

INTEGRATING SMART AGRO-TECHNOLOGIES INTO PRE-UNIVERSITY STEM CURRICULUM: A CASE STUDY OF THE ACADEMIC LYCEUM AT TERMEZ INSTITUTE OF ENGINEERING AND AGRO-TECHNOLOGIES, SURKHANDARYA REGION

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This study examines how early exposure to smart agro-technologies at the academic lyceum level influences STEM retention and research readiness of first-year university students. Using a quasi-experimental design at the Academic Lyceum of Termez Institute of Engineering and Agro-Technologies in Surxondaryo Region, Uzbekistan, we tracked 142 lyceum graduates over the 2024-2025 academic year. Students who participated in the “AgroTech Vertical” program — featuring IoT-based soil monitoring, drone mapping, and AI-driven crop disease detection — demonstrated 34% higher research project completion rates and 22% higher critical thinking scores in their first university semester compared to the control group. Findings suggest that regionally contextualized, technology-integrated lyceum curricula can reduce the “lyceum-to-university gap” in engineering and agricultural fields.

Introduction

Surkhandarya Region produces 18% of Uzbekistan’s agricultural output and faces acute water scarcity, soil salinity, and labor shortages. The regional development strategy for 2022-2026 prioritizes “Agriculture 4.0” and requires 5,000+ agro-engineers by 2030. Termez Institute of Engineering and Agro-Technologies is the primary higher education provider for these specialists.

However, a persistent problem exists: academic lyceum graduates enter university with strong theoretical math/physics knowledge but limited exposure to real agro-engineering problems. This creates a 1-1.5 year “adaptation lag” where students struggle with project-based courses like “Precision Farming” and “Agro-Mechanical Design”.

Research gap: While Uzbekistan has expanded academic lyceums since 2017, few studies examine vertical integration between lyceums and specialized universities in agriculture. Existing literature focuses on Tashkent or general STEM, not on region-specific agro-technical pipelines.

Research question: To what extent does a lyceum-level curriculum integrated with local agro-tech problems improve university readiness for engineering and agro-technology majors?

Methodology

Site: Academic Lyceum under Termez Institute of Engineering and Agro-Technologies. The lyceum shares labs and faculty with the university’s “Smart Agriculture” techno-park.

Participants: 142 students, Grade 11, academic year 2024-2025.

Experimental group, n=71: Enrolled in “AgroTech Vertical” elective, 4 hours/week

Control group, n=71: Standard physics/math lyceum curriculum

AgroTech Vertical Components:

- IoT Soil Lab:** Students built soil moisture/pH sensors using Arduino, tested on university experimental fields in Termez District
- Drone Mapping Module:** Pix4D-based mapping of 5 ha cotton fields in Jarkurgan District to calculate NDVI and identify salinity patches
- AI Crop Clinic:** Trained a basic image classification model to detect tomato leaf diseases using datasets collected from Surkhandarya greenhouses
- Industry Mentorship:** Monthly sessions with engineers from “Surxon Sifat Agro” cluster

Measurement:



- **University Readiness Index:** Measured in Semester 1 at Termez Institute using: 1) Research project score, 2) Watson-Glaser Critical Thinking Appraisal, 3) Lab safety/complexity navigation time
- **Qualitative data:** Semi-structured interviews with 20 students + 8 university faculty

Results:

Metric	Control Group	Experimental Group	Difference
Research project completion rate	61%	95%	+34%
Avg. critical thinking score	68.2/100	83.4/100	+22.3%
Time to complete first lab assignment	4.7 hours	2.9 hours	-38%
Self-reported “major confidence”	6.1/10	8.4/10	+37%

Key qualitative findings:

1. **Regional relevance drives motivation:** 84% of experimental group students mentioned “solving Surxondaryo’s salinity problem” as a key motivator, vs 23% in control.
2. **Faculty observation:** University lecturers reported that AgroTech Vertical graduates “ask system-level questions in Week 1” instead of Week 8.
3. **Gender insight:** Female participation in agro-engineering projects increased from 19% to 41% when tech was framed as “data and drones” rather than “tractors and fieldwork”.

Discussion

The results support the “early vertical immersion” model. By anchoring abstract physics/coding concepts to Surxondaryo’s salinity, water, and yield challenges, the lyceum creates cognitive bridges that university courses later reinforce. This reduces redundant re-teaching of basics in Year 1.

Policy implication: The Ministry of Higher Education’s “University-Lyceum Cluster” initiative should prioritize region-tech alignment. For Surxondaryo, that means agro-tech. For Navoiy, mining-tech. One-size STEM does not work.

Limitations: Single region, single cohort. Self-selection bias possible as AgroTech Vertical was elective. Longitudinal tracking to Year 3 graduation is needed.

Conclusion and Recommendations

Scale the model: Recommend Ministry to approve “AgroTech Vertical” as a 6-credit specialization for all agro-engineering lyceums in southern Uzbekistan.

Shared infrastructure: Lyceums should have scheduled access to university techno-parks. The Termez model costs ~\$14,000 for initial IoT/drone kits — viable if shared across 3-4 lyceums.

Faculty pipeline: University MSc students can teach lyceum modules as “pedagogical practice”, solving staff shortages at both levels.

This model turns the academic lyceum from a “university prep center” into the first step of the R&D pipeline for Surxondaryo’s agricultural modernization.

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