM math topics, their current limitations in accuracy, response clarity, and hardware dependence necessitate further development. Strategic investments in dataset diversity, cloud infrastructure, and multimodal features could transform the system into a viable tool for Malaysian students, particularly in underserved areas. Future work should prioritize teacher collaborations and real-classroom trials to refine the chatbot's pedagogical effectiveness.

#### Recommendations for Improvement:

- Dataset Enhancement: Incorporate common student errors and misconceptions to improve conceptual accuracy.
- Cloud-Based Scaling: Migrate to AWS EduLab (RM70/month) to reduce latency to <1 minute.
- Multimodal Integration: Add diagrams for geometry, leveraging visual learning (Acosta et al., 2022).