Funded by the European Union

GREENLIGHT

Generating Renewable Energy Education Network – Leading Initiatives for Green & Harmonious Tomorrows

JOINT REPORT
Green Energy STEAM Workshops for Students (WP4.4)

Portugal · Türkiye · North Macedonia

Joint implementation and student evaluation report

120	120	120	120
students	pre-test responses	post-test responses	feedback responses

Project No. 2023-2-TR01-KA220-SCH-000180691

Executive Summary

The comparative evaluation covered 120 students: 67 in Portugal, 28 in Türkiye and 25 in North Macedonia. All students completed both the pre-test and post-test, and the three feedback datasets also contained 120 valid responses. Applying the same 43-item knowledge framework, the weighted mean increased from 31.98/43 (74.4%) to 35.02/43 (81.4%), an overall gain of 3.03 score points or 7.1 percentage points.

Türkiye achieved the highest post-test mean (84.4%) and the largest aggregate gain (+13.5 percentage points). Portugal entered with the strongest baseline (78.7%) and reached 82.5%, producing a smaller gain consistent with a ceiling effect. North Macedonia increased from 66.8% to 75.3%; 22 of 25 students improved, the highest individual improvement rate of the three countries.

120	81.4%	4.20/5	67.5%
students reached	post-test mean	quality mean	students improved

- Overall knowledge increased in all three countries, and 69 students achieved at least 80% in the post-test compared with 44 at baseline.
- Türkiye recorded the strongest overall gain and the highest final mean; North Macedonia recorded the broadest student-level improvement; Portugal maintained a high level of attainment.
- Lesson and material quality was rated positively in every country, with country means ranging from 4.02/5 to 4.77/5.
- Because test intervals, grade profiles and implementation contexts differed, country comparisons are descriptive rather than causal.

1. Introduction and Comparative Context

The GREENLIGHT project supports school education in renewable energy, energy efficiency, sustainability and environmental responsibility. Within WP4.4, participating schools used active STEAM approaches including research, digital tasks, group work, practical activities, presentations, posters, videos, quizzes and problem-solving.

This comparative report brings together the cleaned national datasets from Portugal, Türkiye and North Macedonia. It examines participation, paired knowledge change, domain-level strengths, student perceptions, activity experience and shared priorities for future implementation.

2. Scope, Data Sources and Methodological Framework

Nine supplied spreadsheets were analysed: one pre-test, one post-test and one post-implementation feedback file for each country. The pre-test and post-test files contained the same students within each country and were paired by exact name after surrounding spaces were removed. Feedback data were treated as separate aggregate response sets.

Knowledge scores used 43 closed-response items covering questions 1–17. Open-text questions were excluded from the knowledge score. Translation-equivalent response options were aligned across the three languages, and the same answer framework was applied consistently to all countries.

Country	Pre-test	Post-test	Feedback
Portugal	67	67	67
Türkiye	28	28	28
North Macedonia	25	25	25
Total	120	120	120

Data validation rule
All paired test records were retained only where the same named student appeared in both files. The report presents aggregate results and does not display student names. Feedback ratings were converted to common five-point scales. Test timing varied by country, so the results describe observed change and retention but do not isolate the workshop as the only possible cause.

3. Implementation Overview and Participant Profile

The combined cohort included a wide range of ages and grades. Portugal contributed the largest group and had a near-balanced gender profile. Türkiye comprised 28 male students in Grades 9 and 10. North Macedonia included students from four secondary-school years and a majority of female participants.

Country	Students	Gender profile	Age profile	Grade profile
Portugal	67	32 male; 35 female	19 under 15; 48 aged 15–16	17 Grade 8; 50 Grade 10
Türkiye	28	28 male	18 aged 15–16; 10 aged 17–18	14 Grade 9; 14 Grade 10
North Macedonia	25	7 male; 18 female	12 aged 15–16; 13 aged 17–18	1 first; 11 second; 10 third; 3 fourth year

Portugal completed the pre-test between 17 November and 4 December 2025 and the post-test between 14 December 2025 and 30 January 2026. Türkiye completed the pre-test on 27 November 2025 and the post-test on 27 February 2026. North Macedonia completed the pre-test between 14 November and 2 December 2025 and the post-test on 15 May 2026. These different intervals should be considered when interpreting retention and cross-country differences.

4. Student Test on Energy and Environment

Across all 120 students, the mean score increased from 31.98/43 (74.4%) to 35.02/43 (81.4%). Eighty-one students improved, ten recorded the same total and 29 recorded a lower score. The number reaching at least 80% increased from 44 students at baseline to 69 students after implementation.

Country	Pre /43	Pre %	Post /43	Post %	Gain pp	Improved	Post ≥80%
Portugal	33.84	78.7	35.48	82.5	+3.8	39/67 (58.2%)	42/67 (62.7%)
Türkiye	30.46	70.8	36.29	84.4	+13.5	20/28 (71.4%)	19/28 (67.9%)
North Macedonia	28.72	66.8	32.36	75.3	+8.5	22/25 (88.0%)	8/25 (32.0%)
Total / weighted	31.98	74.4	35.02	81.4	+7.1	81/120 (67.5%)	69/120 (57.5%)

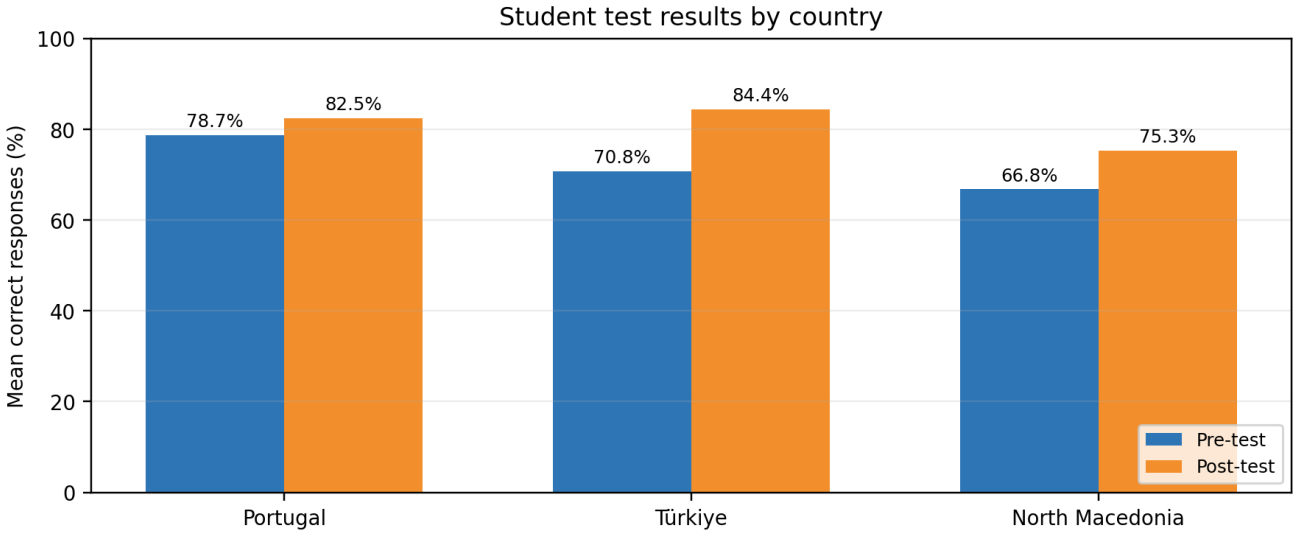

Figure 1. Aggregate pre-test and post-test results by country.

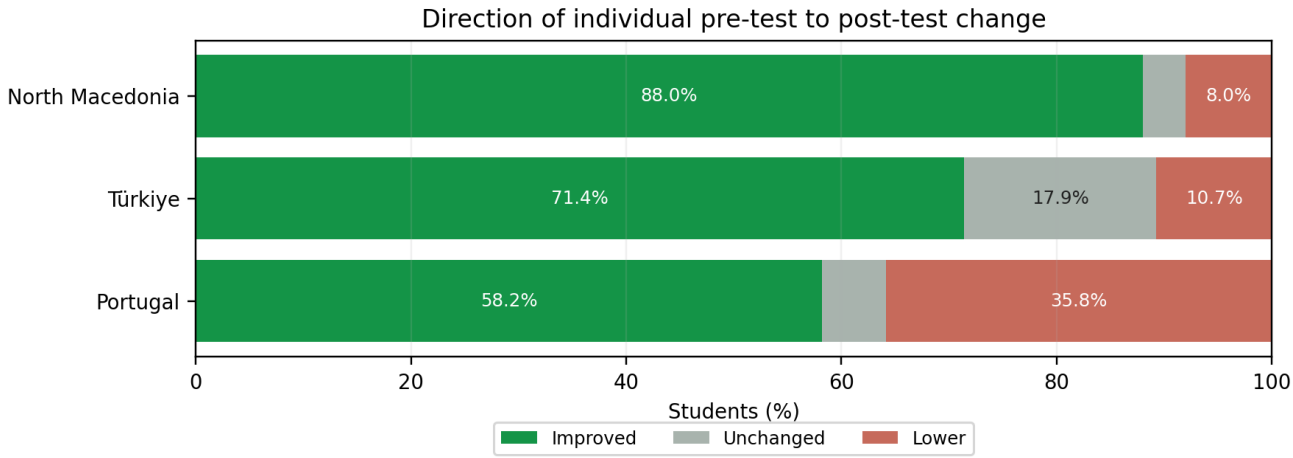

Figure 2. Direction of individual pre-test to post-test change.

Country-level interpretation

Portugal. The group began from the highest baseline (78.7%) and retained a strong final result (82.5%). Thirty-nine students improved, four remained unchanged and 24 recorded lower totals. The smaller aggregate gain (+3.8 percentage points) should be read alongside the high starting level and the large number of students already performing at or above 80%.

Türkiye. The mean increased from 70.8% to 84.4%, the largest gain among the three countries (+13.5 percentage points). Twenty of 28 students improved and 19 reached at least 80% in the post-test. Türkiye therefore combined strong average development with the highest final mean.

North Macedonia. The mean increased from 66.8% to 75.3%. Twenty-two of 25 students improved, showing the broadest distribution of positive change. The final mean remained below Portugal and Türkiye, indicating that additional reinforcement of core concepts would still be beneficial.

Knowledge-domain comparison

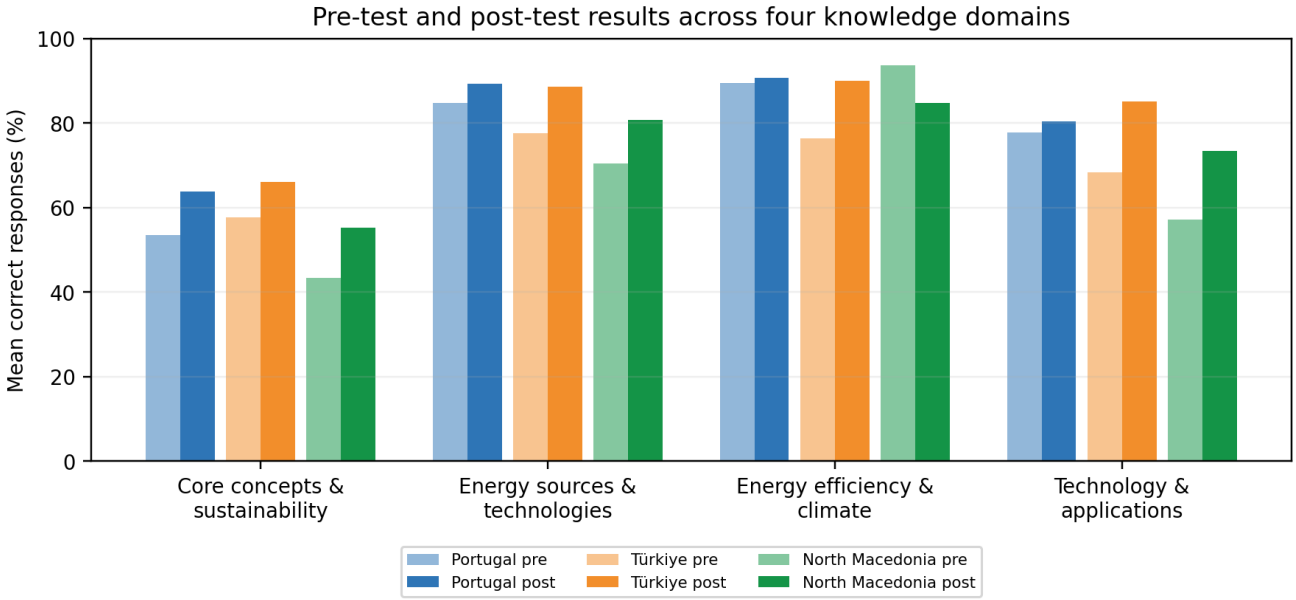

Figure 3. Pre-test and post-test results across four knowledge domains.

Türkiye and North Macedonia recorded their largest domain gains in technology and applications (+16.8 and +16.2 percentage points respectively). Portugal showed its strongest development in core concepts and sustainability (+10.2 pp), while its energy-efficiency and climate result was already very high at baseline. North Macedonia's energy-efficiency and climate score declined from an unusually high baseline of 93.6% to 84.8%; this domain should therefore be reviewed item by item rather than interpreted as a general loss of learning.

Country	Core pre	Core post	Sources pre	Sources post	Efficiency pre/post	Technology pre/post
Portugal	53.5%	63.7%	84.8%	89.3%	89.4% / 90.6%	77.7% / 80.4%
Türkiye	57.7%	66.1%	77.5%	88.6%	76.4% / 90.0%	68.3% / 85.1%
North Macedonia	43.3%	55.3%	70.4%	80.8%	93.6% / 84.8%	57.2% / 73.4%

Item-level strengths and priority needs

Portugal showed the clearest gains in recognising valid biogas uses, understanding generator conversion and consolidating the conservation and transformation of energy. The largest decline concerned the statement on wind-energy installation time, while hydropower regularity and a small number of already-high items also fell slightly.

Türkiye showed strong gains in recognising the hydroelectric device, identifying suitable hydropower conditions, understanding the European renewable-electricity mix, explaining photovoltaic systems, defining energy efficiency and recognising biogas as a vehicle fuel. Reversibility of energy transformations declined by 14.3 percentage points and remains a priority for explicit teaching.

North Macedonia recorded very large gains in biogas heat use, the atmospheric impact of biomass, generator conversion, wind-investment knowledge and biogas electricity generation. At the same time, several items declined from very high pre-test values, particularly regular wind output, photovoltaic function, fossil-fuel share and some hydropower and biogas statements. These mixed item patterns indicate the need for repeated concept checks and consistent wording.

Area	Comparative evidence	Teaching implication
Strong shared foundations	Renewable-source classification, basic energy-saving practices and familiar device recognition were generally strong.	Use these familiar examples as anchors for more abstract concepts.
Positive development	Technology recognition, hydropower, photovoltaics and several biogas applications improved strongly, especially in Türkiye and North Macedonia.	Retain visual materials, practical examples and application-based tasks.
Priority concepts	Reversibility, direct measurement, regularity of renewable output and interpretation of system conditions remained inconsistent.	Use diagrams, demonstrations, retrieval checks and repeated comparison tasks.
Assessment quality	Some items showed unusually high baselines or sharp reversals between tests.	Review item wording and introduce stable anonymous student codes and immediate post-tests.

5. Student Feedback on Classroom Implementation

The six lesson and material indicators averaged 4.02/5 in Portugal, 4.11/5 in Türkiye and 4.77/5 in North Macedonia. Scientific accuracy was Portugal's highest indicator (4.18/5), worksheet readability was Türkiye's highest (4.29/5), and North Macedonia reported very high means across all six indicators, led by worksheet readability (4.88/5).

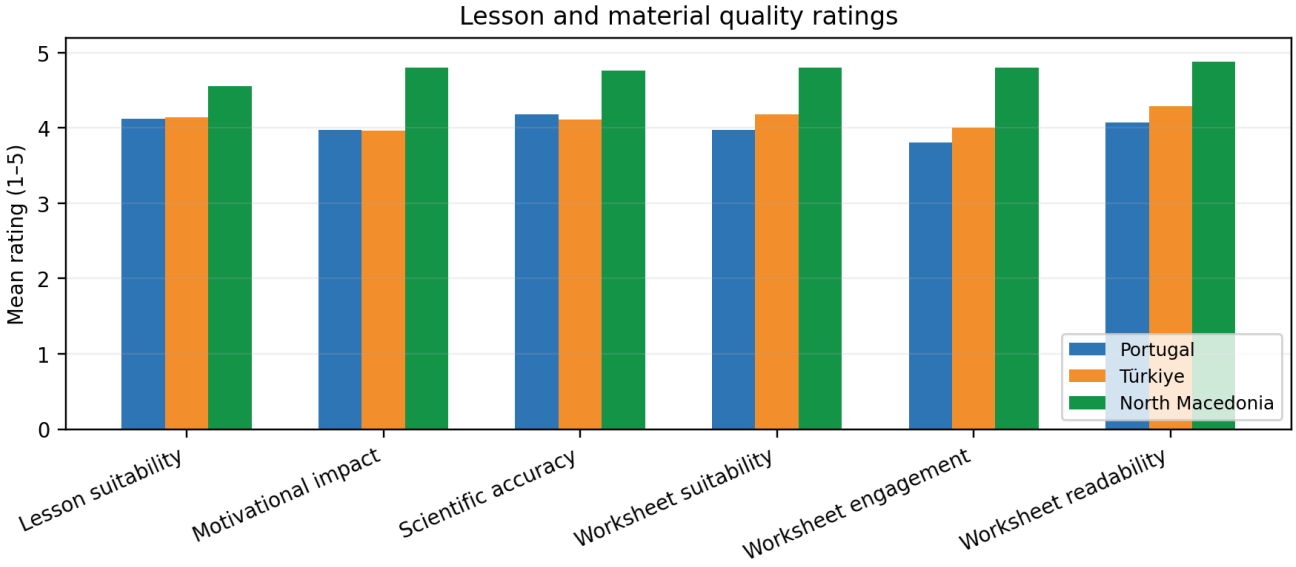

Figure 4. Mean ratings for lesson and material quality.

Good or very good ratings were widespread. Portugal's strongest outcome was participation (94.0%); Türkiye recorded 71.4% positive ratings for the overall course, learning and creative thinking; North Macedonia recorded 92.0%–100.0% positive ratings across all five outcomes. Adequate-or-better ratings were at least 92.9% in every country and outcome.

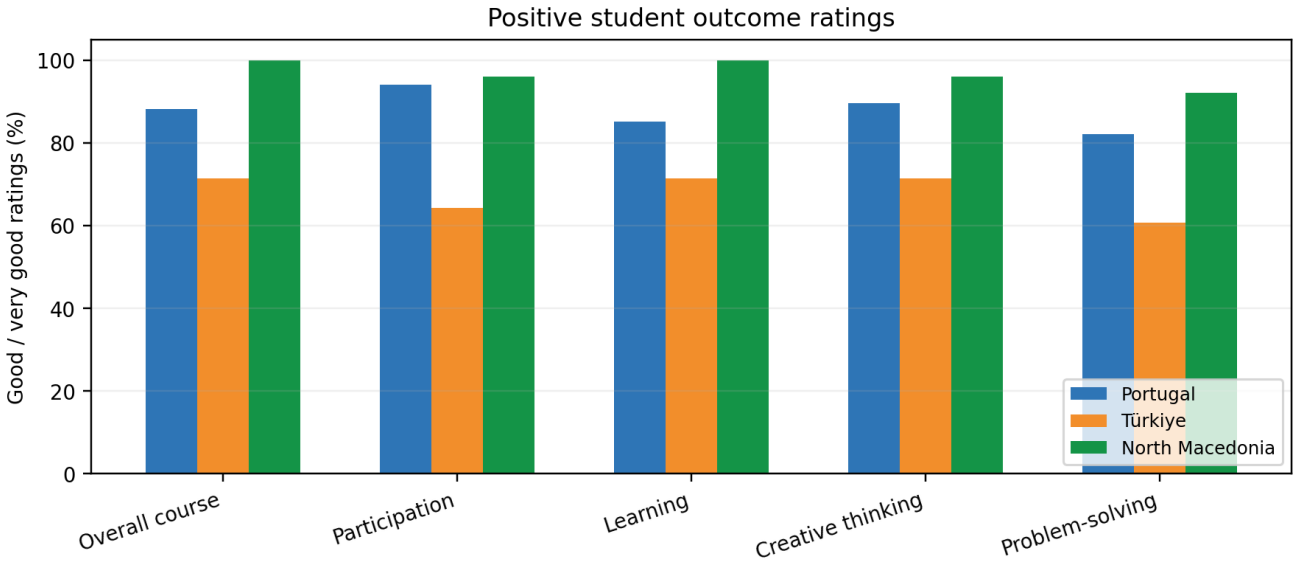

Figure 5. Good or very good student outcome ratings.

6. Activities, Student Voice and Pedagogical Interpretation

Activity ratings differed more strongly between countries than the overall quality ratings. Portugal reported high average engagement (4.21/5) and learning impact (4.16/5), with group work and hands-on activities among the strongest experiences. Türkiye reported more moderate engagement (3.26/5) and learning impact (3.45/5); problem-solving, research, self-assessment, group work and quizzes were among the stronger elements. North Macedonia reported very high engagement (4.79/5) and learning impact (4.86/5), particularly for group work, quizzes, problem-solving and hands-on activities.

Difficulty ratings were modest overall: 1.98/5 in Portugal, 2.43/5 in Türkiye and 1.53/5 in North Macedonia. Türkiye students found quizzes, group work and digital games relatively more demanding, while Portugal identified problem-solving and product creation as the more challenging activities. North Macedonia generally described activities as easy to manage.

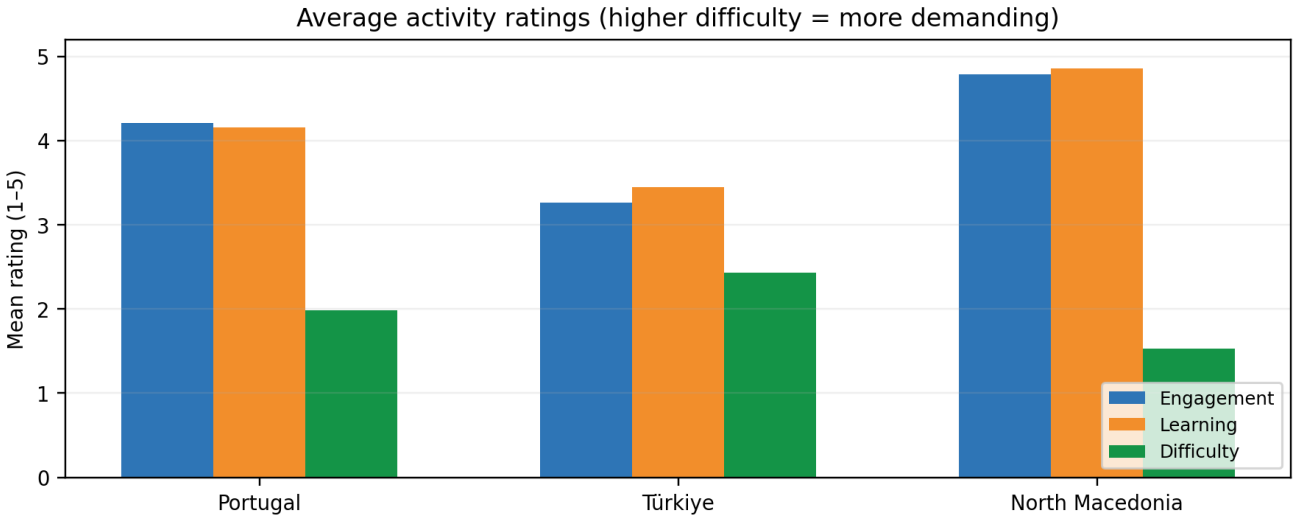

Figure 6. Average activity ratings for engagement, learning and difficulty.

When asked whether other school subjects should use a similar approach, 64.2% of Portuguese students and 64.3% of Turkish students selected definitely or probably yes. In North Macedonia, 96.0% selected definitely or probably yes.

Theme	Evidence from student responses	Implication
Collaborative and practical learning	Students across the three countries valued group work, practical tasks, discussions, problem-solving and real-life examples.	Maintain structured collaboration and increase hands-on investigation.
Creative digital production	Presentations, posters, videos, computer research and visible products were repeatedly highlighted.	Retain digital creation and require students to explain their products.
Environmental relevance	Students valued learning about renewable energy, energy saving, pollution and environmental protection.	Connect lessons with household, school and community action.
Need for concrete explanation	Suggestions included more experiments, models, visual demonstrations, repetition and clearer explanations.	Use models, diagrams, short retrieval checks and repeated application.
Variation in response depth	Some open responses were detailed, while others were minimal or unrelated.	Use clearer prompts, examples and sufficient completion time.

7. Conclusions and Recommendations

1. The three-country implementation produced complete paired test groups and complete feedback datasets for 120 students.

2. Overall knowledge increased from 74.4% to 81.4%; Türkiye achieved the largest gain and highest final mean, Portugal maintained the strongest high-level attainment, and North Macedonia achieved the highest proportion of students improving.

3. Technology and application knowledge developed strongly, but reversibility, direct measurement, output regularity and selected system-condition items require more consistent reinforcement.

4. Lesson quality, participation and learning were evaluated positively in all three countries, although country-level rating patterns should not be treated as direct measures of academic achievement.

5. Collaborative work, hands-on activities, digital production, research and problem-solving should remain central features of future GREENLIGHT workshops.

6. Future cycles should use a stable anonymous student identifier, a common immediate post-test window, consistent item wording and a shared data dictionary across languages.