សន្និសីទស្រាវជ្រាវថ្នាក់ជាតិលើកទី១ ឆ្នាំ២០២៦

The 1st National Research Conference 2026

«ប្រសិទ្ធភាពនៃការសិក្សាបែបចម្រុះដោយប្រើគំរូ Lab Rotation ទៅលើលទ្ធផលសិក្សារបស់សិស្ស ក្នុងមុខវិជ្ជាវិទ្យាសាស្ត្រ នៅកម្រិតមធ្យមសិក្សា ក្នុងប្រទេសកម្ពុជា៖ ការសាកល្បងគ្រប់គ្រងដោយការបែងចែកចៃដន្យ (Randomized Controlled Trial)»

Effectiveness of Blended Learning Using the Lab Rotation Model on Students' Achievement in Secondary School Science Education in Cambodia: A Randomized Controlled Trial

Presented by: **CHHUM Lina, 16th June, 2026**

Contents

Overview

Objective: ការសិក្សាស្រាវជ្រាវអំពីប្រសិទ្ធភាពនៃការសិក្សាបែបចម្រុះដោយប្រើគំរូ Lab-Rotationលើសមិទ្ធផលសិក្សា និងឥរិយាបថរបស់សិស្សនៅវិទ្យាល័យព្រះអង្គឌួង។

Treatment	Lab Rotation Model of Blended Learning ▪ *1: Treatment group (Lab Rotation Model Classroom)* ▪ *0: Control group (Traditional Classroom)*
Outcomes	▪ Student's Achievements (amount of score) ▪ Student's Attitude (1: Positive / 0: Negative)
Unit of analysis	Student In Grade 11th ▪ *Sampling 96* ▪ *Number rote out of 32* ▪ *Total = 64 students including the control group = 32 students and the treatment group = 32 students)* ▪ *Timeline: 3 weeks from 14.12.2024 to 04.01.2025*
Identification strategy	Randomized Controlled Trials (RCT) *Covariates:* Age, Gender, Device Access(Computer and Tablet), Internet, Computer Anxiety)
Results	▪ Student's Achievement (+) ▪ Student's Attitude (+)

1- Introduction

ប្រទេសកម្ពុជាបាននិងកំពុងធ្វើទំនើបកម្មប្រព័ន្ធអប់រំរបស់ខ្លួន តាមរយៈការដាក់ឱ្យប្រើប្រាស់ឧបករណ៍ឌីជីថល មន្ទីរពិសោធន៍កុំព្យូទ័រ និងកម្មវិធីបណ្តុះបណ្តាលគ្រូបង្រៀន។ ការប្រើប្រាស់បច្ចេកវិទ្យាព័ត៌មាន និងសារគមនាគមន៍ (ICT) នៅក្នុងសាលាមធ្យមសិក្សាបានកើនឡើងពី 10% ក្នុងឆ្នាំសិក្សា 2018–2019 ដល់ 26.68% ក្នុងឆ្នាំសិក្សា 2022–2023 ស្របតាមកំណែទម្រង់របស់រាជរដ្ឋាភិបាល ដូចជាផែនការយុទ្ធសាស្ត្រវិស័យអប់រំ (Education Sector Strategic Plan: ESSP) 2024–2028។ កំណែទម្រង់ទាំងនេះមានគោលបំណងអភិវឌ្ឍជំនាញសតវត្សទី២១ និងលើកកម្ពស់ការបញ្ចូលបច្ចេកវិទ្យាទៅក្នុងការបង្រៀនក្នុងថ្នាក់រៀន និងការកែលម្អលទ្ធផលសិក្សារបស់សិស្ស។ទោះបីជាមានការរីកចម្រើនទាំងនេះក៏ដោយ ក៏នៅតែមានបញ្ហាប្រឈមសំខាន់ៗមួយចំនួន រួមមាន៖

• គុណភាពគ្រូបង្រៀនទាប៖ គ្រូបង្រៀននៅកម្រិតមធ្យមសិក្សាជាច្រើននៅកម្ពុជាមិនទាន់មានគុណវុឌ្ឍិគ្រប់គ្រាន់ ដែលបណ្តាលឱ្យការបង្រៀនមានប្រសិទ្ធភាពទាប និងលទ្ធផលសិក្សារបស់សិស្សមិនទាន់ល្អប្រសើរ (GEM Report UNESCO, 2023; Pen & Morrell, 2024; UNICEF Cambodia, 2025)។

• ការបណ្តុះបណ្តាលគ្រូបង្រៀនផ្នែកគរុកោសល្យឌីជីថលនៅមានកម្រិត៖ ទោះបីជាសាលារៀនមានហេដ្ឋារចនាសម្ព័ន្ធ ICT ក៏ដោយ គ្រូបង្រៀនភាគច្រើននៅតែខ្វះជំនាញជាក់ស្តែងក្នុងការបញ្ចូលបច្ចេកវិទ្យាទៅក្នុងការបង្រៀន (GEM Report UNESCO, 2023; Ministry of Education, Youth and Sport, 2019)។

1- Introduction

• ថ្នាក់រៀនមានសិស្សច្រើន និងសមាមាត្រសិស្ស-គ្រូខ្ពស់៖ សាលារដ្ឋមានសិស្សជាមធ្យមប្រមាណ 42 នាក់ក្នុងមួយថ្នាក់ បើប្រៀបធៀបនឹង 32 នាក់ក្នុងសាលាឯកជន ហើយសមាមាត្រសិស្ស-គ្រូមានចន្លោះពី 23.5:1 ដល់ 29:1 ដែលធ្វើឱ្យការអនុវត្តវិធីសាស្ត្របង្រៀនផ្តោតលើសិស្សជាមជ្ឈមណ្ឌលមានការលំបាក (Lattanavong et al., 2022; MoEYS, 2022; Thy Savrin et al., 2023)។

• សមិទ្ធផលសិក្សាទាប និងអត្រាបោះបង់ការសិក្សា៖ ការអនុវត្តការបង្រៀនដែលមិនទាន់មានប្រសិទ្ធភាព និងស្ថានភាពថ្នាក់រៀនដែលមានសិស្សច្រើន បានរួមចំណែកធ្វើឱ្យសមិទ្ធផលសិក្សាផ្នែកវិទ្យាសាស្ត្ររបស់សិស្សមានកម្រិតទាប និងបង្កើនអត្រាបោះបង់ការសិក្សា (Ministry of Education, Youth and Sport & UNICEF Cambodia, 2024)។

• ការសិក្សាបែបចម្រុះ (Blended Learning) ជាពិសេសគំរូ Lab Rotation Model អាចជួយដោះស្រាយបញ្ហាប្រឈមទាំងនេះបាន តាមរយៈការបញ្ចូលគ្នារវាងការបង្រៀនផ្ទាល់ក្នុងថ្នាក់ និងការរៀនដោយប្រើបច្ចេកវិទ្យាឌីជីថល។ គំរូនេះអាចប្រើប្រាស់មន្ទីរពិសោធន៍កុំព្យូទ័រ និងធនធាន ICT ដែលមានស្រាប់ប្រកបដោយប្រសិទ្ធភាព គាំទ្រដល់ការរៀនដែលមានភាពបត់បែន និងអន្តរកម្មខ្ពស់ ព្រមទាំងជួយលើកកម្ពស់ការគ្រប់គ្រងថ្នាក់រៀននៅក្នុងបរិបទដែលមានសិស្សច្រើន។

1- Introduction

• ការសិក្សានៅកម្រិតអន្តរជាតិជាច្រើនបានបង្ហាញថា ការសិក្សាបែបចម្រុះ និងជាពិសេសគំរូ Lab Rotation មានប្រសិទ្ធភាពក្នុងការលើកកម្ពស់សមិទ្ធផលសិក្សាផ្នែកវិទ្យាសាស្ត្រ អាកប្បកិរិយាក្នុងការរៀន ការគិតបែបវិភាគ និងដោះស្រាយបញ្ហា (Critical Thinking) ព្រមទាំងជំនាញឌីជីថលរបស់សិស្ស ជាពិសេសនៅក្នុងបរិបទដែលមានធនធានកំណត់ (Alim et al., 2024; Alsalhi et al., 2019; Horn & Staker, 2015)។ទោះបីជាប្រទេសកម្ពុជាមានគោលនយោបាយ និងការគាំទ្រយ៉ាងខ្លាំងចំពោះការប្រើប្រាស់បច្ចេកវិទ្យាក្នុងការអប់រំក៏ដោយ ក៏នៅតែមានភស្តុតាងស្រាវជ្រាវជាក់ស្តែង (Empirical Evidence) នៅមានកម្រិតអំពីឥទ្ធិពលនៃការសិក្សាបែបចម្រុះ ជាពិសេសគំរូ Lab Rotation Model ទៅលើសមិទ្ធផលសិក្សា និងអាកប្បកិរិយារបស់សិស្សនៅកម្ពុជា។

ដូច្នេះការសិក្សានេះមានគោលបំណងផ្តល់ភស្តុតាងជាក់ស្តែងដែលមានលក្ខណៈបច្ចាញ្ញធំនាក់ធំនចហេតុ និងផល (Causal Evidence) អំពីប្រសិទ្ធភាពនៃការអនុវត្តការសិក្សាបែបចម្រុះដោយប្រើគំរូ Lab Rotation Model ទៅលើសមិទ្ធផលសិក្សា និងអាកប្បកិរិយារបស់សិស្ស តាមរយៈការប្រើប្រាស់វិធីសាស្ត្រសាកល្បងដោយការចាត់តាំងដោយចៃដន្យ (Randomized Controlled Trial: RCT) នៅកម្រិតមធ្យមសិក្សាក្នុងប្រទេសកម្ពុជា។ លទ្ធផលនៃការសិក្សានេះនឹងផ្តល់ជាភស្តុតាង និងគំរូនៃការរៀននិងបង្រៀន សម្រាប់គាំទ្រដល់ការសម្រេចចិត្ត របស់លោកគ្រូ អ្នកគ្រូ នាយក ថ្នាក់ដឹកនាំ និងការរៀបចំគោលនយោបាយកំណែទម្រង់វិស័យអប់រំនាពេលអនាគត ស្របតាមទិសដៅរបស់ក្រសួងអប់រំ យុវជន និងកីឡា និងផែនការយុទ្ធសាស្ត្រវិស័យអប់រំ 2024–2028 (MoEYS & CDRI, 2021; ESSP 2024–2028)។

1- Introduction

- Cambodia has recently modernized its education system by introducing digital tools, computer labs, and teacher training. ICT use in secondary schools increased from 10% in 2018–2019 to 26.68% in 2022–2023, following government reforms like the Education Sector Strategic Plan (ESSP) 2024–2028. These reforms aim to develop 21st-century skills and improve technology integration in the classroom and learning outcomes.

Major challenges that remain include:

- **Low teacher quality:** Many Cambodian secondary school teachers are underqualified, leading to weak instructional delivery and poor learning outcomes (GEM Report UNESCO, 2023; Pen & Morrell, 2024; UNICEF Cambodia, 2025).
- **Limited teacher training in digital pedagogy:** Although ICT facilities exist, most teachers lack practical skills to integrate technology into teaching (GEM Report UNESCO, 2023; Ministry of Education, Youth and Sport, 2019).
- **Overcrowded classrooms and high student-teacher ratios:** Public schools average 42 students per class compared to 32 in private schools, with ratios ranging from 23.5:1 to 29:1, making student-centered approaches difficult (Lattanavong et al., 2022; MoEYS, 2022; Thy Savrin et al., 2023).
- **Low student achievement and dropout rates:** Poor teaching practices and overcrowded conditions have contributed to low performance in science and increased dropout rates (Ministry of Education, Youth and Sport & UNICEF Cambodia, 2024).

1- Introduction: Problem Statement (con.)

- Blended learning, especially the **Lab Rotation Model**, could address these challenges by combining face-to-face teaching with digital learning. This model effectively utilizes ICT labs, supports flexible and interactive learning, and improves classroom management in large classes.

- **International studies** have demonstrated their effectiveness in enhancing science achievement, attitude, critical thinking, and digital skills, particularly in low-resource contexts (Alim et al., 2024; Alsalhi et al., 2019; Horn & Staker, 2015). Despite strong policy support in Cambodia, **there remains limited empirical evidence** on how blended learning—particularly the Lab Rotation Model affects student achievement and attitudes.

- This study aims to provide **empirical evidence** **(Causal results)** for implementing the blended learning-lab rotation model on students' achievement and attitudes by using a randomized controlled trial in Cambodia, specifically in secondary schools, providing evidence to inform future education reforms (MoEYS & CDRI, 2021; ESSP 2024–2028).

1- Introduction:1.2 Research Objective

វត្ថុបំណង៖ការសិក្សាស្រាវជ្រាវអំពីប្រសិទ្ធភាពនៃការសិក្សាបែបចម្រុះដោយប្រើគំរូ Lab-Rotationលើសមិទ្ធផលសិក្សា និងឥរិយាបថរបស់សិស្សនៅវិទ្យាល័យព្រះអង្គឌួងតាមរយៈការប្រើប្រាស់វិធីសាស្ត្រ**ការសាកល្បងគ្រប់គ្រងដោយការបែងចែកចៃដន្យ** (Randomized Controlled Trial)។

The research objective is to investigate the effectiveness of blended learning on students' achievement and attitudes at Preah Angduong Secondary School using evidence from a **Randomized Controlled Trial**.

1- Introduction:1.3 Research Questions

សំណួរស្រាវជ្រាវ

សំណួរទី១ ៖ តើការសិក្សាបែបចម្រុះ (Blended Learning) មានឥទ្ធិពលយ៉ាងដូចម្តេចទៅលើសមិទ្ធផលសិក្សារបស់សិស្សថ្នាក់ទី ១១ ក្នុងមុខវិជ្ជាវិទ្យាសាស្ត្រផែនដី (Earth Science) ?

សំណួរទី២ ៖ តើសិស្សថ្នាក់ទី១១ មានអាកប្បកិរិយាយ៉ាងដូចម្តេចចំពោះការសិក្សាបែបចម្រុះ (Blended Learning) ក្នុងមុខវិជ្ជាវិទ្យាសាស្ត្រផែនដី (Earth Science) ?

Q1: What is the effect of blended learning on Grade 11 students' achievement in Earth Science?

Q2: What are Grade 11 students' attitudes toward blended learning in Earth Science?

1- Introduction: 1.4 Study Hypotheses

According to the main questions, this study formulated the hypotheses for testing as follows:

Research Question 1:

- Null hypothesis: no significant difference between the post-test achievement of the blended learning group and the traditional learning group.
- Alternative hypothesis: a significant difference between the post-test achievement of the blended learning group and the traditional learning group.

Research Question 2:

- Null hypothesis: no significant difference between the students' attitudes of the blended learning group and the traditional learning group.
- Alternative hypothesis: a significant difference between the students' attitudes of the blended learning group and the traditional learning group.

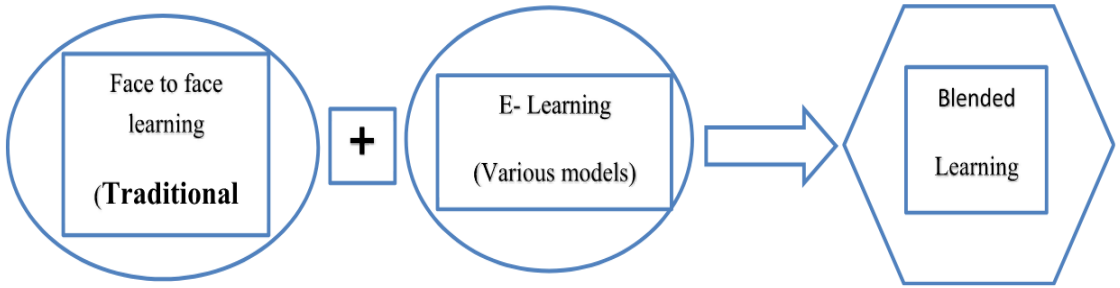
1- Introduction: 1.5 Significance of the study

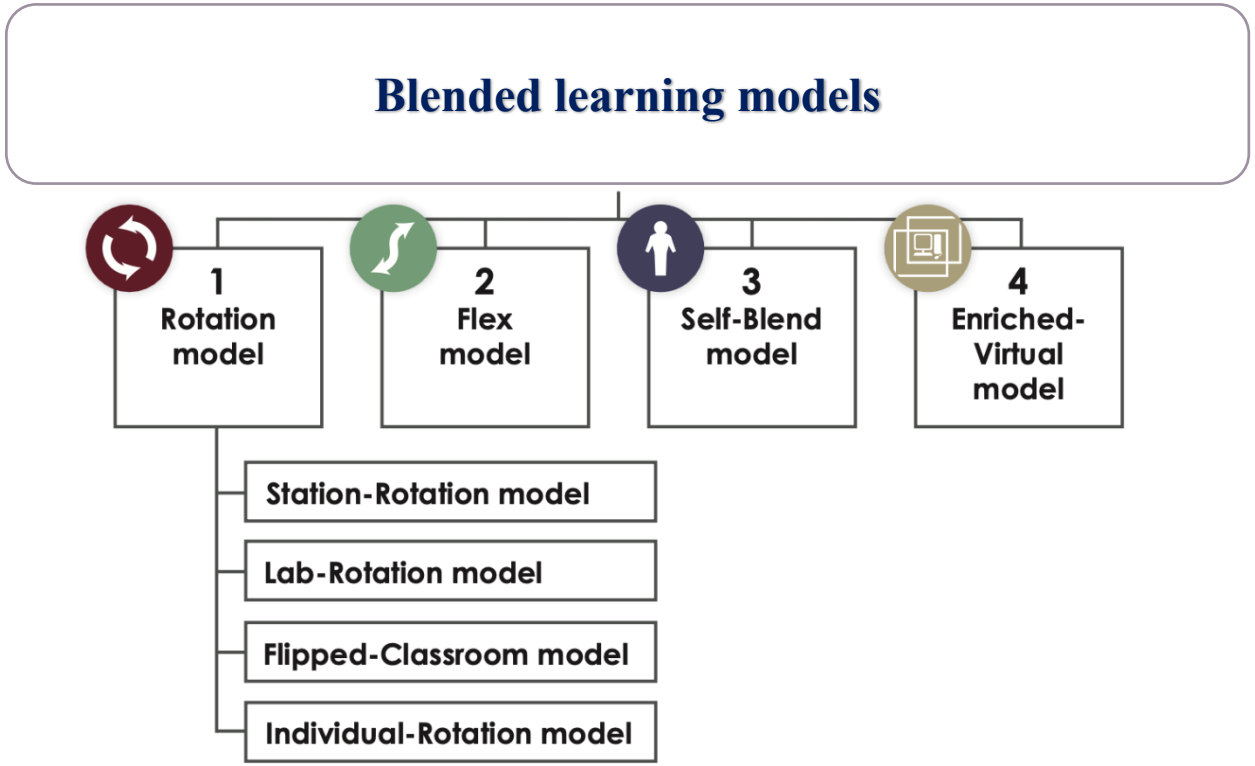
- **ការលើកកម្ពស់ការរៀនផ្តោតលើសិស្សជាមជ្ឈមណ្ឌល (Student-Centered Learning)**:ការសិក្សាបែបចម្រុះដោយប្រើគំរូ Lab Rotation ជួយលើកទឹកចិត្តឱ្យសិស្សចូលរួមយ៉ាងសកម្មក្នុងដំណើរការរៀន ស្របតាមតម្រូវការ និងសមត្ថភាពរៀនរបស់បុគ្គលម្នាក់ៗ ខណៈពេលដែលប្រើប្រាស់ហេដ្ឋារចនាសម្ព័ន្ធឌីជីថលដែលមានស្រាប់ឱ្យមានប្រសិទ្ធភាពខ្ពស់។
- **ការដោះស្រាយបញ្ហាការប្រើប្រាស់ហេដ្ឋារចនាសម្ព័ន្ធមិនទាន់អស់សក្តានុពល:**ទោះបីជាសាលាមធ្យមសិក្សាជាច្រើននៅកម្ពុជាមានមន្ទីរពិសោធន៍កុំព្យូទ័រ និងបរិក្ខារ ICT ក៏ដោយ ក៏ធនធានទាំងនេះមិនទាន់ត្រូវបានប្រើប្រាស់ឱ្យអស់សក្តានុពលនៅឡើយ ដោយសារកង្វះគំរូគរុកោសល្យដែលមានរចនាសម្ព័ន្ធច្បាស់លាស់។ គំរូ Lab Rotation ផ្តល់នូវក្របខណ្ឌអនុវត្តជាក់ស្តែង ដោយរួមបញ្ចូលការបង្រៀនផ្ទាល់ក្នុងថ្នាក់ជាមួយការរៀនតាមកុំព្យូទ័រតាមកាលវិភាគ ដែលអាចជាដំណោះស្រាយសមស្របចំពោះបញ្ហានេះ។
- **ការឆ្លើយតបទៅនឹងបញ្ហាប្រឈមក្នុងវិស័យអប់រំ:**គំរូ Lab Rotation អាចជួយដោះស្រាយបញ្ហាសំខាន់ៗក្នុងវិស័យអប់រំនៅកម្ពុជា ដូចជាគុណវុឌ្ឍិគ្រូបង្រៀននៅមានកម្រិត និងទំហំថ្នាក់រៀនដែលមានសិស្សច្រើន ជាពិសេសនៅកម្រិតមធ្យមសិក្សា។
- **ការគាំទ្រដល់ការអប់រំឌីជីថលនៅកម្ពុជា:**គំរូ Lab Rotation មានភាពស្របគ្នាជាមួយនឹងទិសដៅរបស់ប្រទេសកម្ពុជាក្នុងការអភិវឌ្ឍប្រព័ន្ធអប់រំឌីជីថល ដោយជួយសម្រួលដល់ការបញ្ចូលបច្ចេកវិទ្យាឌីជីថលទៅក្នុងដំណើរការបង្រៀន និងរៀននៅក្នុងថ្នាក់រៀន។
- **ការចូលរួមចំណែកដល់គោលនយោបាយ និងការអនុវត្ត:**ការសិក្សានេះនឹងផ្តល់នូវភស្តុតាងផ្អែកលើទិន្នន័យស្រាវជ្រាវ (Evidence-Based Insights) អំពីរបៀបដែលគំរូ Lab Rotation អាចជួយលើកកម្ពស់សមិទ្ធផលសិក្សា និងអាកប្បកិរិយារបស់សិស្ស។លទ្ធផលនៃការសិក្សានឹងរួមចំណែកដល់ការរៀបចំគោលនយោបាយ និងការអនុវត្តជាក់ស្តែង ដើម្បីសម្រេចគោលដៅអប់រំឌីជីថលរបស់ប្រទេសកម្ពុជា។

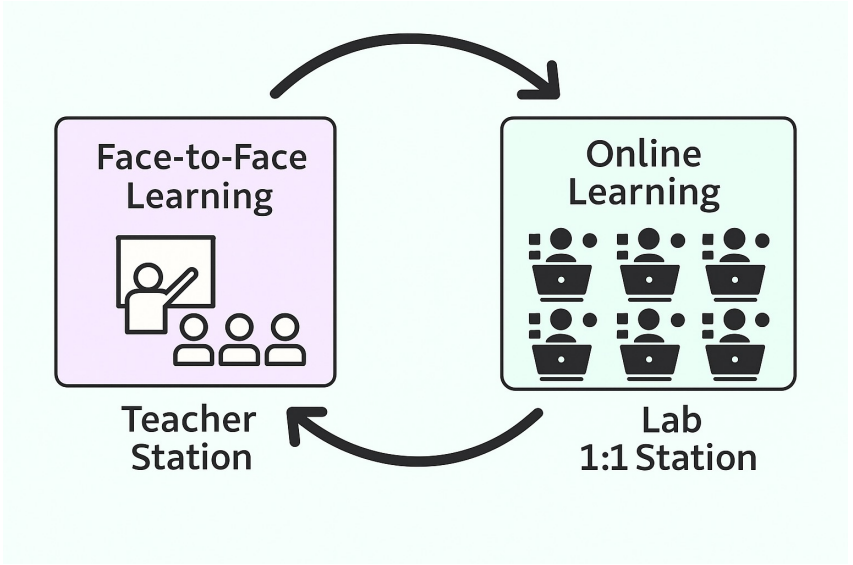
1- Introduction: 1.5 Significance of the study

- **Promoting Student-Centered learning:** It encourages active student engagement and personalized learning while optimizing existing digital infrastructure.
- **Addressing Underused Infrastructure**: Although many secondary schools in Cambodia have computer labs, they are underutilized due to a lack of structured pedagogical models. The Lab Rotation Model, a practical framework, combines scheduled face-to-face instruction with computer-based learning, providing a solution to this issue.
- **Response to Educational Challenges**: The model addresses critical issues in Cambodia, such as low teacher qualifications and large class sizes, particularly at the secondary school level.
- **Support for Digital Education in Cambodia**: The Lab Rotation Model aligns with Cambodia's push toward a digital education system, facilitating the integration of digital technology into classrooms.
- **Policy and Practice Contribution**: This study offers evidence-based insights on how the Lab Rotation Model can enhance academic achievement and student attitudes, contributing to Cambodia's digital education policy goals.

2- Materials : Lab Rotation Model of Blending Learning







1. **Definition of Lab Rotation:** Students rotate to a separate computer lab for the digital learning portion while receiving face-to-face instruction in the classroom. This model supports flexible scheduling and efficient use of lab space.

2-Materials: Contents for Intervention (con.)

December Detailed Curriculum Distribution

Grades:11th

Month	Week	Time	Title (Chapter/Lessons/Sub-content)
Dec	1st	2 hours	Lesson 1: The Planet Earth 1. Origin of the Earth 1.1 Origin of the Earth's Solid Structure 2. Origin of the Atmosphere 3. Origin of the Oceans
	2nd	2 hours	Lesson 1: The Planet Earth 2. Size and Shape of Earth 2.1 Shape of the Earth 2.2 Equatorial Bulge
	3rd	2 hours	Lesson 1: The Planet Earth 3. Size of the Earth 4. Lesson Summary
	4th	1 hour	Monthly Exams

3- Intervention (con.)

Treatment Group

Teacher Paraprofessional

Blended learning Classroom (Lab Rotation Model)

Earth Science Class 48 Students	**Time (2 hours)**	
	1 hour	1 hour
Group **A** 24 Students	Direct Instruction: Math & Science	Learning Lab: Reading & Math
Group **B** 24 Students	Learning Lab: Reading & Math	Direct Instruction: Math & Science

Control Group

Teacher

Traditional Classroom

Earth Science _Class 48 Students	**Time (2 hours)**
	2 hours
	Direct Instruction: Math & Science

Figure 1 Procedure of Lab Rotation Model (Adiwisastra et al., 2020)

3- Intervention (con.)

Timeline and Instruments of Experiment(6 weeks):

Note:

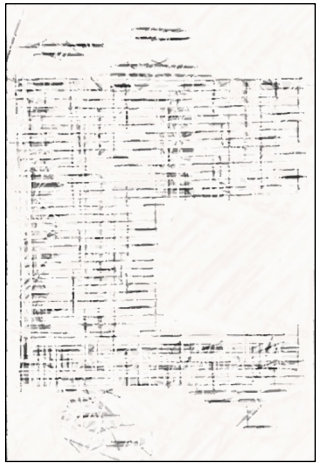
- An experiment is conducted by a teacher of Earth Science.
- Research Instrument: there are two types of instruments
  - Survey Questionnaire is conducted by a researcher
  - Learning Achievement Test: is designed and conducted by teacher.

4- Outcome

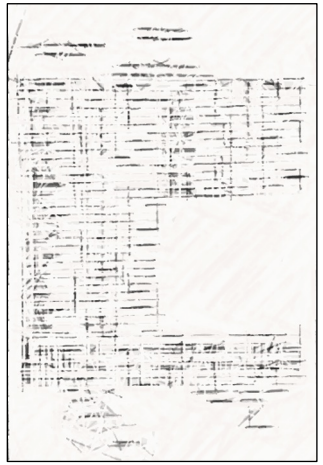
Outcomes

Student's Achievement

- Test Score
  - Measure: Numerical
  - Score reported by teacher and approved by the vice-school principal .



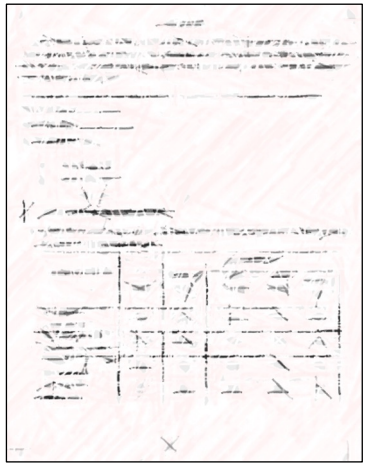
Pre-Test Score

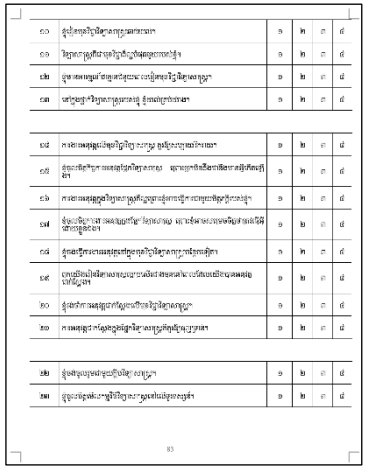


Post-Test Score

Student's Attitude

- Questionnaires
  - Measure: 4 Scale (1- 4)
  - Adapt from Patrick Barmby (2008)
  - Conducted by Researcher





5- Methodology

Research Approach: Quantitative

Research Design: Experimental: According to Creswell and Creswell (2018) in Research Design (Fifth Edition)

Identification strategy: Randomized Controlled Trial

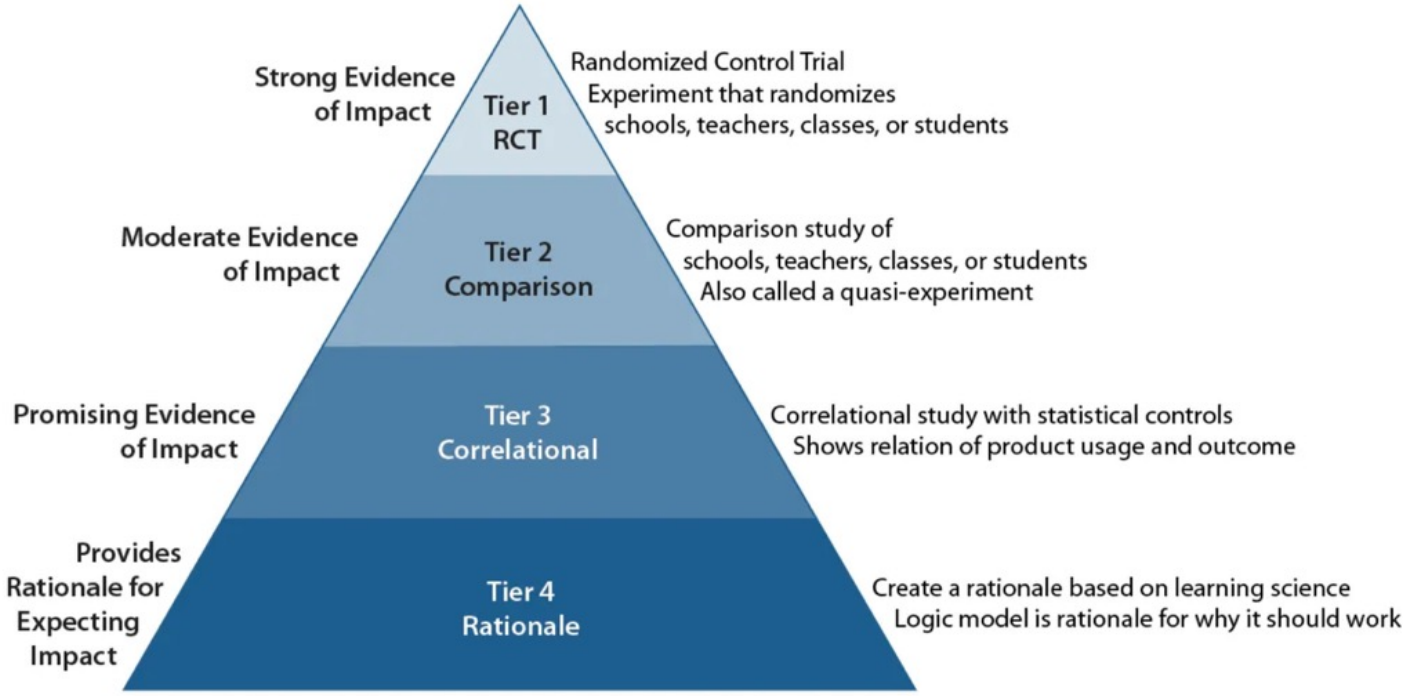


Figure 1: The four tiers of evidence defined in ESSA (Newman, 2020)

5- Methodology

យោងតាម Newman et al. (2018), Solomon et al. (2009) និង Wang (2020) ការសាកល្បងដោយការចាត់តាំងដោយចៃដន្យ (Randomized Controlled Trial: RCT) ត្រូវបានចាត់ទុកថាជាស្តង់ដារមាស (Gold Standard) ក្នុងការស្រាវជ្រាវផ្នែកអប់រំ ពីព្រោះវាផ្តល់នូវភស្តុតាងដែលមានភាពរឹងមាំ និងគួរឱ្យទុកចិត្តបំផុត សម្រាប់កំណត់ថាតើកម្មវិធី គោលនយោបាយ ឬអន្តរាគមន៍ណាមួយពិតជាបណ្តាលឱ្យមានការកែលម្អលទ្ធផលដែរឬទេ។

វិធីសាស្ត្រ RCT ដំណើរការដោយការចាត់តាំងអ្នកចូលរួមក្នុងការសិក្សា (ឧទាហរណ៍ សិស្ស គ្រូបង្រៀន ឬសាលារៀន) ទៅក្នុងក្រុមពិសោធន៍ (Treatment Group) និងក្រុមគ្រប់គ្រង (Control Group) ដោយចៃដន្យ។ ក្រុមពិសោធន៍ទទួលបានអន្តរាគមន៍ ឬកម្មវិធីដែលត្រូវបានសាកល្បង ខណៈដែលក្រុមគ្រប់គ្រងមិនទទួលបានអន្តរាគមន៍នោះទេ។ ការចាត់តាំងដោយចៃដន្យនេះជួយកាត់បន្ថយភាពលំអៀង (Bias) និងធានាថា ភាពខុសគ្នានៃលទ្ធផលដែលកើតឡើងរវាងក្រុមទាំងពីរ អាចត្រូវបានពន្យល់ដោយអន្តរាគមន៍ដែលបានអនុវត្ត មិនមែនដោយកត្តាផ្សេងៗដូចជា ប្រវត្តិគ្រួសារ ស្ថានភាពសេដ្ឋកិច្ចសង្គម សមត្ថភាពដើមរបស់សិស្ស ឬគុណភាពគ្រូបង្រៀននោះឡើយ។

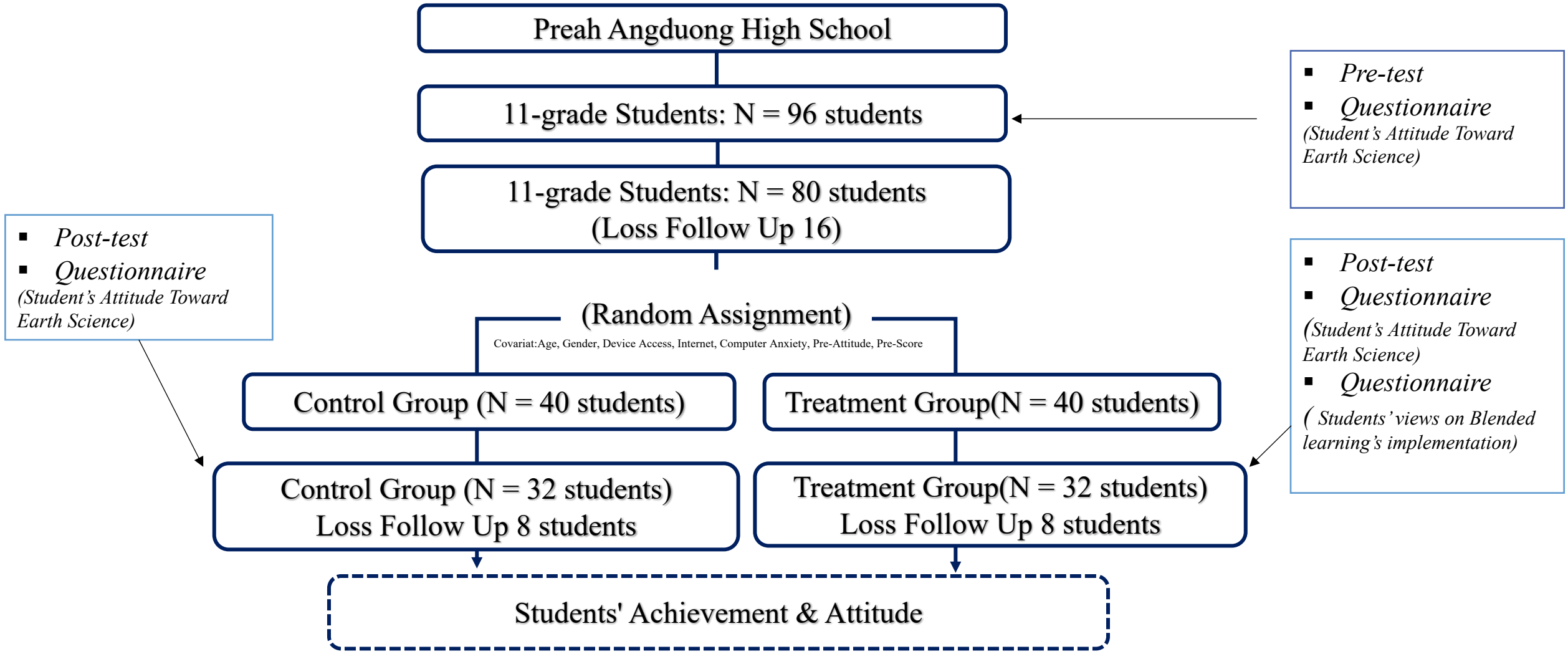
5- Methodology (Con.)

លើសពីនេះទៅទៀត យោងតាមក្របខណ្ឌ Every Student Succeeds Act (ESSA) របស់ក្រសួងអប់រំសហរដ្ឋអាមេរិក (U.S. Department of Education, 2025) ការសាកល្បងដោយការចាត់តាំងដោយចៃដន្យ (RCT) ត្រូវបានទទួលស្គាល់ថា ជា «ភស្តុតាងកម្រិតទី១៖ ភស្តុតាងរឹងមាំ (Level 1: Strong Evidence)» ដែលជាកម្រិតខ្ពស់បំផុតនៃភាពតឹងរឹងផ្នែកវិធីសាស្ត្រស្រាវជ្រាវក្នុងវិស័យអប់រំ។ ការបំពេញតាមស្តង់ដារនេះជាទូទៅត្រូវបានចាត់ទុកថាជាលក្ខខណ្ឌសំខាន់សម្រាប់ការទទួលបានមូលនិធិគាំទ្រពីរដ្ឋាភិបាល ជាពិសេសសម្រាប់គម្រោងកំណែទម្រង់សាលារៀន និងការបញ្ចូលបច្ចេកវិទ្យាអប់រំទៅក្នុងដំណើរការបង្រៀន និងរៀន។

ដោយសារតែភាពរឹងមាំនៃការរចនាស្រាវជ្រាវនេះ ការប្រើប្រាស់ RCT ក្នុងការសិក្សាអំពីប្រសិទ្ធភាពនៃការសិក្សាបែបចម្រុះដោយប្រើគំរូ Lab Rotation Model អាចផ្តល់នូវភស្តុតាងដែលមានសុពលភាពខ្ពស់អំពីឥទ្ធិពលពិតប្រាកដរបស់អន្តរាគមន៍ទៅលើសមិទ្ធផលសិក្សា និងអាកប្បកិរិយារបស់សិស្ស។

5 – Methodology (Con.)

Identification strategy: Randomized Controlled Trial.



5- Methodology (Con.)

Estimation Method:

- Regression
  - Simple linear regression model: $\mathbf{Y_i = \beta_0 + \beta_1 x_i}$
  - Multiple linear regression model: $Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_p X_p$
- Robustness Check:
  - T-Test (numerical outcome)

6– Data Descriptions

Data Description

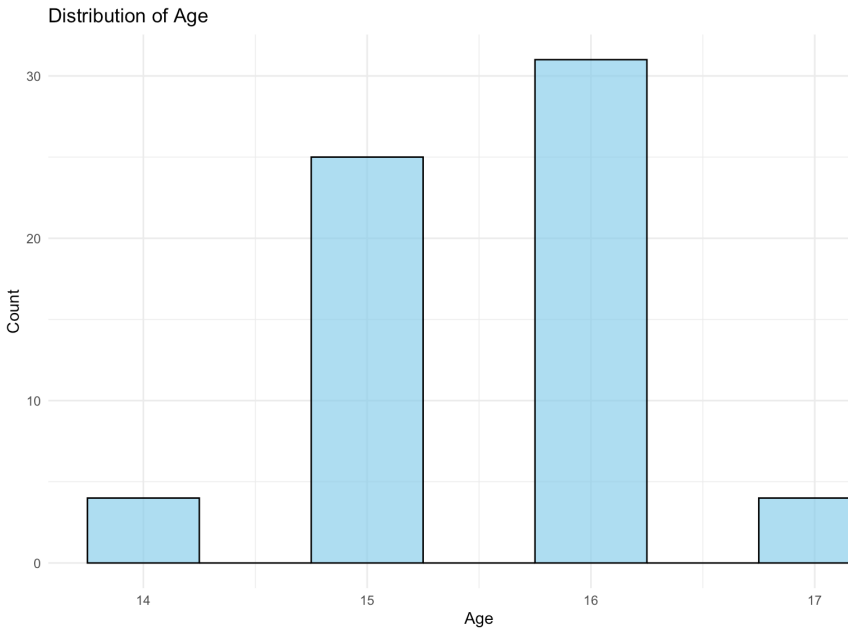


Figure 1.1

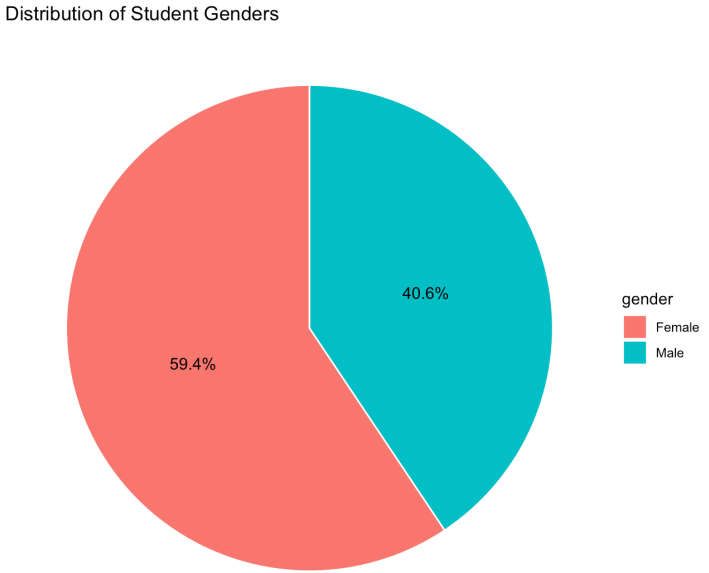


Figure 1.2

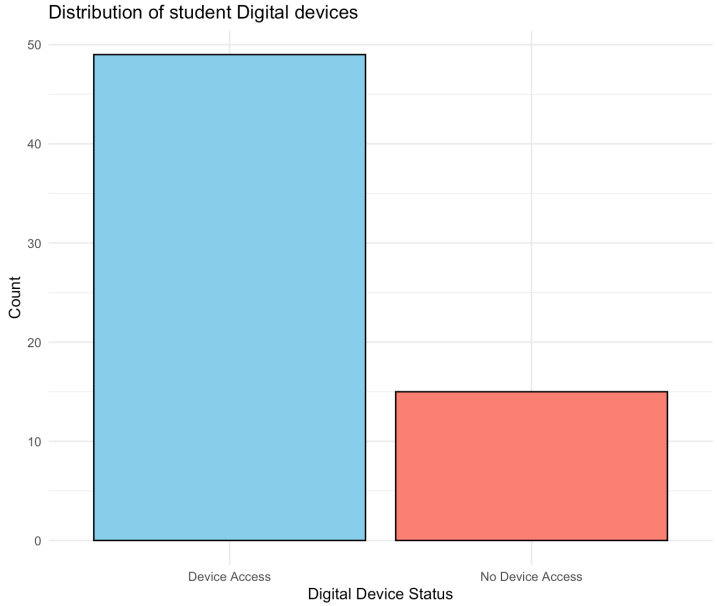


Figure 1.3

Figure1.1: The age distribution reveals that most students are 15 or 16 years old, with fewer students are 14 or 17 years old.

Figure1.2: Gender distribution Show that there are more female students than male students in the dataset. Therefore, 59.4% of the students are female, while 40.6% are male.

Figure1.3: A smaller portion lacks access to digital devices.

6– Data Descriptions (Con.)

Data Description

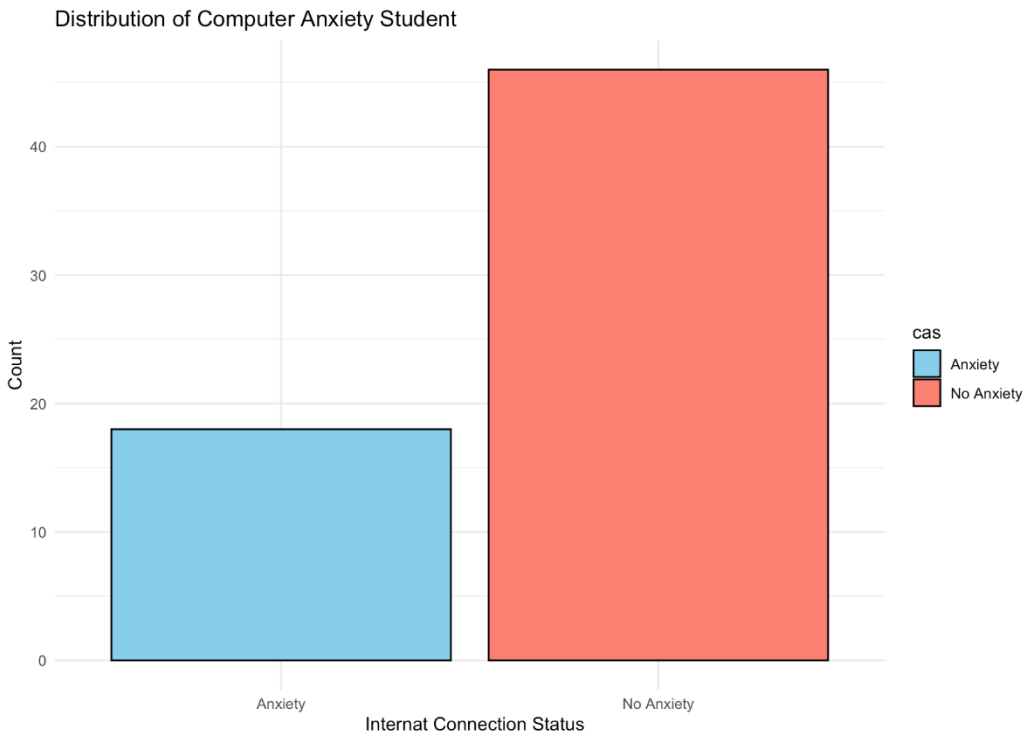


Figure 1.4

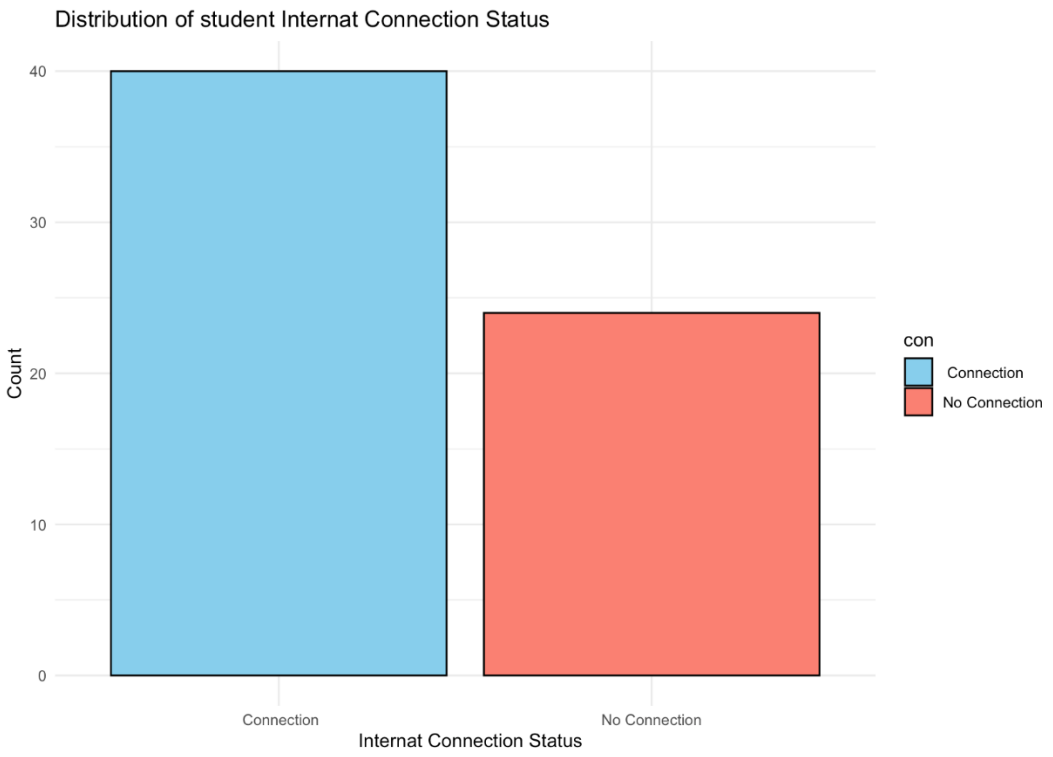


Figure 1.5

Figure1.4: The data shows that most students (47) do not have computer anxiety, while 17 do.
Figure1.5: In terms of internet access, 40 students have a connection, but 25 do not

6– Data Descriptions (Con.)

- **Data Description**

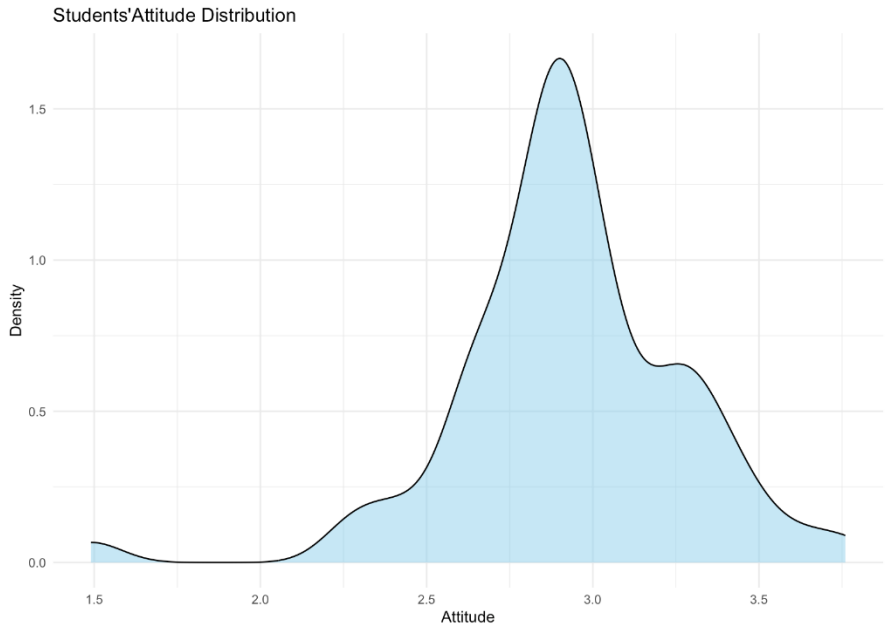


Figure 1.6

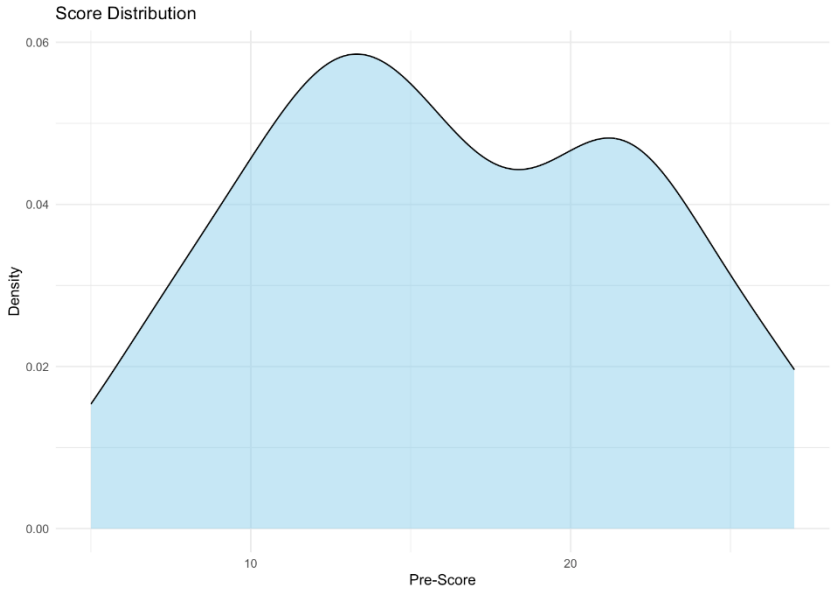


Figure 1.7

Figure1.6 (Attitude Distribution):Most students have a moderately positive attitude, with scores clustering around 2.8 to 3.2. Few students scored very low or very high.

Figure1.7(Pre-Score Distribution):Students' pre-test scores are fairly spread out, but most scored between 10 and 22, showing a moderate performance before the intervention.

7: Baseline Equivalence

- **Random assignment** done in R with reproducible seed (set.seed(7)) to ensure fairness.
- **Half of the students were assigned to the control group; half to the treatment group.**
- **Baseline balance check** (CreateTableOne, {tableone} package) confirmed no significant differences in key variables (pre-test scores, attitudes, demographics, device/internet access).

Confirms **internal validity**: Post-test differences are due to the Lab **Rotation Model**, not pre-existing factors (Yoshida & Bartel, 2014,2024).

7: Baseline Equivalence

Table 1 : Baseline Characteristics of Control and Treatment Groups

Variable	Control (n = 32)	Treatment (n = 32)	p-value
Age (years), M (SD)	15.59 (0.71)	15.50 (0.72)	.602
Gender = Male, n (%)	13 (40.6)	13 (40.6)	1.000
Device access = No device, n (%)	8 (25.0)	7 (21.9)	1.000
Internet = No connection, n (%)	13 (40.6)	11 (34.4)	.796
Computer anxiety = No anxiety, n (%)	22 (68.8)	24 (75.0)	.781
Pre-intervention attitude, M (SD)	2.88 (0.35)	2.97 (0.35)	.282
Pre-test score, M (SD)	16.28 (6.49)	16.12 (5.43)	.917

Note. Group “C” = control; Group “T” = treatment.

8– Result: Findings related to RQ1 (Academic Achievement)

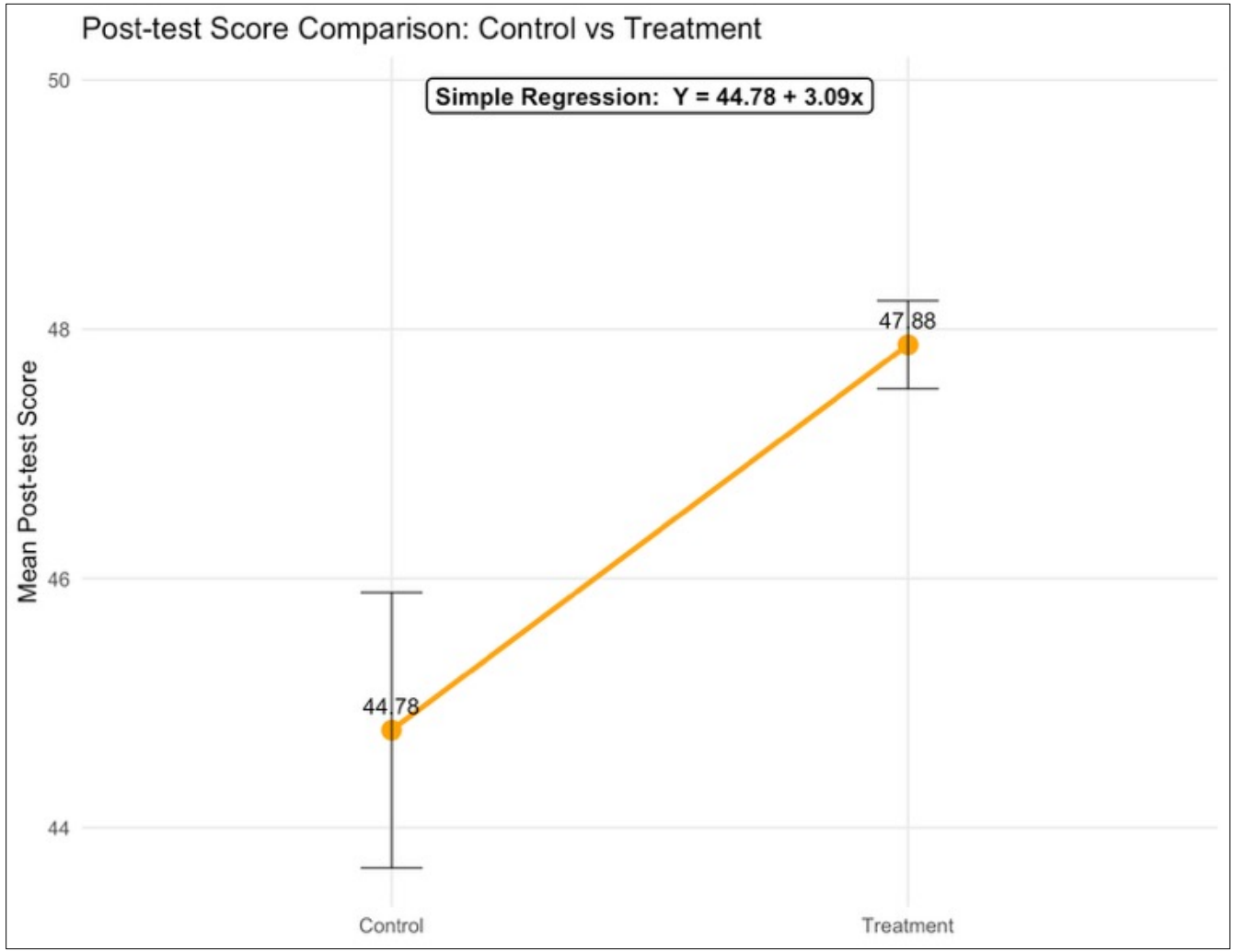
Q1=> H1: There is a significant difference in post-test achievement between students in the blended learning classroom and the traditional learning classroom.

Post-test Comparison Results	Regression(Basic)		t.test()		Add More Covariates	
	Estimate	P-Value	Estimate	P-Value	Estimate	P-Value
Group T	3.09-point increase	p = .0098 (**)	3.09-point increase	p = .0098 (**)	2.98-point increase	p = .0090 (**)

Note: p < .01 (highly significant) **, p< .05 (statistically significant) *

- The study found that Students who experienced instruction via the Lab Rotation Model demonstrated **significantly higher academic achievement** than those taught through traditional methods.
- The observed gains ranging from **2.98 to 3.09 raw points**, or approximately **6.7% to 6.9% improvement** in predicted scores, remained statistically significant even after adjusting for covariates such as **age, gender, device access, internet connectivity, computer anxiety, and baseline scores**.

8– Result: Findings related to RQ1 (Academic Achievement)



8– Result: Finding Q1 (Independent-samples t-test)

Table 3: Post-test science achievement by group and **independent-samples t-test r**esults

Group	n	M	SD
Control (C)	32	44.78	4.64
Treatment (T)	32	47.88	4.64

Inferential statistics:

Mean difference (T − C) **= 3.09**, 95% CI [0.77, 5.41];t(62)=−2.66; p=.0098;Cohen's d=0.6
Note. Equal variances assumed; pooled SD = 4.64. Effect size is calculated as (Treatment − Control).

8– Result: Findings related to RQ2(Attitudes toward Earth Science)

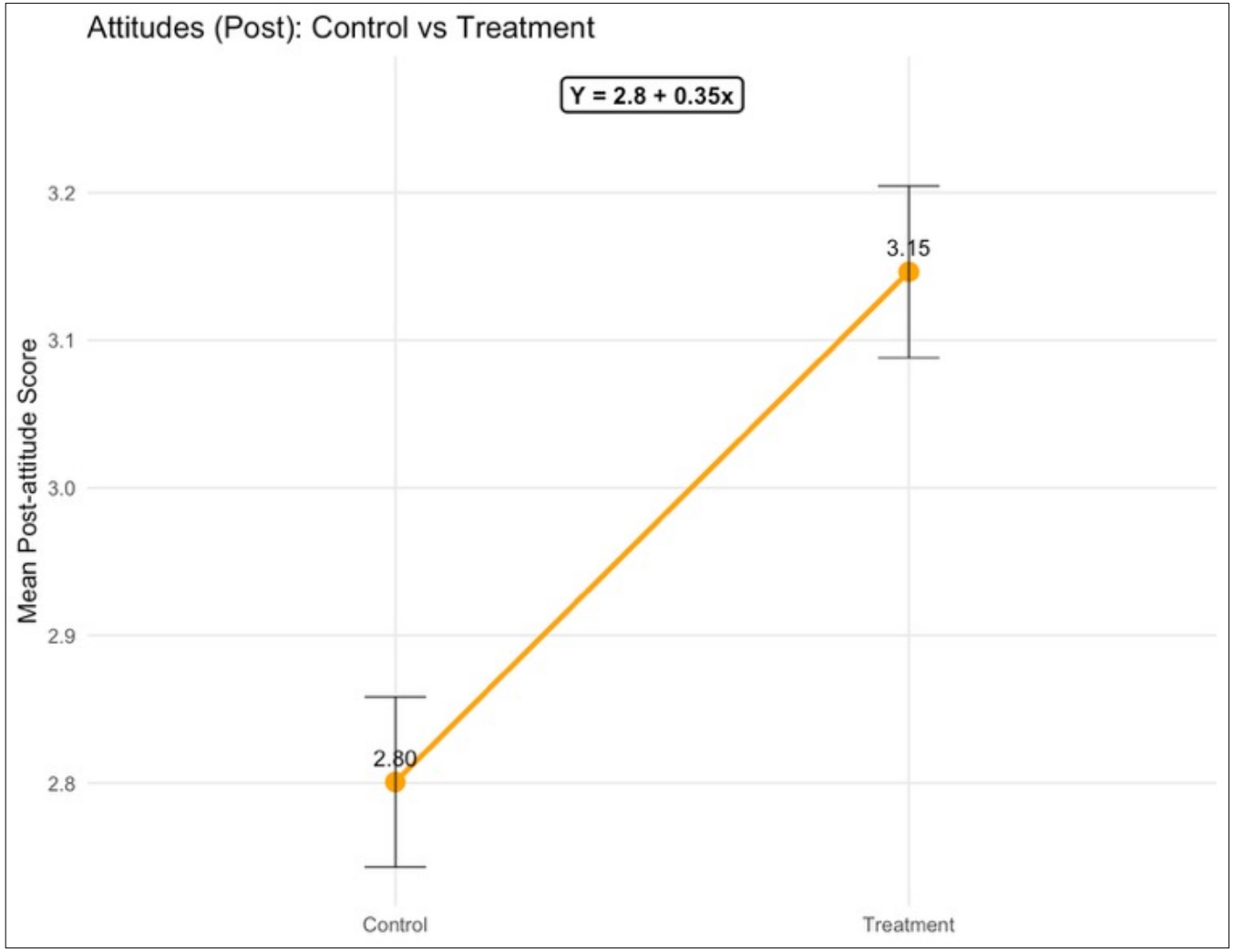
Q2=> H_2: There is a significant change in students' attitudes toward blended learning in Earth Science before and after implementing the intervention.

Post-test Comparison Results	**Regression(Basic)**		**Independent Sample t-test**		**Add More Covariates**	
Group T	Estimate	P-Value	Estimate	P-Value	Estimate	P-Value
	β = +0.34 point increase	p < .001(**)	+0.35 point increase	p < .001(**)	0.29	p < .001 (**)

Note: p < .01 (highly significant) **, p< .05 (statistically significant) *

- The study found that students in the experimental group reported **significantly more positive attitudes toward science.**
- The mean post-test **difference of 0.35 points**, confirmed by regression analysis, indicates a meaningful shift in students' affective responses to learning.
- Logistic regression further revealed that these students were nearly **20 times** more likely to report a positive attitude toward science than those in the control group.

8– Result: Findings related to RQ2(Attitudes toward Earth Science)



8– Result: Finding Q2 (Independent-samples t-test)

Table 3: Independent samples t-test comparing post-intervention attitude between Control and Treatment groups

Group	n	M	Pooled SD
Control (C)	32	2.80	4.64
Treatment (T)	32	3.15	4.64

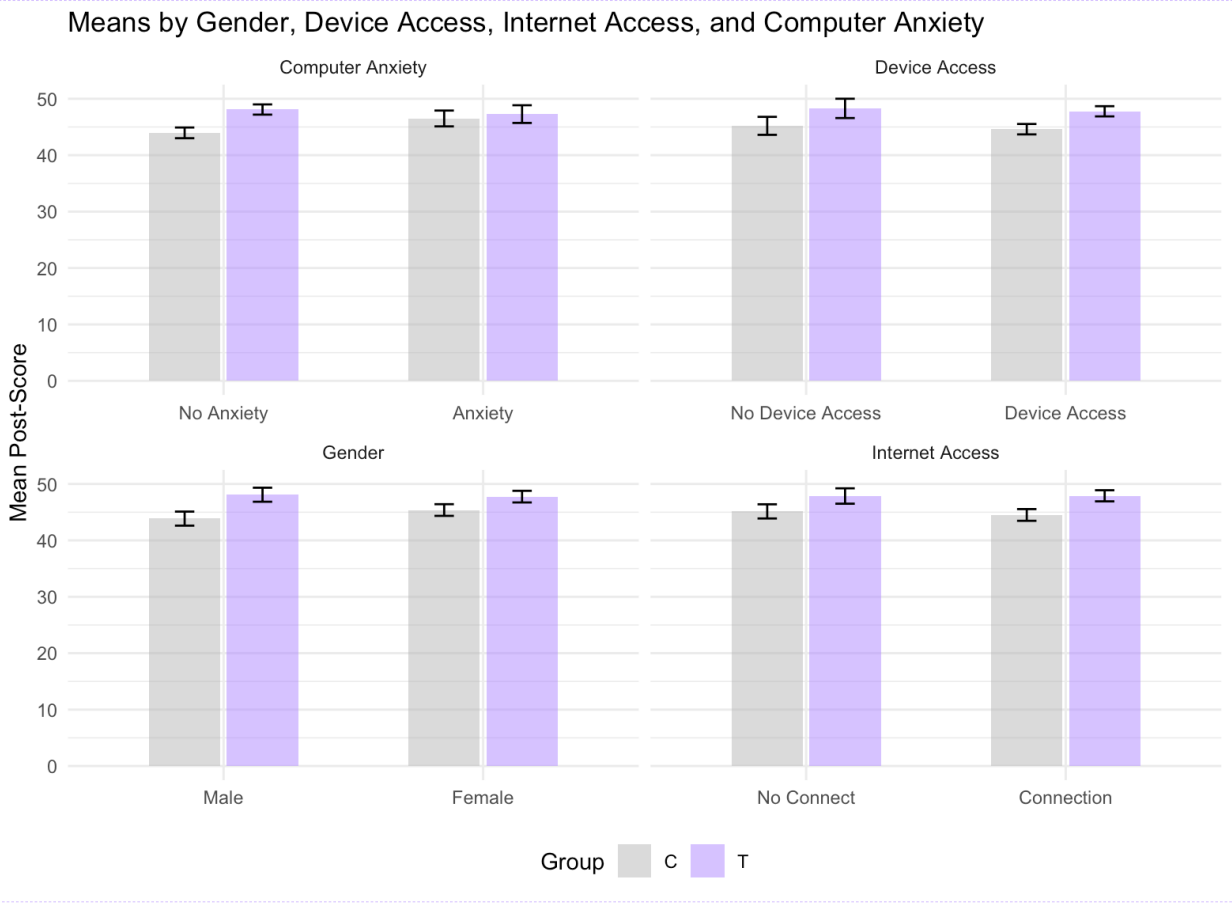
Inferential statistics:

Note. Equal variances assumed; pooled SD = 0.33 was used to compute effect size. Effect size is calculated as (Treatment − Control). Mean difference (T − C) **= 0.35**, 95% CI [0.18, 0.51]; t(62)=4.22; p<.001 ;Cohen's d=1.6 (large effect)

An independent samples *t*-test showed that the treatment group (M = 3.15) had significantly higher post-attitude scores than the control group (M = 2.80), $t(62) = 4.22$, $p < .001$, 95% CI for the mean difference (T − C) = [0.18, 0.51], Cohen's $d = 1.06$, indicating a significant effect.

8– Result: Subgroup Analysis on Student Achiveement

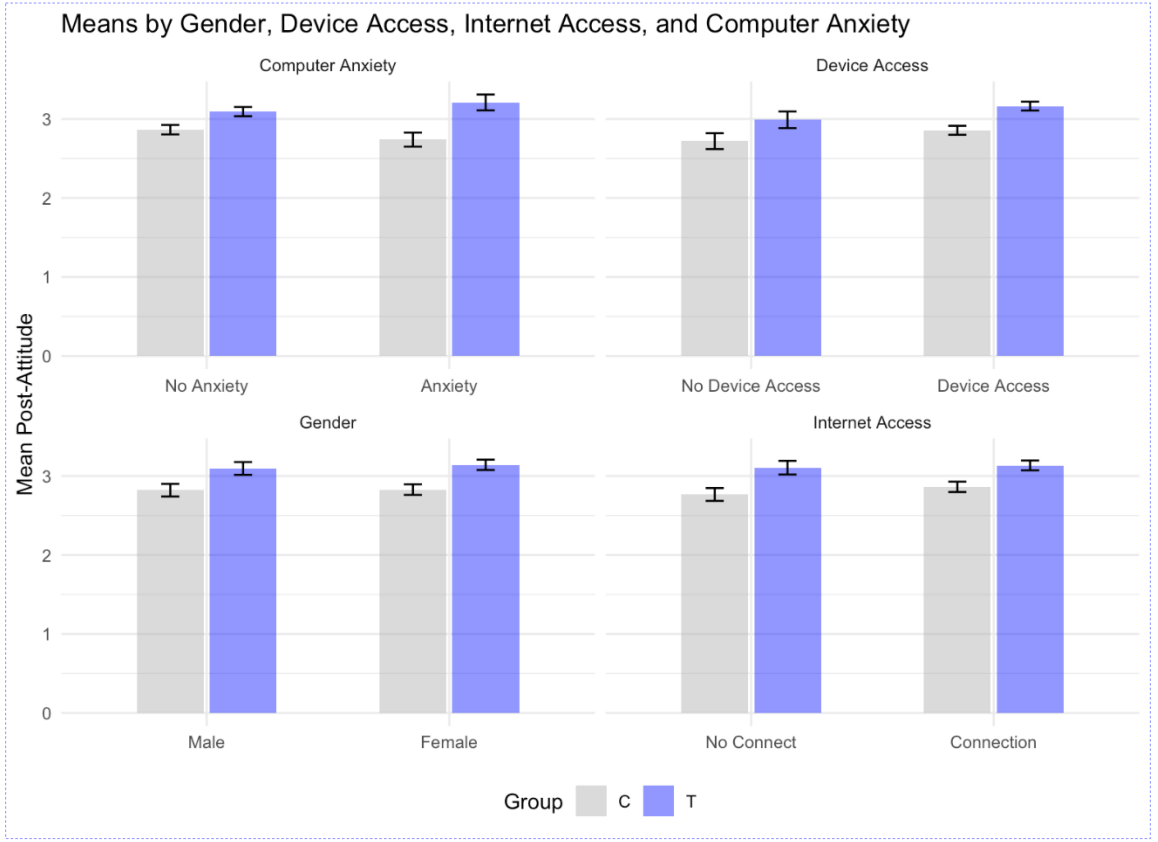
Subgroup	Estimate(Δ)	SE	df	t-ratio	p-value
Gender-Male	4.23*	1.76	59	2.40	<.019(*)
Gender-Female	2.38	1.46	59	1.63	<.108
Device Access-No	3.09	2.34	59	1.32	<.191
Device Access-Yes	3.17*	1.29	59	2.46	<.017(*)
Internet-No Connection	2.73	1.85	59	1.47	<.146
Internet-Connection	3.40*	1.43	59	2.38	<.020(*)
Computer Anxiety-No	4.14**	1.31	59	3.15	<.002(**)
Computer Anxiety-Yes	0.77	2.11	59	0.36	<.717



Estimate = difference in means (T - C)
SE = standard error of the contrast
df = degrees of freedom
t-ration = test statistic
p-value = significance level
Estimates marked with * indicate p<.0.5, and ** indicate p<.01.

8– Result: Subgroup Analysis on Attitude toward Earth Science

Subgroup	Estimate(Δ)	SE	df	t-ratio	p-value
Gender-Male	0.27*	0.11	59	2.45	<.017(*)
Gender-Female	0.31**	0.09	59	3.35	<.001(**)
Device Access-No	0.27	0.14	59	1.86	<.068
Device Access-Yes	0.31***	0.07	59	3.84	<.001(***)
Internet-No Connection	0.34**	0.12	59	2.82	<.007(**)
Internet-Connection	0.27**	0.08	59	3.02	<.004(**)
Computer Anxiety-No	0.23**	0.08	59	2.72	<.009(**)
Computer Anxiety-Yes	0.47***	0.13	59	3.53	<.001(***)



Estimate = difference in means (T - C)

SE = standard error of the contrast

df = degrees of freedom

t-ration = test statistic

p-value = significance level

Estimates marked with * indicate p<.0.5, and ** indicate p<.01.

8– Result: Subgroup Analysis

The Lab Rotation Model improved both achievement and attitudes, with academic gains **strongest** for tech-ready students (**males, those with device/internet access, and low computer anxiety**) while attitude gains were broad and especially **strong** for **females** and those with **computer anxiety**.

9– Discussions:

Consistent:

Meta-analyses consistently show **blended learning improves both academic achievement and attitudes** compared to traditional teaching (Means et al., 2009; Cao, 2023b; Christensen et al., 2013; Li & Wang, 2022; Solomon et al., 2009).

Inconsistent:

Blended learning's effects are inconsistent—some studies show attitude gains without achievement improvement, others show no change or worse results, and a meta-analysis found no overall effect—**implying success depends on design and context, not the model itself** (Yick et al., 2019; Berga et al., 2021; Al-Qatawneh et al., 2020; Yen & Lee, 2011; Botts et al., 2018; Li & Wang, 2022).

10– Limitations

- Conducted in **one school** and focused on **one subject** → limits generalizability.
- **Short intervention period** → cannot show long-term effects.
- Results may not apply to **other contexts, subjects, or grade levels**.

11– Suggestions for Further Research

- Use **multi-site RCTs** to improve external validity.
- Extend **implementation and follow-up periods** to measure long-term impact.
- Apply **mixed-methods** (quantitative + qualitative) for deeper insights.
- Explore using the Lab Rotation Model in **other subjects and grade levels—study teacher facilitation styles** to identify factors driving success.

12– Conclusion:

The Lab Rotation Model can boost science learning and attitude if schools invest in technology and teacher support.

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THANK YOU
FOR YOUR ATTENTION

APPENDIX

Appendix: 1.1 Achievement Pre-Post Test

Preah AngDoung High School

Pre -Test and Post-Test Name: .....

Subject: Earth Science Gender: .....

Grade 11th : (……) Date: .....

Group: .....

Examination

I. Choose the correct answer from the options below. (9 points)

1. How many million years ago did the planet come into being? (3 points)

   A. 4500 B.4600 C.4700 D.4800

2. Which gases were present in the Earth's early atmosphere? (3 points)

   A. O_2 B. H_2 and He C. N D. CO_2

3. How long is the radius of the Earth? (3 points)

   A.4600 B.6400 C.4500 D.6500

II. Fill in the blanks correctly. (points)

1. The Earth's equator has a length of ..... (3 points)
2. The presence of methane gas, ammonia (NH_3), water vapor (H_2O), and carbon dioxide (CO_2) originated from..... (3 points)
3. The earth's solid structure is divided into three layers: the core, the mantle, and.....(3 points)

III. Questions (32 points)

1. How did the planet come about? (8 points)
2. Describe the evolution of the Earth's atmosphere. (8 points)
3. To prove that the Earth is spherical, how many observations did Aristotle make? What were they? (8 point)
4. Based on the spherical shape of the Earth, calculate the surface area of the Earth.

Note: The Earth's radius is 6,400 km. (8 points)

55

វិទ្យាល័យព្រះអង្គដួង

ប្រឡងមុនចាប់ផ្តើមមេរៀន គោត្តនាម-នាម.....

មុខវិជ្ជា៖ ផែនដី និង បរិស្ថានវិទ្យា ភេទ.....

ថ្នាក់ទី ១១ ( ) សម័យប្រឡង.....

ក្រុម.....

ឥរិយាបថ

I. ជ្រើសរើសចម្លើយដែលត្រឹមត្រូវខាងក្រោម៖ (៩ពិន្ទុ)

១. ភពផែនដីបានកកើតឡើងកាលពីប៉ុន្មានលានឆ្នាំមុន? (៣ពិន្ទុ)

ក. ៤៥០០ ខ. ៤៦០០ គ. ៤៧០០ ឃ. ៤៨០០

២. តើឧស្ម័នណាដែលមានតែមាននៅក្នុងបរិយាកាសភពផែនដីមុនគេ? (៣ពិន្ទុ)

ក. O_2 ខ. H_2 និង He គ. N ឃ. CO_2

៣. តើកាំផែនដីមានប្រវែងប៉ុន្មាន គ.ម? (៣ពិន្ទុ)

ក. ៨៦០០ ខ. ៦៤០០ គ. ៤៥០០ ឃ. ៦៥០០

II. បំពេញចន្លោះខាងក្រោមឲ្យបានត្រឹមត្រូវ៖ (៩ពិន្ទុ)

១. ខ្សែរង្វង់ផែនដីមានប្រវែង.....។ (៣ពិន្ទុ)

២. ឧស្ម័នមេតាន អាម៉ូញ៉ាក់ ចំហាយទឹក និងឧស្ម័នកាបូនិចមានប្រភពចេញពី.....។ (៣ពិន្ទុ)

៣. ផ្នែកវែងរបស់ផែនដីត្រូវបានបែងចែកជា ៣ ស្រទាប់គឺ ស្នូល ម៉ង់តូ និង.....។ (៣ពិន្ទុ)

III. សំណួរ (៣២ពិន្ទុ)

១. តើភពផែនដីបានកកើតឡើងយ៉ាងដូចម្តេច? (៨ពិន្ទុ)

២. ចូរឲ្យបរិយាយពីការវិវត្តនៃបរិយាកាសផែនដី។ (៨ពិន្ទុ)

៣. ដើម្បីអះអាងថាផែនដីមានរាងស្វ៊ែរ លោកអារីស្តូតមានអំណះអំណាងប៉ុន្មាន? អ្វីខ្លះ? (៨ពិន្ទុ)

៤. ដោយយោងទៅតាមរាងស្វ៊ែររបស់ផែនដី ចូរគណនាក្រឡាផ្ទៃរបស់ផែនដី។

បម្រាប់៖ កាំផែនដីមានប្រវែង ៦៤០០ គ.ម។(៨ពិន្ទុ)

66

Appendix: 1.2 Test Survey Questionnaire

Appendix B: Survey Questionnaire (English Khmer)

SURVEY QUESTIONNAIRE

This survey aims to gather your feedback on your learning experiences in Earth Science. Your insights are highly valuable and will help improve the quality of education and resources provided. All responses are confidential and will be used only for educational improvement. This survey is anonymous, and results will only be reported in aggregate form.

Date: _____

Type of Test : ☐ Pre-test ☐ Post-test

Student ID. : _____

I. Demographic Information

- Sex : ☐ Male ☐ Female
- Age : _____ (years old)

II. The Digital Devices Use

- Please indicate which devices you own and select the duration of use

Please select all that apply to you.

Type of electronic devices		Duration of Use			
	Not use	1 year or less than	2 - 3 years	4- 5 years	More than year
Smart phone	○0	○1	○2	○3	○4
Computer or Desktop	○0	○1	○2	○3	○4
Tablet or iPad	○0	○1	○2	○3	○4
Smartwatch	○0	○1	○2	○3	○4

- How do you connect to the internet? Please select all that apply to you.

☐1 Personal mobile data

☐2 Wi-Fi at home

☐3 Wi-Fi at cafes

☐4 Wi-Fi at school

☐5 Other: (Please specify) _____

☐6 No

III. Computer Anxiety

A fear or apprehension that people experience when using computers or thinking about using them.

Please indicate the extent of your agreement with each of the following statements regarding your understanding of using computers. Select the number in the right column that best represents your perspective using the following scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree.

№	Statement	Scale			
1	I think that it takes a long time to finish when I use a computer.	1	2	3	4
2	I think that computers are very easy to use.	1	2	3	4
3	I get a sinking feeling when I think of trying to use a computer.	1	2	3	4
4	Working with a computer makes me nervous.	1	2	3	4
5	Using a computer is very frustrating.	1	2	3	4
6	I will do as little work with computers as possible.	1	2	3	4
7	Computers are difficult to use.	1	2	3	4
8	Computers do not scare me at all.	1	2	3	4

IV. Student's Attitude Toward Earth Science Please indicate the extent of your agreement with each of the following statements regarding your understanding of Earth Science. Select the number in the right column that best represents your perspective using the following scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree.

Attitude measure	Items comprising the measure	Scale			
Learning science in school	We learn interesting things in science lessons.	1	2	3	4
	I look forward to my science lessons.	1	2	3	4
	Science lessons are exciting.	1	2	3	4
	I would like to do more science at school.	1	2	3	4
	I like Science better than most other subjects at school.	1	2	3	4
	Science is boring.	1	2	3	4
Self-concept in science	I find science difficult.	1	2	3	4
	I am just not good at science.	1	2	3	4
	I get good marks in science.	1	2	3	4
	I learn Science quickly.	1	2	3	4
	Science is one of my best subjects.	1	2	3	4
	I feel helpless when doing Science.	1	2	3	4
	In my Science class, I understand everything.	1	2	3	4
Practical work in science	Practical work in science is exciting.	1	2	3	4
	I like science practical work because you don't know what will happen.	1	2	3	4
	Practical work in science is good because I can work with my friends.	1	2	3	4
	I like practical work in science because I can decide what to do myself.	1	2	3	4
	I would like more practical work in my science lessons.	1	2	3	4
	We learn science better when we do practical work.	1	2	3	4
	I look forward to doing science practical.	1	2	3	4
	Practical work in science is boring.	1	2	3	4

Attitude measure	Items comprising the measure	Scale			
Science outside of school	I would like to join a science club.	1	2	3	4
	I like watching science programmes on TV.	1	2	3	4
	I like to visit science museums.	1	2	3	4
	I would like to do more science activities outside school.	1	2	3	4
	I like reading science magazines and books.	1	2	3	4
	It is exciting to learn about new things happening in science.	1	2	3	4
Future participation in science	I would like to study more science in the future.	1	2	3	4
	I would like to study science at university.	1	2	3	4
	I would like to have a job working with science.	1	2	3	4
	I would like to become a science teacher.	1	2	3	4
	I would like to become a scientist.	1	2	3	4
Importance of science	Science and technology are important for society.	1	2	3	4
	Science and technology make our lives easier and more comfortable.	1	2	3	4
	The benefits of science are greater than the harmful effects.	1	2	3	4
	Science and technology are helping the poor.	1	2	3	4
	There are many exciting things happening in science and technology.	1	2	3	4

V. Student's Achievement

- Score : _____

Thank you for participating in this survey.
Your time and feedback are essential for enhancing the quality of Earth Science education. By providing your responses, along with information such as demographic details, grade scores, attendance, and attitudes toward the Earth Science subject, you are contributing valuable insights that will support efforts to improve educational engagement and effectiveness in this field.