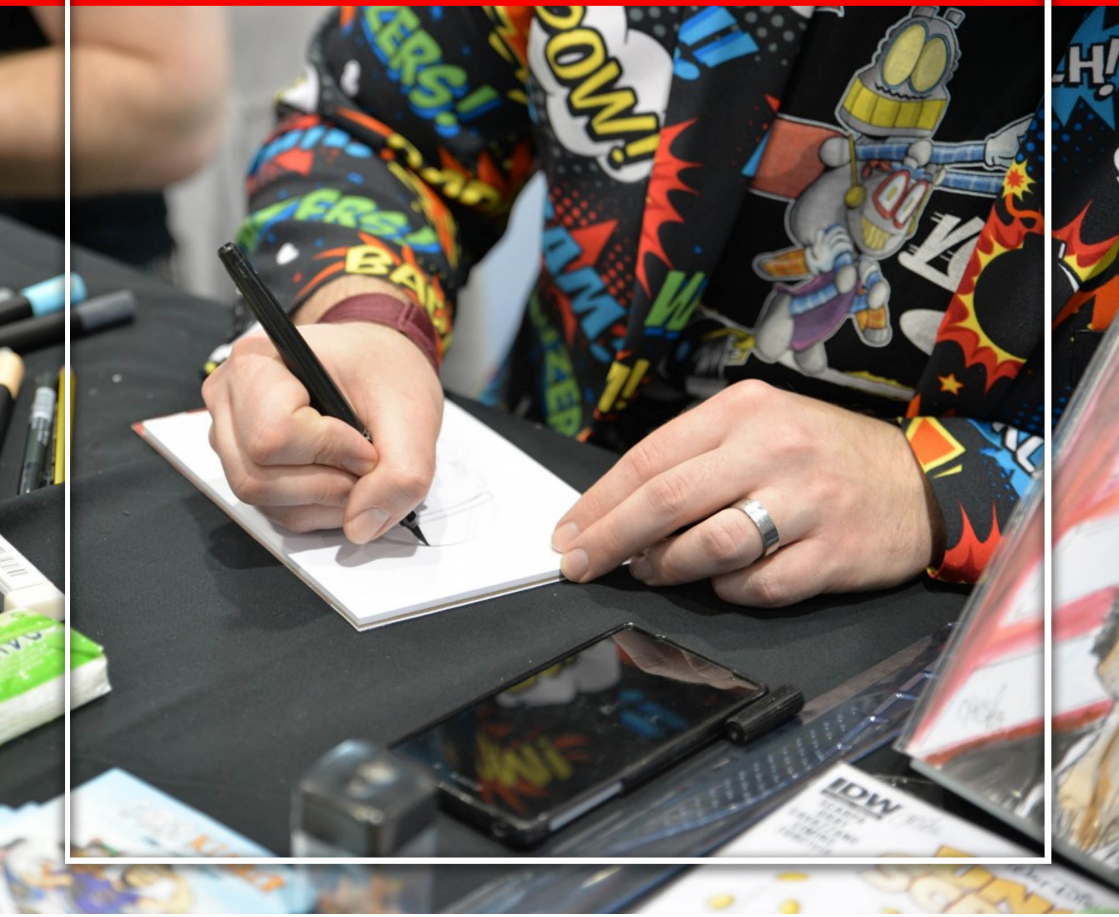
MIRACLE Project Validation Report



MIRACLE

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Co-funded by the European Union

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MIRACLE Project Validation Report

2024

Project Title:
"coMics and IllustRations Augmented to tackle Climate change in primary Education"

Project Administration

Acronym: MIRACLE
Project ID: 2022-2-IE01-KA220-SCH-000098059

Work package n°2 - MIRACLE Sustainability Mindset in European Schools
Deliverable Title: Validation Report
Responsible Partner: PARAGON-eduTech
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Date and version: August 2024, Final Version

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Contents

MIRACLE Project Validation Report: Analysis of Pilot Pre- and Post-Tests

Introduction

The MIRACLE (coMics and IllustRations Augmented to tackle Climate change in primary Education) project develops inclusive strategies for teachers and students to learn about and engage with climate change (CC), a topic that at Primary Education level is perceived as abstract, distant, and complex, and at the same time contributes to growing feelings of sadness, hopelessness, and anxiety.

MIRACLE draws on augmented reality as a medium to educate about climate issues, directly expose users to novel stimuli, and create comics about sustainability, offering the pupils' learning experiences that are engaging, available, and impactful. Comics in education support scientific literacy (Tatalovic, 2009) and creativity, helping learners develop imagination and read between the lines. Comics with AR can also boost digital skills development. Building on art as effective communication for CC education, MIRACLE offers school communities a broader portfolio for CC engagement that combines the multiple possibilities of comics art with digital technologies.

This Validation Report summarizes data from pre-test and post-test surveys administered to the students and teachers that took part in project pilot.

Methodology

Pilot Surveys were designed as two blind treatments (pre- and post-test) for three groups: students; teachers; and community members. Each participating school in each participating country was assigned a unique id, and each respondent in each school received a unique personal id that was recorded for purposes of paired statistical analysis but not shared with the researchers. This report summarizes in the aggregate the results of the pre- and post-tests for student and teacher groups from Croatia, Greece, Malta, Portugal, and Spain. Three categories of questions were presented to participants: Knowledge, Attitude,

and Behaviour. Results for each question were averaged, as were the results for each category of questions. In addition, as the student data from Spain had perfectly matched pre- and post-test groups, additional statistical tests were possible and are included. The current report does not include analysis of community groups as this data was incomplete.

Results: Student Survey

A series of demographic questions collected information on the students' age, gender, grade level, and country. The student survey includes seven Knowledge questions, eight Attitude questions, and seven Behaviour questions, all created with a 5-point Likert Scale (1="Strongly Disagree"; 2="Disagree"; 3="Neither Agree nor Disagree"; 4="Agree"; and 5="Strongly Agree". There were also five open-ended questions that are not analyzed here.

In order to determine the effect of training in Climate Change (CC), the pre-test was administered before the CC lesson, and the post-test after. The number of subjects completing the pre-test and post-test from each country are summarized in Table 1.

Table 1

Students completing the Pre-test and Post-test in Five Countries

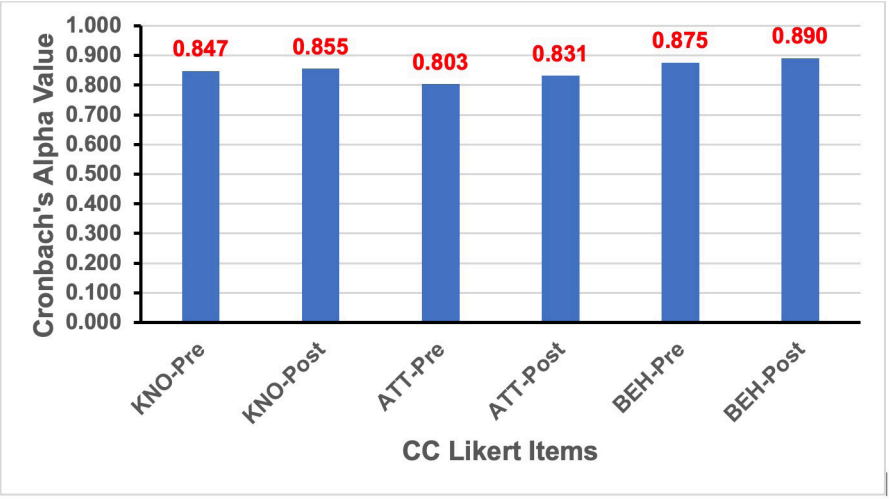
Country	Pre-test n	Post-test n
Croatia	50	41
Greece	110	70
Malta	74	27
Portugal	74	49
Spain	57	57
Total	365	244

Cronbach's Alpha Values were calculated for CC latent items for all five countries together, with 365 students completing the pre-test and 244 completing the post-test. Cronbach's Alpha

varied from .803 to .890, with a qualitative interpretation of "Good", meaning the results are reliable (see Figure 1). Each set of questions—Knowledge (KNO), Attitude (ATT), and Behaviour (BEH)—will be further analyzed below. Complete data analysis is available in Annexes 1, 2 and 3.

Figure 1

Cronbach's Alpha for Climate Change Pilot Student Likert Items



In Croatia, Greece, Malta, and Portugal, the total of students completing the pre-test was not equal to the total of students completing the post-test. As a result, inferential statistical analysis could not be used in the combined analysis of all five countries together. However, in Spain, the same students completed both pre-test and post-test (n = 57). Therefore, student data is analyzed in two ways.

The first analysis combines the data from students in all five countries with all the Knowledge questions, all the Attitude questions, and all the Behaviour questions considered individually and in sets.

There is also a separate analysis of student data from Spain that includes inferential statistics. As the same students completed both pre-test and post-test, it was possible to implement a Non-parametric Paired-Samples Wilcoxon-Test on those results and

report on levels of significance for each question within each set.

An analysis of the open-ended questions is not included here, but this information is incorporated informally in the pilot teacher reports.

Students Combined Results: Croatia, Greece, Malta, Portugal, and Spain

The combined survey results are analyzed in three groups: Knowledge, Attitudes, and Behaviour.

Students Combined: Knowledge Questions

For the pre-test, the students indicated they knew least about: utilizing augmented reality to learn more about CC (X=2.523); the enhanced greenhouse effect (X=2.751); and how to create comic books about climate change (X=2.896). Each of these scored below the midpoint of the 5-point Likert scale. The highest score was for KQ7, "I know how to collaborate or work with other pupils to learn more about climate change" (X=3.718); this might reflect their overall experience in working with others rather than specific experience in working with others to learn about climate change. The results are summarized in Table 2.

For each Knowledge question, the post-test mean was greater than the pre-test mean, indicating that the students had benefitted from the CC lesson.

The Mean Percent Variation (M%V) provides the percentage by which the post-test mean differs from the pre-test mean (see Table 2). The greatest differences between the pre- and post-test were for Knowledge Question (KQ) 1, "I know the meaning of the enhanced greenhouse effect" (M%V =26.48%), and KQ4, "I know how to create comics about climate change" (M%V=25.380%). The smallest difference was for KQ7, "I know how to collaborate or work with other pupils to learn more about climate change" (M%V=6.583%), likely because this question scored the highest in the pre-test.

Figure 2 demonstrates these results visually.

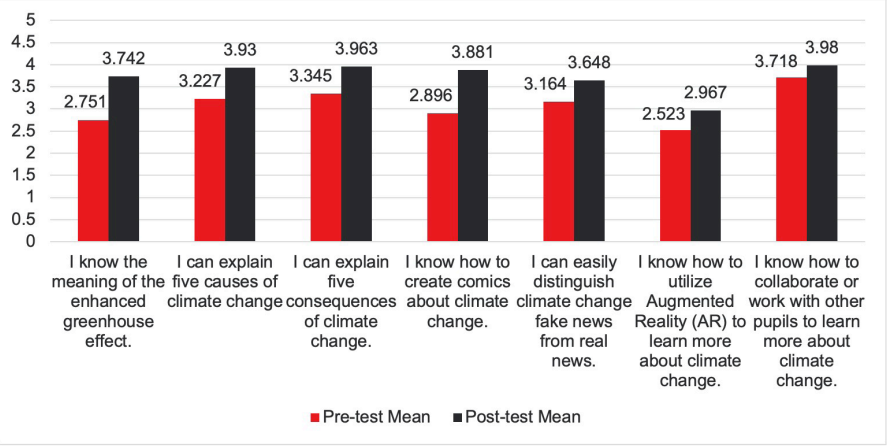
Table 2

Students Combined: Pre-test and Post-test Results for Knowledge Questions (5-pt Likert Scale with 1=Strongly Disagree"

Survey Question	Survey Question Text	Pre-test Mean (1-5)	Post-test Mean (1-5)	Mean % Variation (M%V) (%)
Student Knowledge Q1	I know the meaning of the enhanced greenhouse effect.	2.751	3.742	26.483%
Student Knowledge Q2	I can explain five causes of climate change	3.227	3.930	17.888%
Student Knowledge Q3	I can explain five consequences of climate change.	3.345	3.963	15.594%
Student Knowledge Q4	I know how to create comics about climate change.	2.896	3.881	25.380%
Student Knowledge Q5	I can easily distinguish climate change fake news from real news.	3.164	3.648	13.268%
Student Knowledge Q6	I know how to utilize Augmented Reality (AR) to learn more about climate change.	2.523	2.967	14.965%
Student Knowledge Q7	I know how to collaborate or work with other pupils to learn more about climate change.	3.718	3.980	6.583%

Figure 2

Students Combined: Pre-test and Post-test Results for Knowledge Questions



Students Combined (all five countries): Attitude Questions

All the Attitude questions scored above the midpoint in the pre-test, with the highest score for AQ1, "I believe climate change is real and dangerous" (X=3.934) (Table 3). The lowest mean was for AQ6, "I believe I am at great risk of being manipulated by climate change fake news" (X=3.030).

As with the Knowledge questions, **the mean response to the Attitude questions rose in every case between the pre-test and the post-test**, though some of the increases were small. The highest score was for AQ1, "I believe climate change is real and dangerous" (X=4.270). The greatest difference between the pre- and post-test was for AQ2, "I believe I can have an impact on slowing climate change", with an M%V of 13.099%.

Table 3

Students Combined: Pre-test and Post-test Results for Attitude Questions (5-pt Likert Scale with 1=Strongly Disagree"

Survey Question	Survey Question Text	Pre-test Mean (1-5)	Post-test Mean (1-5)	Mean % Variation (M%V)
Student Attitude Q1	I believe climate change is real and dangerous.	3.934	4.270	7.869%
Student Attitude Q2	I believe I can have an impact on slowing climate change.	3.430	3.947	13.099%
Student Attitude Q3	I believe any citizen can have an impact on slowing climate change.	3.699	4.020	7.985%
Student Attitude Q4	I believe my creation of comics about climate change will help me learn more about climate change.	3.674	4.037	8.992%
Student Attitude Q5	I believe my creation of comic books about climate change will help me be more positive about the environment.	3.619	3.906	7.348%
Student Attitude Q6	I believe I am at great risk of being manipulated by climate change fake news.	3.030	3.143	3.595%
Student Attitude Q7	I believe Augmented Reality (AR) can help me learn more about climate change.	3.433	3.701	7.241%
Student Attitude Q8	I believe collaborating or working with other pupils can help me learn more about climate change.	3.874	4.061	4.605%

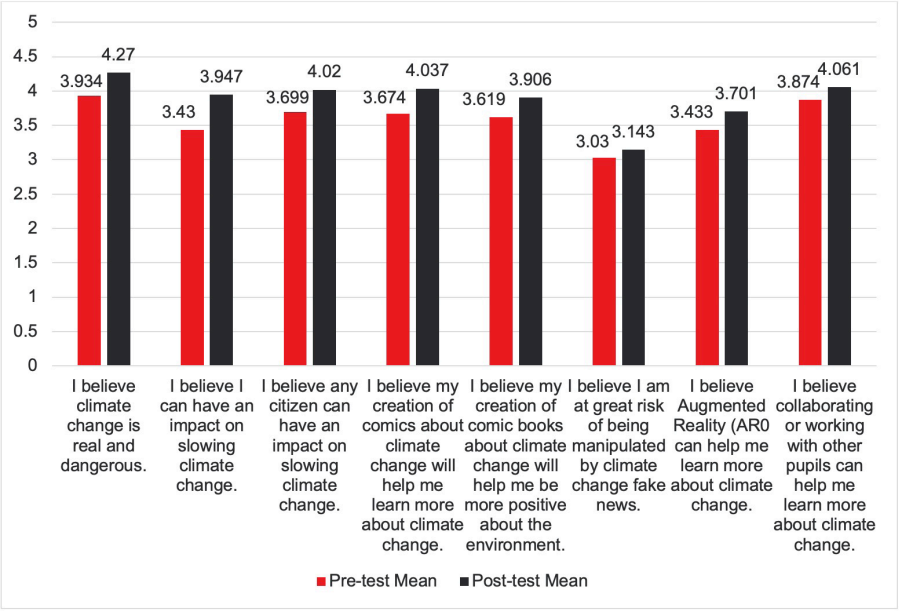
Results are graphed in Figure 3.

Students Combined: Behaviour Questions

The last set of multiple choice questions focused on participant behaviours in order to examine whether the CC

Figure 3

Students Combined: Pre-test and Post-test Results for Attitude Questions (5-pt Likert Scale with 1=Strongly Disagree"



lessons translated into behavioral changes that might have a positive effect on the environment.

In general, the pre-test average for Behaviour questions was lower than that of the other categories. On the pre-test, the average of five of the eight Behaviour questions was below "3", the midpoint of the 1-5 Likert scale. The lowest initial score was for Behaviour Question 6 (BQ6), "I am actively using Augmented Reality (AR) to learn more about climate change", with a pre-test mean of 2.493 on a scale of 5. Still, this score is high considering it is unlikely any of the students were actually using AR in any context let alone to learn about CC. Only two questions averaged above the midpoint. Very slightly above the midpoint was BQ2, "I am actively advocating among my friends for behaviours that will reduce climate change" (X=3.041). The highest pre-test average was for BQ1(X=3.156), "I am actively engaging in ways to combat climate change by reducing my carbon footprint". Still, this is only slightly above

the Likert scale midpoint. The results are summarized in Table 4.

Table 4

Students Combined: Pre-test and Post-test Results for Behaviour Questions (5-pt Likert Scale with 1=Strongly Disagree"

Survey Question	Survey Question Text	Pre-test Mean (1-5)	Post-test Mean (1-5)	Mean % Variation (M%V) (%)
Student Behaviour Q1	I am actively engaging in ways to combat climate change by reducing my carbon footprint.	3.156	3.545	10.973%
Student Behaviour Q2	I am actively advocating among my friends for behaviours that will reduce climate change.	3.041	3.385	10.162%
Student Behaviour Q3	I am actively advocating within my school for policies that will reduce climate change.	2.934	3.496	16.076%
Student Behaviour Q4	I am actively advocating within my community for policies and behaviours that will reduce climate change.	2.830	3.365	15.899%
Student Behaviour Q5	I am actively teaching my friends how to identify climate change fake news.	2.619	3.254	19.514%
Student Behaviour Q6	I am actively using Augmented Reality (AR) to learn more about climate change.	2.493	2.693	7.427%
Student Behaviour Q7	I frequently collaborate or work with friends and family to learn more about climate change.	2.893	3.299	12.307%

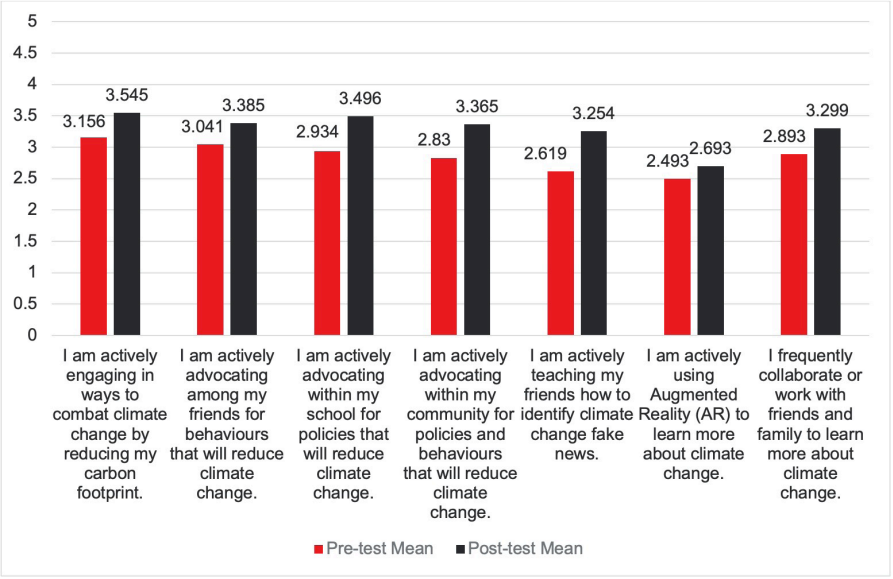
As with the Knowledge and Attitude questions, in each case participants' scores on the Behaviour questions increased in the post-test. In the post-test, the mean for BQ6, the lowest initial score, increased to 2.693, though this is still below the midpoint of the scale.

The average for BQ1, "I am actively engaging in ways to combat climate change by reducing my carbon footprint" which had the highest mean of 3.156 on the pre-test, increased to 3.545 on the post-test. Overall, the biggest changes as measured by M%V were in response to BQ5, "I am actively teaching my friends how to identify climate change fake news" (19.514% increase) and BQ3, "I am actively advocating within my school for policies that will reduce climate change." (16.076% increase).

The results are graphed in Figure 4.

Figure 4

Students Combined: Pre-test and Post-test Results for Behaviour Questions (5-pt Likert Scale with 1=Strongly Disagree"



Students Combined: Comparison of Survey Results by Category

The results of the Knowledge, Attitude, and Behaviour Questions can be compared by utilizing a Weighted Average (WAvg). This is calculated by summing up the mean value for each question in a specific category, and then dividing this sum by the number of questions in the category. This allows consideration of students' average response to each group of questions. The results are summarized in Table 5.

For each category, the students' average increased between pre- and post-test. Overall, the greatest gain occurred in the Knowledge question set, with an increase of 17.185%. The smallest gain occurred in the Attitude question set, with an increase of 7.694%; note that this set had the highest initial average, which could explain why the gain was lower in the post-test.

The results are graphed in Figure 5.

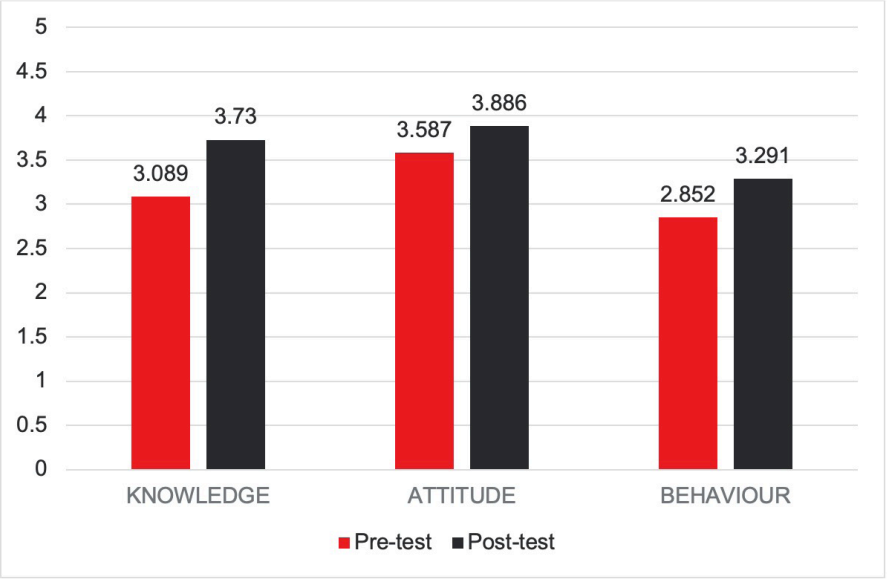
Table 5

Students Combined: Weighted Averages of Pre- and Post-test Knowledge, Attitude, and Behaviour Question Sets

CC Latent Variable	Pre-Test WAvg	Post-Test WAvg	WAvg Variation (%)
KNOWLEDGE	3.089	3.730	17.185
ATTITUDE	3.587	3.886	7.694
BEHAVIOUR	2.852	3.291	13.339

Figure 5

Weighted Averages of Student Pre- and Post-test Knowledge, Attitude, and Behaviour Question Sets



Student Results from Spain Analyzed Separately

As exactly the same 57 students responded to the pre-test and post-test in Spain, it is possible to analyze the Spanish data on its own in order to perform tests of significance. As with the combined data, the analysis will include three sets of questions:

Knowledge, Attitude, and Behaviour. As the Likert scale data is ordinal, the Wilcoxon signed rank test was used to test the difference between the means of pre-test and post-test.

Students from Spain: Knowledge Questions

Table 6 presents data from the Spanish student pre- and post-test on the Knowledge questions, including tests of significance. For each question, averages increased between pre- and post-test. Three of the questions were highly significant ($p < .001$): KQ1, "I know the meaning of the greenhouse effect", KQ2, "I can explain five causes of climate change", and KQ4, "I know how to create comics about climate change" (the probability level for the significant results is bold-faced here and in subsequent

Table 6

Students from Spain: Pre-test and Post-test Results for Knowledge Questions (5-pt Likert Scale with 1=Strongly Disagree)

Survey Question	Survey Question Text	Pre-test Mean (1-5)	Post-test Mean (1-5)	Mean % Variation (M%V) (%)	W	P-Value
Student Knowledge Q1	I know the meaning of the enhanced greenhouse effect.	3.088	3.947	21.763	169.000	**< 0.001**
Student Knowledge Q2	I can explain five causes of climate change	2.982	3.842	22.384	161.500	**< 0.001**
Student Knowledge Q3	I can explain five consequences of climate change.	3.544	3.877	8.589	212.000	n.s. (0.079)
Student Knowledge Q4	I know how to create comics about climate change.	3.018	4.035	25.204	104.500	**< 0.001**
Student Knowledge Q5	I can easily distinguish climate change fake news from real news.	3.632	3.789	4.144	391.500	n.s. (0.607)
Student Knowledge Q6	I know how to utilize Augmented Reality (AR) to learn more about climate change.	2.807	3.175	11.591	265.500	n.s. (0.193)
Student Knowledge Q7	I know how to collaborate or work with other pupils to learn more about climate change.	3.526	3.825	7.817	297.000	n.s. (0.182)

tables). The remaining questions demonstrated an increase in knowledge in the post-test but were not statistically significant (n.s.).

Students from Spain: Attitude Questions

Among the attitude questions, in each case the results of the post-test demonstrated students were more engaged with climate change issues after the lesson (Table 7). However, only one question was statistically significant, AQ2, "I believe I can have an impact on slowing climate change" (p=.037). It is interesting to note that in the pre-test, AQ2 "I believe I can have an impact…" scored 3.579 on the Likert scale, below AQ3, "I believe any citizen can have an impact…", which scored 3.842. However, in the post-test, AQ2 "I believe I can have an impact…" scored 4.000, above AQ3, "I believe any citizen can have an impact…" which scored 3.860. It appears that after the lesson the students felt more empowered and believed they were more able to make an impact than they believed others could.

Students from Spain: Behaviour Questions

Table 8 summarizes the results of the behavior questions in the administration of the pre-test and post-test to students in Spain. **In every case, self-report of behaviour related to managing climate change increased after the lesson.** Results were statistically significant for every question but one, BQ3, "I am actively advocating within my school for policies that will reduce climate change", although there was a significant difference for BQ4, "I am actively advocating within my community…" Perhaps the students saw their "community" as a more personal one than that of the school, and therefore felt more empowered to advocate within that more personal group.

Table 7

Students from Spain: Pre-test and Post-test Results for Attitude Questions (5-pt Likert Scale with 1=Strongly Disagree"

Survey Question	Survey Question Text	Pre-test Mean (1-5)	Post-test Mean (1-5)	Mean % Variation (M%V) (%)	W	P-Value
Student Attitude Q1	I believe climate change is real and dangerous.	4.018	4.228	4.967	183.000	n.s. (0.189)
Student Attitude Q2	I believe I can have an impact on slowing climate change.	3.579	4.000	10.525	133.000	**0.037**
Student Attitude Q3	I believe any citizen can have an impact on slowing climate change.	3.842	3.860	0.466	228.500	n.s. (0.941)
Student Attitude Q4	I believe my creation of comics about climate change will help me learn more about climate change.	3.719	3.860	3.653	259.000	n.s. (0.497)
Student Attitude Q5	I believe my creation of comic books about climate change will help me be more positive about the environment.	3.544	3.842	7.756	299.000	n.s. (0.196)
Student Attitude Q6	I believe I am at great risk of being manipulated by climate change fake news.	3.053	3.368	9.353	315.500	n.s. (0.199)
Student Attitude Q7	I believe Augmented Reality (AR0 can help me learn more about climate change.	3.368	3.456	2.546	352.000	n.s. (0.789)
Student Attitude Q8	I believe collaborating or working with other pupils can help me learn more about climate change.	3.754	3.895	3.620	181.500	n.s. (0.432)

Table 8

Students from Spain: Pre-test and Post-test Results for Behaviour Questions (5-pt Likert Scale with 1=Strongly Disagree"

Survey Question	Survey Question Text	Pre-test Mean (1-5)	Post-test Mean (1-5)	Mean % Variation (M%V) (%)	W	P-Value
Student Behaviour Q1	I am actively engaging in ways to combat climate change by reducing my carbon footprint.	3.018	3.614	16.491	185.500	**0.003**
Student Behaviour Q2	I am actively advocating among my friends for behaviours that will reduce climate change.	2.965	3.509	15.503	214.500	**0.012**
Student Behaviour Q3	I am actively advocating within my school for policies that will reduce climate change.	3.404	3.579	4.890	219.000	n.s. (0.397)
Student Behaviour Q4	I am actively advocating within my community for policies and behaviours that will reduce climate change.	3.018	3.421	11.780	149.500	**0.029**
Student Behaviour Q5	I am actively teaching my friends how to identify climate change fake news.	2.333	3.263	28.501	98.000	**<.001**
Student Behaviour Q6	I am actively using Augmented Reality (AR) to learn more about climate change.	2.579	3.123	17.419	219.000	**0.044**
Student Behaviour Q7	I frequently collaborate or work with friends and family to learn more about climate change.	2.737	3.474	21.215	201.000	**0.003**

Students from Spain: Comparison of Survey Results by Category

As with the five countries combined, the results of Spain's Knowledge, Attitude, and Behaviour Questions can be compared. The results are summarized in Table 9, including Wilcoxon score and probability level.

All categories demonstrate an increase between pre- and post-test. As the data from Spain includes perfectly matches pairs for pre- and post-test, it was also possible to utilize inferential statistics utilizing a paired samples t-test to calculate significance. The categories of Knowledge and Behaviour

Table 9

Students from Spain: Weighted Averages of Pre- and Post-test Knowledge, Attitude, and Behaviour Question Sets

CC Latent Variable	Pre-Test WAvg	Post-Test WAvg	WAvg Variation (%)	W	p
KNOWLEDGE	3.228	3.784	14.693	275.000	**<.001**
ATTITUDE	3.610	3.814	5.349	550.000	n.s. (0.291)
BEHAVIOUR	2.865	3.426	16.375	323.000	**<.001**

demonstrate significantly higher averages between pre- and post-test, while the difference in the Attitude category, the highest overall, is not significant.

Results – Teacher Survey

A pre-test and post-test survey were administered to the teachers from all five countries that were involved in the project. The survey questions in many cases were identical to those asked of the students, with some demographic and content questions directed to the teacher role. Forty teachers from five countries completed the pre-test survey. Twenty-two teachers completed the post-test survey (Table 10).

Table 10

Teachers completing the Pre-test and Post-test in Five Countries

Country	Pre-test n	Post-test n
Croatia	6	3
Greece	13	9
Malta	14	4
Portugal	4	3
Spain	3	3
Total	*40*	*22*

As with the combined students, the numbers completing the pre-test were not identical to those completing the post-test, and therefore inferential statistical analysis could not be used in the combined analysis of teachers from all five countries together. Instead, the data from all teachers is combined as

in the first analysis of student data, with all the Knowledge questions, all the Attitude questions, and all the Behaviour questions considered individually and in sets.

An analysis of the Teacher open-ended questions is not included here, but this information is incorporated informally in the pilot teacher reports.

Teachers Combined: Knowledge Questions

In the pre-test the average of each question except for one was above the midpoint of the 5-point Likert scale. The average response to KQ6, "I can utilize Augmented Reality (AR) to facilitate climate change pupil learning" was 2.925, very slightly below the midpoint of 3. The highest score on the pre-test was KQ3, "I can explain five consequences of climate change" (X=4.275), followed closely by KQ2, "I can explain five causes of climate change" (X=4.200) (Table 11).

As with the students, **each knowledge question for the teachers demonstrated a gain between the pre- and post-test.** The largest gain was for KQ4, "I can integrate pupil creation of comics into the climate change curriculum to help pupils meet EU standards or European Green Deal" (16.016%), demonstrating the impact of training and implementation. The smallest gain was for KQ3, "I can explain five consequences of climate change" (X=4.818, M%V = 11.270%); recall that this was the highest scoring question in the pre-test and therefore there was not much room for improvement.

These results are depicted in graph form in Figure 6.

Teachers Combined: Attitude Questions

Every one of the Attitude questions that teachers responded to averaged above 4 on the Likert scale on both the pre-test and post-test. This is the only set of questions for which this occurred. The lowest score was AQ7, "I believe Augmented Reality (AR) can help me learn more about climate change" (X=4.000), while the highest score was AQ1, "I believe climate change is real and dangerous" (X=4.775). Results are summarized in Table 12.

Table 11

Teachers Combined: Pre-test and Post-test Results for Knowledge Questions (5-pt Likert Scale with 1=Strongly Disagree"

Survey Question	Survey Question Text	Pre-test Mean (1-5)	Post-test Mean (1-5)	Mean % Variation (M%V) (%)
Teachers Knowledge Q1	I know the meaning of the enhanced greenhouse effect.	4.075	4.682	12.965%
Teachers Knowledge Q2	I can explain five causes of climate change	4.200	4.909	14.433%
Teachers Knowledge Q3	I can explain five consequences of climate change.	4.275	4.818	11.270%
Teachers Knowledge Q4	I can integrate pupil creation of comics into the climate change curriculum to help pupils meet EU standards or European Green Deal.	3.550	4.227	16.016%
Teachers Knowledge Q5	I can easily distinguish climate change fake news from real news.	3.625	4.182	13.319%
Teachers Knowledge Q6	I can utilize Augmented Reality (AR) to facilitate climate change pupil learning.	2.925	3.364	13.050%
Teachers Knowledge Q7	I know how to utilize pupil collaboration to enhance climate change learning outcomes.	3.900	4.409	11.545%

Figure 6

Teachers Combined: Pre-test and Post-test Results for Knowledge Questions

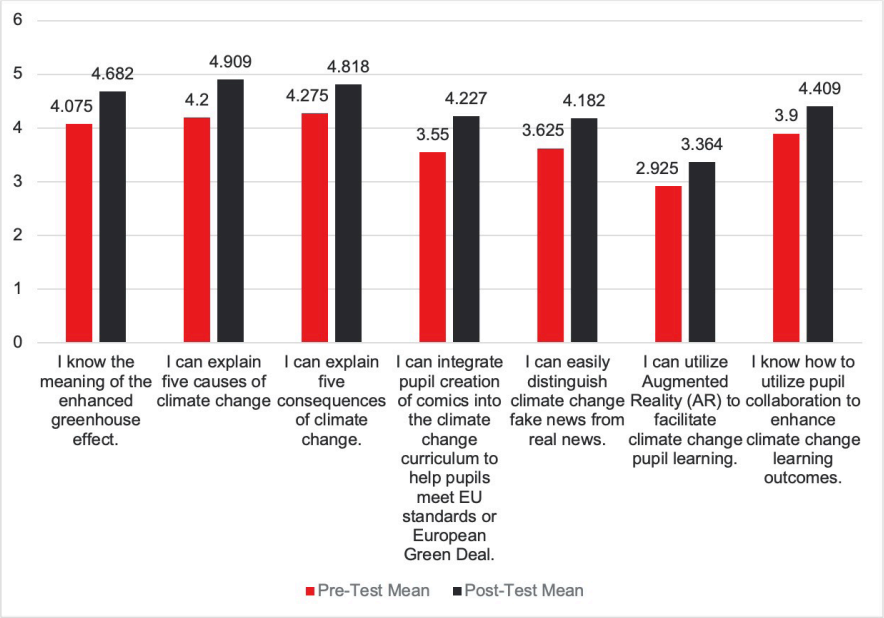


Table 12

Teachers Combined: Pre-test and Post-test Results for Attitude Questions (5-pt Likert Scale with 1=Strongly Disagree"

Survey Question	Survey Question Text	Pre-test Mean (1-5)	Post-test Mean (1-5)	Mean % Variation (M%V)
Teacher Attitude Q1	I believe climate change is real and dangerous.	4.775	4.818	0.892%
Teacher Attitude Q2	I believe I can have an impact on slowing climate change.	4.325	4.773	9.386%
Teacher Attitude Q3	I believe any citizen can have an impact on slowing climate change.	4.475	4.773	6.243%
Teacher Attitude Q4	I believe my creation of comics about climate change will help me learn more about climate change.	4.225	4.545	7.041%
Teacher Attitude Q5	I believe my creation of comic books about climate change will help me be more positive about the environment.	4.325	4.682	7.625%
Teacher Attitude Q6	I believe I am at great risk of being manipulated by climate change fake news.	4.225	4.500	6.111%
Teacher Attitude Q7	I believe Augmented Reality (AR) can help me learn more about climate change.	4.000	4.364	8.341%
Teacher Attitude Q8	I believe collaborating or working with other pupils can help me learn more about climate change.	4.575	4.818	5.044%

Scores for teachers increased on every attitude question in the post-test. Mean % Variation for the Attitude Questions is lower than for the other sets of questions since the averages are so high to begin with. The lowest gain was for AQ1, "I believe climate change is real and dangerous" (X=4.818, M%V = 0.892%). The biggest gain was for AQ2, "I believe I can have an impact on slowing climate change" (X=4.773, M%V = 9.386%). This reveals that teachers already thought that climate change was real and dangerous before training, but they felt more empowered to do something about it after training.

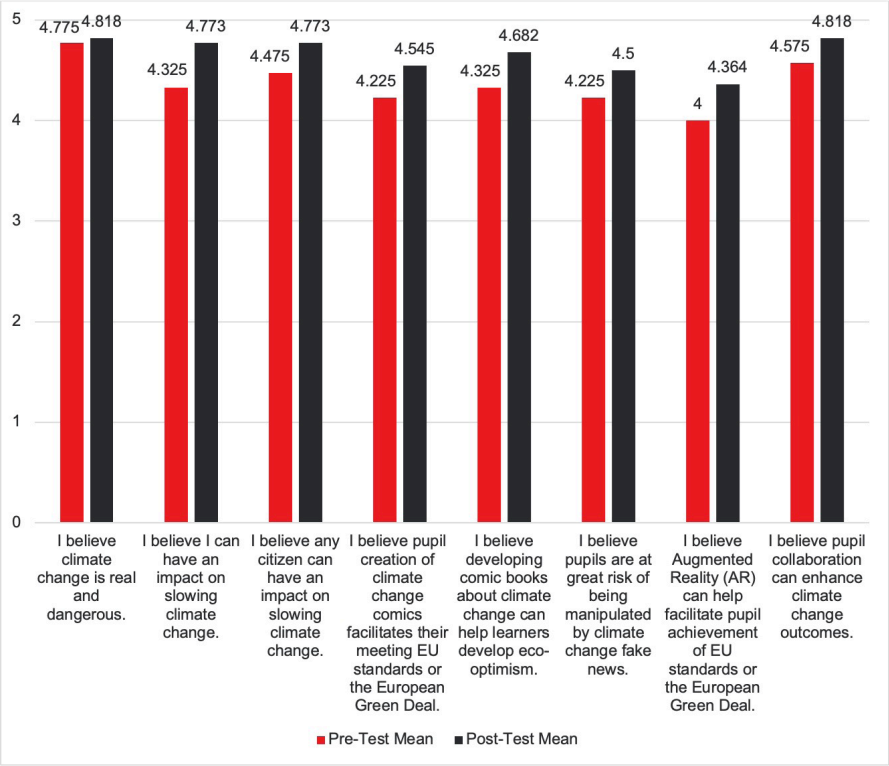
Results are graphed in Figure 7.

Teachers Combined: Behaviour Questions

In the pre-test Behaviour question set, teacher responses ranged from an average of 2.675 for BQ6 ("I am actively using Augmented Reality (AR) to facilitate climate change pupil learning") to 4.150 for BQ2 ("I am actively advocating among my friends for behaviours that will reduce climate change"). Results are summarized in Table 13.

Figure 7

Teachers Combined: Pre-test and Post-test Results for Attitude Questions



Average responses to each Behaviour question increased between pre- and post-test for the teachers. The highest score on the post-test was for BQ1, "I am actively engaging in ways to combat climate change by reducing my carbon footprint" (X=4.500). The next highest mean was 4.364, shared by BQ2 "I am actively advocating among my friends for behaviours that will reduce climate change" and BQ3 "I am actively advocating within my school for policies that will reduce climate change". The questions with the greatest gain were BQ5 "I am actively teaching my pupils how to identify climate change fake news" (M%V = 18.699%) and BQ7 "I frequently implement pupil collaboration to enhance climate change learning (M%V = 18.675%). The results are graphed in Figure 8.

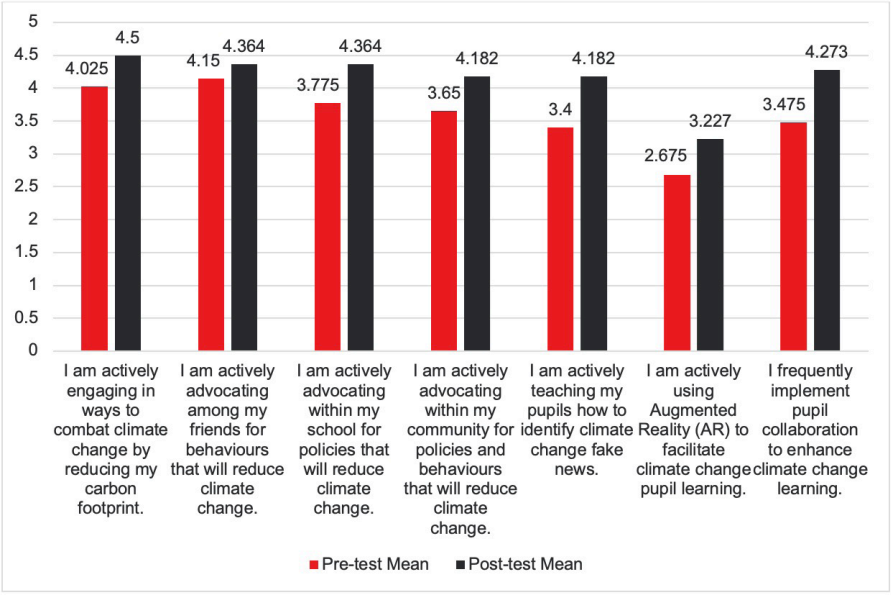
Table 13

Teachers Combined: Pre-test and Post-test Results for Behaviour Questions (5-pt Likert Scale with 1=Strongly Disagree"

Survey Question	Survey Question Text	Pre-test Mean (1-5)	Post-test Mean (1-5)	Mean % Variation (M%V)
Teacher Behaviour Q1	I am actively engaging in ways to combat climate change by reducing my carbon footprint.	4.025	4.500	10.556%
Teacher Behaviour Q2	I am actively advocating among my friends for behaviours that will reduce climate change.	4.150	4.364	4.904%
Teacher Behaviour Q3	I am actively advocating within my school for policies that will reduce climate change.	3.775	4.364	13.497%
Teacher Behaviour Q4	I am actively advocating within my community for policies and behaviours that will reduce climate change.	3.650	4.182	12.721%
Teacher Behaviour Q5	I am actively teaching my pupils how to identify climate change fake news.	3.400	4.182	18.699%
Teacher Behaviour Q6	I am actively using Augmented Reality (AR) to facilitate climate change pupil learning.	2.675	3.227	17.106%
Teacher Behaviour Q7	I frequently implement pupil collaboration to enhance climate change learning.	3.475	4.273	18.675%

Figure 8

Teachers Combined: Pre-test and Post-test Results for Behaviour Questions



Teachers Combined: Comparison of Survey Results by Category

As with the Student data, the results of the Knowledge, Attitude, and Behaviour Questions are compared by utilizing a Weighted Average (WAvg), calculated by summing up the mean value for each question in a specific category, and then dividing this sum by the number of questions in the category. This allows consideration of teachers' average response to each group of questions. The results are summarized in Table 14.

Table 14

Teachers Combined: Weighted Averages of Pre- and Post-test Knowledge, Attitude, and Behaviour Question Sets

CC Latent Variable	Pre-Test WAvg	Post-Test WAvg	WAvg Variation (%)
KNOWLEDGE	3.793	4.370	13.204%
ATTITUDE	4.366	4.659	6.289%
BEHAVIOUR	3.593	4.156	13.547%

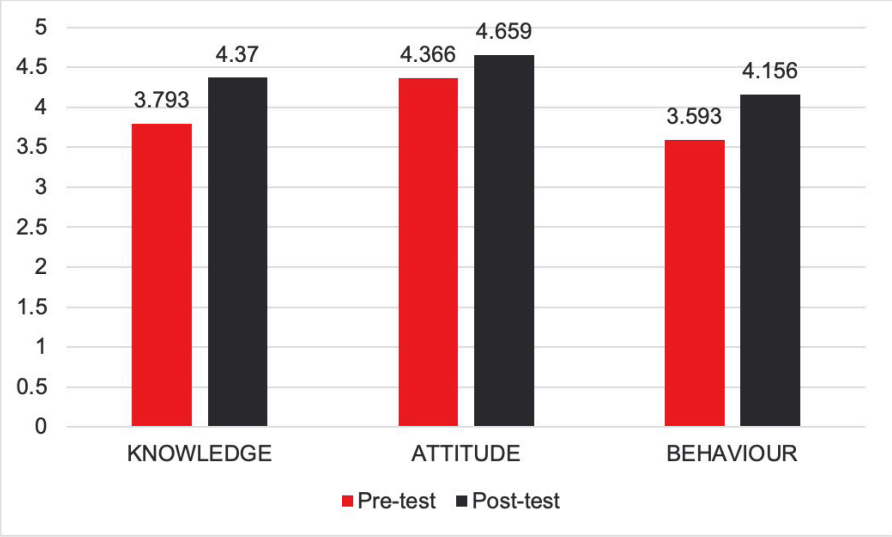
For each category, the teachers' average increased between pre- and post-test. Overall, the greatest gain occurred in the Behaviour question set, with an increase of 13.547%, followed closely by the Knowledge question set, with an increase of 13.204%. The smallest gain occurred in the Attitude question set, with an increase of 6.289%. Note however that, as with the student data, the Attitude questions had the highest initial average, which could explain why the gain was lowest for this set in the post-test. The results are graphed in Figure 9.

Result Comparison – Student and Teacher Question Sets

In most cases, questions in the Student and Teacher question sets were identical, but in several cases, they differed as to perspective. For example, students were asked about their own use of tools to learn about CC while teachers were asked about utilizing tools to teach CC to students. As a result, rather than directly comparing each question, this analysis will

Figure 9

Weighted Averages of Teacher Pre- and Post-test Knowledge, Attitude, and Behaviour Question Sets



directly compare the questions sets: Knowledge, Attitude, and Behaviour. Results are summarized in Table 15.

Table 15

Comparison of Students and Teachers: Weighted Averages of Pre- and Post-test Knowledge, Attitude, and Behaviour Question Sets

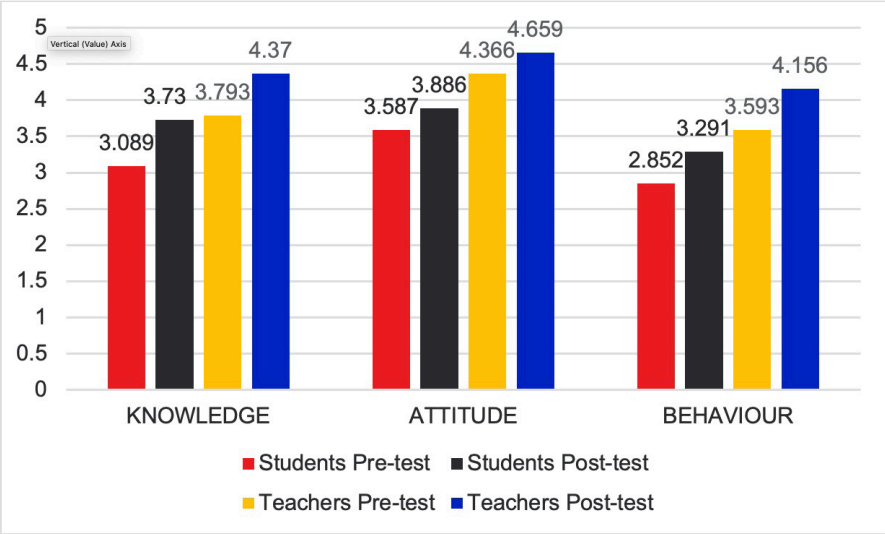
	Students		Teachers	
Question Set	**Pre-test**	**Post-test**	**Pre-test**	**Post-test**
KNOWLEDGE	3.089	3.730	3.793	4.370
ATTITUDE	3.587	3.886	4.366	4.659
BEHAVIOUR	2.852	3.291	3.593	4.156

These results summarize the effectiveness of the lessons for both the Student and Teacher groups. For each group, on each question set, the average of the post-test exceeded that of the pre-test. It is also possible to see that for each question set, while the average of the Student post-test increased from that of the

pre-test, it still fell below the average of the Teacher pre-test. For example, for the Knowledge question set, the Student post-test average was 3.730, while the Teacher pre-test average was 3.793, rising to 4.37 on the post-test. Comparison results are graphed in Figure 10.

Figure 10

Comparison of Students and Teachers: Weighted Averages of Pre- and Post-test Knowledge, Attitude, and Behaviour Question Sets



Conclusions

For both Students and Teacher groups, for each Knowledge, Attitude, and Behaviour question and also for each question set, there was an increase in desired response between the pre-test and post-test. This suggests that **the teacher training and student lessons were effective in increasing student knowledge, attitudes, and behavior with respect to climate change.**

Logistical challenges during the pilot suggest simplifying some procedures for large scale implementation. It will not be necessary, for example, to require administration of a pre-test since the results of the pilot are sufficient to demonstrate the effect of the treatment.

The pilot validates the positive impact of the training on the teachers and of the lessons on the students.

Annex 1
HR-EL-EN-PT-ES Pilot Student Survey
Pre- & Post-Test Data Analysis (5)

Miracle Climate Change Project
HR-EL-EN-PT-ES Pilot Student Survey
Pre- & Post-Test Data Analysis (5)

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PARAGON-eduTech
2024-08-18

Introduction

A student pilot survey for the Miracle's **Climate Change (CC)** Project was conducted at several schools in Croatia, Greece, Malta, Portugal, and Spain. The objective of this pilot survey was to acquire relevant data for the development of suitable Statistical Analysis Methods capable of evaluating the students' perception of their **CC Knowledge**, **CC Attitude**, and **CC Behaviour**, prior to and post their CC training.

To this end, three sets of a **5-point Likert Scale questions,** identified as **Likert Items**, were generated, a set for each of the project's three latent variables of **Knowledge**, **Attitude**, and **Behaviour,** designed to provide an evaluation scale for its corresponding latent variable**.** The final goal of this exercise would be to use the developed statistical methods and evaluate the overall effect of CC training upon the students' perception of their **CC Knowledge**, **CC Attitude**, and **CC Behaviour**.

CC Project Latent Variables & Generated Likert Item IDs

Table 1

Knowledge (KNO) Likert Item IDs	Attitude (ATT) Likert Item IDs	Behaviour (BEH) Likert Item IDs
KNO-1	ATT-1	BEH-1
KNO-2	ATT-2	BEH-2
KNO-3	ATT-3	BEH-3
KNO-4	ATT-4	BEH-4
KNO-5	ATT-5	BEH-5
KNO-6	ATT-6	BEH-6
KNO-7	ATT-7	BEH-7
	ATT-8	

5-Point Likert Scale

Table 2

5-Point Likert Scale	Symbol	Assigned Value	Assigned Interval
Strongly Disagree	**(SD)**	**1**	**(1.00 – 1.80)**
Disagree	**(D)**	**2**	**(1.81 – 2.60)**
Neither Agree Nor Disagree	**(N)**	**3**	**(2.61 – 3.40)**
Agree	**(A)**	**4**	**(3.41 – 4.20)**
Strongly Agree	**(SA)**	**5**	**(4.21 – 5.00)**

Pilot Survey Demographics (DEM)

- **DEM-1.** Age
  Code: 1. [6-7], 2. [8-9], 3. [10-11], 4. [12-13], 5. [14-15], 6. [16-17], 7. Over 17
- **DEM-2**. Gender
  Code: 1. Female, 2. Male, 3. Other (specify), 4. Prefer not to say
- **DEM-3.** Grade Level
  Code: 1. [1-2], 2. [3-4], 3. [5-6], 4. [7-8], 5. [9-10], 6. [11-12]
- **DEM-4**. Country
  Code: 1. Croatia, 2. Greece, 3. Malta, 4. Portugal, 5. Spain, 6. Other

CC Knowledge Likert Items

CC Knowledge (KNO):

- **KNO-1.** I know the meaning of the enhanced greenhouse effect.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **KNO-2.** I can explain five causes of climate change.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **KNO-3.** I can explain five consequences of climate change.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **KNO-4.** I know how to create comics about climate change.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **KNO-5.** I can easily distinguish climate change fake news from real news.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **KNO-6.** I know how to utilize Augmented Reality (AR) to learn more about climate change.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **KNO-7.** I Know how to collaborate or work with other pupils to learn more about climate change.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree

CC Attitude Likert Items

CC Attitude (ATT):

- **ATT-1.** I believe climate change is real and dangerous.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **ATT-2.** I believe I can have an impact on slowing climate change.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **ATT-3.** I believe any citizen can have an impact on slowing climate change.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **ATT-4.** I believe my creation of comics about climate change will help me learn more about climate change.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **ATT-5.** I believe my creation of comic books about climate change will help me be more positive about the environment.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **ATT-6.** I believe I am at great risk of being manipulated by climate change fake news.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **ATT-7.** I believe Augmented Reality (AR) can help me learn more about climate change.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **ATT-8.** I believe collaborating or working with other pupils can help me learn more about climate change.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree

7

CC Behaviour Likert Items

CC Behaviour (BEH):

- **BEH-1.** I am actively engaging in ways to combat climate change by reducing my carbon footprint.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **BEH-2.** I am actively advocating among my friends for behaviours that will reduce climate change.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **BEH-3.** I am actively advocating within my school for policies that will reduce climate change.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **BEH-4.** I am actively advocating within my community for policies and behaviours that will reduce climate change.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **BEH-5.** I am actively teaching my friends how to identify climate change fake news.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **BEH-6.** I am actively using Augmented Reality (AR) to learn more about climate change**.**
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree
- **BEH-7.** I frequently collaborate or work with friends and family to learn more about climate change.
  Code: 5. Strongly agree, 4. Agree, 3. Neither, 2. Disagree, 1. Strongly disagree

Pilot Survey Open-ended Questions

General Open-ended CC Questions:

- **Q1**: What tools are you familiar with for comic book creation?
- **Q2**: Do you believe you will have sufficient support from your friends and family to implement strategies for preventing climate change? Explain.
- **Q3**: Do you have current concerns about the environment, and if so, what do you think is the source (home, news, school, other)?
- **Q4**: Do you have any concerns about this project?
- **Q5**: Is there anything else you would like to comment on?

Conducted Data Analysis Remarks (1)

1. The students' responses for **CC Knowledge**, **CC Attitude**, and **CC Behaviour** were analyzed and evaluated separately.
2. Two methods of analysis were implemented for evaluating the effect of students' CC training upon their pilot survey responses.
   a. In the **1st Method of Analysis**, the effect of CC training upon each one of the student's **Likert Item** responses was analyzed and evaluated. Here, the students' responses were treated as **ordinal measures** and therefore, the data analysis focuses on **frequencies and proportions** as provided by the generated Descriptive Statistics Frequency Tables.
   b. In the **2nd Method of Analysis**, the effect of CC training upon the student's **Latent Variable** average responses was analyzed and evaluated. Here, the students' responses were treated as **scale measures** and therefore, the data analysis focuses on the obtained **Mean**, **Median and Standard Deviation**.
3. Further insight into the CC training effect upon the students' responses, can be obtained by conducting a statistical **inference analysis**. The underlining principle of an inference analysis is that the obtained pre-test and post-test survey responses were respectively collected from small samples of a much larger student population. The inference analysis seeks to characterize the statistical properties of the larger population based upon the small sample's obtained test results.

10

Conducted Data Analysis Remarks (2)

4. Examination of whether there is a **statistically significant difference** between the pre-test responses and the post-test responses for each Likert item can be done using the **Non-parametric Paired-Samples Wilcoxon-Test**. Here, the use of a non-parametric test is required since all Likert item responses were treated as **ordinal measures.** Implementation of this test, however, requires that the number of students participated in the pre-test survey must also participate in the post-test survey. Unfortunately, the number of participated pre-test students was **365** and the number of participated post-test students was **244**. As such, the **Non-parametric Paired-Samples Wilcoxon-Test** could not be used for the entire body of participated students.
5. However, a subset of **57 Spanish students** participated in both the pre-test and the post-test survey and the **Non-parametric Paired-Samples Wilcoxon-Test** was conducted as a special case for this survey and its corresponding data analysis is presented as an **appendix** to this study.
6. For this work, the statistical analysis and all related data tables and charts were done using the open-source statistical analysis software **JASP (0.17.3.0)** in conjunction with the **Microsoft Excel** and **Word** software.

11

Data Reliability

Prior to implementation of the chosen data analysis technique, examination of the internal consistency (**Reliability**) of all Likert items assigned to a latent variable was conducted. For an effective measurement, the corresponding Likert item responses must be highly correlated with each other.

The so-called **Cronbach's alpha** is an estimate of how well the assigned Likert items measure the latent variable and therefore, is an indication of the measurement accuracy. A **qualitative interpretation** of Cronbach's alpha value is given below as follows:

Cronbach's Alpha Value Ranges

Table 3

Qualitative Interpretation of Cronbach's Alpha Value	Cronbach's Alpha Value Range
Excellent	Alpha ≥ 0.9
Good	0.9 > Alpha ≥ 0.8
Acceptable	0.8 > Alpha ≥ 0.7
Questionable	0.7 > Alpha ≥ 0.6
Poor	0.6 > Alpha ≥ 0.5
Unacceptable	0.5 > Alpha

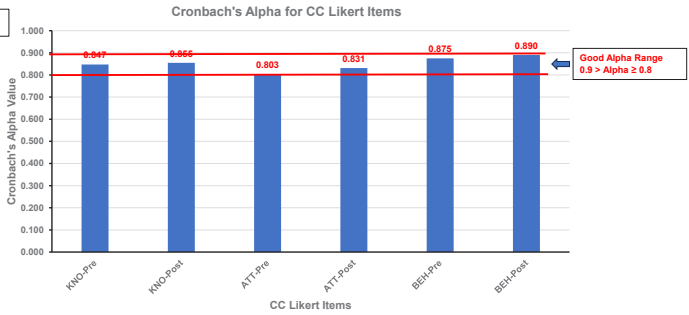
Computed Cronbach's Alpha Values for KNO, ATT, & BEH Likert Items

Table 4

CC Likert Items	Cronbach's Alpha	Data Reliability
KNO-Pre	0.847	Good
KNO-Post	0.855	Good
ATT-Pre	0.803	Good
ATT-Post	0.831	Good
BEH-Pre	0.875	Good
BEH-Post	0.890	Good

Plot of Computed Cronbach's Alpha Values for KNO, ATT, & BEH Likert Items

Chart 1



Data Analysis Remarks (1)

1. The effect of CC training upon the students' responses was analyzed and evaluated for each Likert item, using their Descriptive Statistics obtained prior to and post the students' CC training.
2. The **Mean** value of a **Likert item** represents the students' average evaluation grade (1 to 5) for that Likert item.
3. The **Mean (%) Variation** of a **Likert item** indicates the percent variation of its pre-test and post-test Means.
4. **Mean (%) Variation = {[(Post-Test Mean) – (Pre-Test Mean)] / (Post-Test Mean)} * 100**
5. A **positive** Mean (%) Variation indicates that the post-test Mean is **greater** than the pre-test Mean. A **negative** Mean (%) Variation indicates that the post-test Mean is **smaller** than the pre-test Mean.

Data Analysis Remarks (2)

6. The **WAvg** value of a **Latent Variable** represents the students' average evaluation grade (1 to 5) for that Latent variable. It is obtained by summing up all the mean values of its Likert items and divide the obtained sum by the number of Likert items.
7. The **Grade (%) Variation** of a **Likert item** gives the percent variation of its Mean value from the WAvg value of its corresponding Latent Variable. It is a measure of how much the students' evaluation grade of a particular Likert item varies from the average evaluation grade of its corresponding Latent Variable.
8. **Grade (%) Variation = [(Mean – WAvg) / Mean] * 100**
9. A **positive** Grade (%) Variation indicates that the students' evaluation grade (**Mean**) of a Likert item is higher than the students' average evaluation grade (**WAvg**) of the corresponding Latent Variable**.** A **negative** Grade (%) Variation indicates that the students' evaluation grade of a Likert item is lower than the students' average evaluation grade of the corresponding Latent Variable**.**

17

KNO: Pre-Test Descriptive Statistics

Table 5

Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade (%) Variation
KNO-1_Pre	105 (28.767)	45 (12.329)	95 (26.027)	76 (20.822)	44 (12.055)	**2.751**	1.381	**-12.286**
KNO-2_Pre	60 (16.438)	39 (10.685)	95 (26.027)	100 (27.397)	71 (19.452)	**3.227**	1.330	**4.276**
KNO-3_Pre	52 (14.247)	33 (9.041)	95 (26.027	107 (29.315)	78 (21.370)	**3.345**	1.301	**7.653**
KNO-4_Pre	91 (24.932)	49 (13.425)	89 (24.384)	79 (21.644)	57 (15.616)	**2.896**	1.403	**-6.664**
KNO-5_Pre	62 (16.986)	59 (16.164)	78 (21.370)	89 (24.384)	77 (21.096)	**3.164**	1.381	**2.370**
KNO-6_Pre	126 (34.521)	54 (14.795)	90 (24.658)	58 (15.890)	37 (10.137)	**2.523**	1.368	**-22.434**
KNO-7_Pre	42 (11.507)	39 (10.685)	55 (15.068)	73 (20.000)	156 (42.740)	**3.718**	1.402	**16.918**

Table 5 Footnote:
N=365
KNO_Pre: Weighted Average (WAvg) = 3.089
SD = Strongly Disagree, D = Disagree,
N = Neither, A = Agree, SA = Strongly Agree.

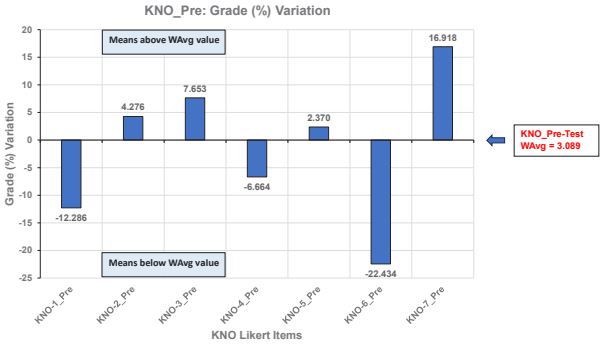
18

KNO: Pre-Test Descriptive Statistics

Table 5 shows the pre-test **Number** and **Percentage** of students out of the **365** participants who for each KNO_Pre Liker item they evaluate their perception of it with the same Likert scale value, as well as, the calculated **Mean** and **Std. Deviation** for each KNO_Pre Liker item. The **WAvg** value of **3.089** is also shown at the Table footnote. It is obtained by summing up all mean values and divide their sum by the number of Likert items. Its value provides an average student evaluation grade (1 to 5) for the pre-test KNO Latent Variable. The **Grade (%) Variation** displayed at the table's last column, shows the percent variation of the calculated Mean from the WAvg value for each KNO_Pre Likert item. It is a measure of how much the students' evaluation grade of a particular KNO_Pre Likert item varies from their average evaluation grade of the pre-test KNO Latent Variable**.**

KNO: Plot of Pre-Test Grade (%) Variation

Chart 2



20

KNO: Pre-Test Grade (%) Variation

Chart 2 plots the pre-test **Grade (%) Variation** of all KNO_Pre Likert items. A positive percent variation indicates that the Likert item's student grade is higher than the average grade of pre-test KNO Latent Variable**.** Here, KNO-2_Pre, KNO-3_Pre, KNO-5_Pre, and KNO-7_Pre all have evaluation grades higher than **3.089** with **KNO-7_Pre** having the greatest positive percent variation of (**16.918%**). On the other hand, a negative percent variation indicates that the Likert item's student grade is lower than the average grade of pre-test KNO Latent Variable**.** Here, KNO-1_Pre, KNO-4_Pre, and KNO-6_Pre all have grades lower than **3.089** with **KNO-6_Pre** having the largest negative variation magnitude of (**22.434%**). Note that KNO-7_Pre is about **Student Collaboration**, while KNO-6_Post is about **Augmented Reality**.

KNO: Post-Test Descriptive Statistics

Table 6

Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade (%) Variation
KNO-1_Post	24 (9.836)	6 (2.459)	62 (25.410)	69 (28.279)	83 (34.016)	**3.742**	1.232	**0.321**
KNO-2_Post	7 (2.869)	18 (7.377)	49 (20.082)	81 (33.197)	89 (36.475)	**3.930**	1.058	**5.089**
KNO-3_Post	12 (4.918)	11 (4.508)	46 (18.852)	80 (32.787)	95 (38.934)	**3.963**	1.097	**5.879**
KNO-4_Post	15 (6.148)	10 (4.098)	46 (18.852)	91 (37.295)	82 (33.607)	**3.881**	1.110	**3.891**
KNO-5_Post	14 (5.738)	16 (6,557)	63 (25.820)	100 (40.984)	51 (20.902)	**3.648**	1.061	**-2.248**
KNO-6_Post	44 (18.033)	51 (20.902)	54 (22.131)	59 (24.180)	36 (14.754)	**2.967**	1.330	**-25.716**
KNO-7_Post	13 (5.328)	11 (4.508)	46 (18.852)	72 (29.508)	102 (41.803)	**3.980**	1.127	**6.281**

Table 6 Foot Note:
N=244
KNO_Post: Weighted Average (WAvg) = 3.730
SD = Strongly Disagree, D = Disagree,
N = Neither, A = Agree, SA = Strongly Agree.

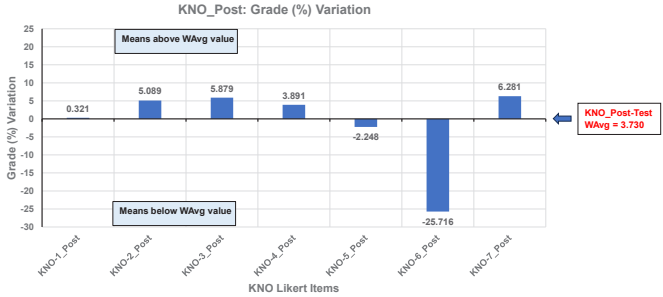
22

KNO: Post-Test Descriptive Statistics

Table 6 shows the post-test **Number** and **Percentage** of students out of the **244** participants who for each KNO_Post Liker item they evaluate their perception of it with the same Likert scale value, as well as, the calculated **Mean** and **Std. Deviation** for each KNO_Post Liker item. The **WAvg** value of **3.730** is also shown at the Table footnote. It is obtained by summing up all mean values and divide their sum by the number of Likert items. Its value provides an average student evaluation grade (1 to 5) for the post-test KNO Latent Variable. The **Grade (%) Variation** displayed at the table's last column, shows the percent variation of the calculated Mean from the WAvg value for each KNO_Post Likert item. It is a measure of how much the students' evaluation grade of a particular KNO_Post Likert item varies from their average evaluation grade of the post-test KNO Latent Variable.

KNO: Plot of Post-Test Grade (%) Variation

Chart 3



24

KNO: Plot of Post-Test Grade (%) Variation

Chart 3 plots the post-test **Grade (%) Variation** of all KNO_Post Likert items. A positive percent variation indicates that the Likert item's student grade is higher than the average grade of post-test KNO Latent Variable**.** Here, KNO-1_Post, KNO-2_Post, KNO-3_Post, KNO-4_Post, and KNO-7_Post all have evaluation grades higher than **3.730** with **KNO-7_Post** having the greatest positive percent variation of (**6.281%**). On the other hand, a negative percent variation indicates that the Likert item's student grade is lower than the average grade of post-test KNO Latent Variable**.** Here, KNO-5_Post, and KNO-6_Post all have grades lower than **3.730** with **KNO-6_Post** having the largest negative variation magnitude of (**25.716%**). Note that KNO-7_Post is about **Student Collaboration**, while KNO-6_Post is about **Augmented Reality**.

KNO: Pre & Post-Test Grade (%) Variation

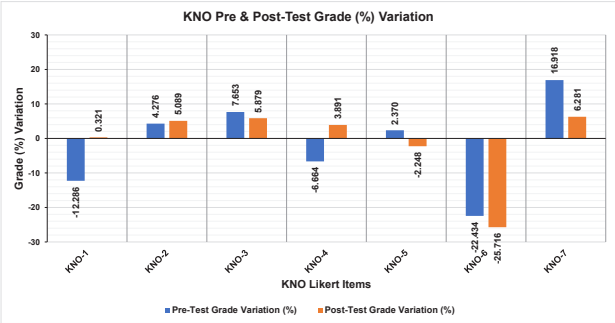
Table 7

Likert Item	Pre-Test Grade (%) Variation	Post-Test Grade (%) Variation
KNO-1	-12.286	0.321
KNO-2	4.276	5.089
KNO-3	7.653	5.879
KNO-4	-6.664	3.891
KNO-5	2.370	-2.248
KNO-6	-22.434	-25.716
KNO-7	16.918	6.281

26

KNO: Plot of Pre & Post-Test Grade (%) Variation

Chart 4



27

KNO: Plot of Pre & Post-Test Grade (%) Variation

Chart 4 plots the pre-test and post-test **Grade (%) Variation** for all KNO Likert items. The effect of CC training upon the students' pre and post-test responses is clearly demonstrated at the Grade (%) Variation values for KNO-1, KNO-4, KNO-5, and KNO-7 as follows:

- **KNO-1**: Pre-test % Var = **-12.286%**; Post-test % Var = **0.321%**
- **KNO-4**: Pre-test % Var = **-6.664%**; Post-test % Var = **3.891%**
- **KNO-5**: Pre-test % Var = **2.370%**; Post-test % Var = **-2.248%**
- **KNO-7**: Pre-test % Var = **16.918%**; Post-test % Var = **6.281%**

KNO: Pre & Post-Test Mean Values

Table 8

Likert Item	Pre-Test Mean	Post-Test Mean	Mean (%) Variation
KNO-1	2.751	3.742	26.483
KNO-2	3.227	3.930	17.888
KNO-3	3.345	3.963	15.594
KNO-4	2.896	3.881	25.380
KNO-5	3.164	3.648	13.268
KNO-6	2.523	2.967	14.965
KNO-7	3.718	3.980	6.583

Table 8 summarizes the pre-test and post-test **Mean** values and their corresponding **Mean (%) Variation** for all KNO Likert Items.

29

KNO: Plot of Pre & Post-Test Mean (%) Variation

Chart 6

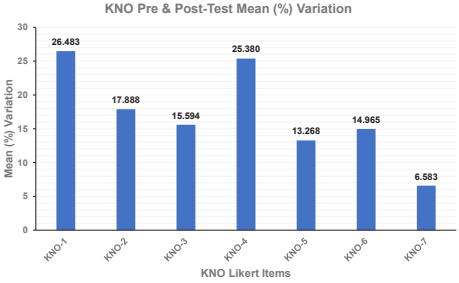


Chart 6 plots the pre and post-test **Mean (%) Variation** for all KNO Likert Items. It shows that all percent variations are positive which indicates that the **applied CC training increased** the overall students' perception of their **CC Knowledge**.

31

ATT: Pre-Test Descriptive Statistics

Table 9

Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade (%) Variation
ATT-1_Pre	28 (7.671)	22 (6.027)	63 (17.260)	85 (23.288)	167 (45.753)	**3.934**	1.250	**8.821**
ATT-2_Pre	41 (11.233)	44 (12.055)	93 (25.479)	91 (24.932)	96 (26.301)	**3.43**	1.300	**-4.577**
ATT-3_Pre	27 (7.397)	42 (11.507)	79 (21.644)	83 (22.740)	134 (36.712)	**3.699**	1.274	**3.028**
ATT-4_Pre	30 (8.219)	42 (11.507)	63 (17.260)	112 (30.685)	118 (32.329)	**3.674**	1.263	**2.368**
ATT-5_Pre	34 (9.315)	36 (9.863)	73 (20.000)	114 (31.233)	108 (29.589)	**3.619**	1.26	**32.300**
ATT-6_Pre	74 (20.274)	51 (13.973)	91 (24.932)	88 (24.110)	61 (16.712)	**3.03**	1.365	**-18.383**
ATT-7_Pre	49 (13.425)	29 (7.945)	85 (23.288)	119 (32.603)	83 (22.740)	**3.433**	1.292	**-4.486**
ATT-8_Pre	24 (6.575)	28 (7.671)	69 (18.904)	93 (25.479)	151 (41.370)	**3.874**	1.22	**7.408**

Table 9 Foot Note:
N=365
ATT_Pre: Weighted Average (WAvg) = 3.587
SD = Strongly Disagree, D = Disagree,
N = Neither, A = Agree, SA = Strongly Agree.

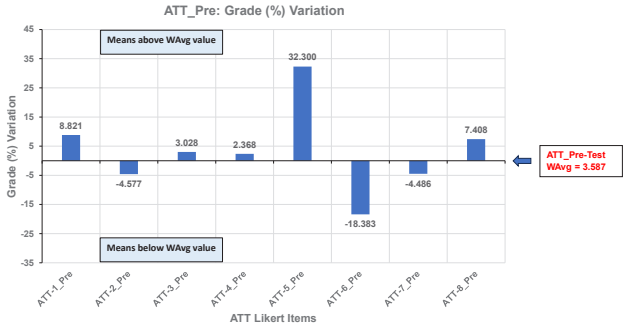
32

ATT: Pre-Test Descriptive Statistics

Table 9 shows the pre-test **Number** and **Percentage** of students out of the **365** participants who for each ATT_Pre Liker item they evaluate their perception of it with the same Likert scale value, as well as, the calculated **Mean** and **Std. Deviation** for each ATT_Pre Liker item. The **WAvg** value of **3.587** is also shown at the Table footnote. It is obtained by summing up all mean values and divide their sum by the number of Likert items. Its value provides an average student evaluation grade (1 to 5) for the pre-test ATT Latent Variable. The **Grade (%) Variation** displayed at the table's last column, shows the percent variation of the calculated Mean from the WAvg value for each ATT_Pre Likert item. It is a measure of how much the students' evaluation grade of a particular ATT_Pre Likert item varies from their average evaluation grade of the pre-test ATT Latent Variable.

ATT: Plot of Pre-Test Grade (%) Variation

Chart 7



34

ATT: Pre-Test Descriptive Statistics

Chart 7 plots the pre-test **Grade Variation (%)** of all ATT_Pre Likert items. A positive percent variation indicates that the Likert item's student grade is higher than the average grade of pre-test ATT Latent Variable**.** Here, ATT-1_Pre, ATT-3_Pre, ATT-4_Pre, ATT-5_Pre, and ATT-8_Pre all have evaluation grades higher than **3.587** with **ATT-5_Pre** having the greatest positive percent variation of (**32.300%**). On the other hand, a negative percent variation indicates that the Likert item's student grade is lower than the average grade of pre-test ATT Latent Variable**.** Here, ATT-2_Pre, ATT-6_Pre, and ATT-7_Pre all have grades lower than **3.587** with **ATT-6_Pre** having the largest negative variation magnitude of (**18.383%**)**.**

ATT: Post-Test Descriptive Statistics

Table 10

Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade (%) Variation
ATT-1_Post	4 (1.639)	7 (2.869)	39 (15.984)	63 (25.820)	131 (53.689)	**4.270**	0.943	**8.993**
ATT-2_Post	10 (4.098)	17 (6.967)	39 (15.984)	88 (36.066)	90 (36.885)	**3.947**	1.085	**1.545**
ATT-3_Post	12 (4.918)	11 (4.508)	41 (16.803)	76 (31.148)	104 (42.623)	**4.020**	1.105	**3.333**
ATT-4_Post	10 (4.098)	10 (4.098)	43 (17.623)	79 (32.377)	102 (41.803)	**4.037**	1.063	**3.740**
ATT-5_Post	14 (5.738)	15 (6.148)	42 (17.213)	82 (33.607)	91 (37.295)	**3.906**	1.142	**0.512**
ATT-6_Post	25 (10.246)	43 (17.623)	90 (36.885)	44 (18.033)	42 (17.213)	**3.143**	1.200	**-23.640**
ATT-7_Post	14 (5.738)	13 (5.328)	71 (29.098)	80 (32.787)	66 (27.049)	**3.701**	1.098	**-4.999**
ATT-8_Post	10 (4.098)	14 (5.738)	35 (14.344)	77 (31.557)	108 (44.262)	**4.061**	1.089	**4.309**

Table 10 Foot Note:
N=244
ATT_Post: Weighted Average (WAvg) = 3.886
SD = Strongly Disagree, D = Disagree,
N = Neither, A = Agree, SA = Strongly Agree.

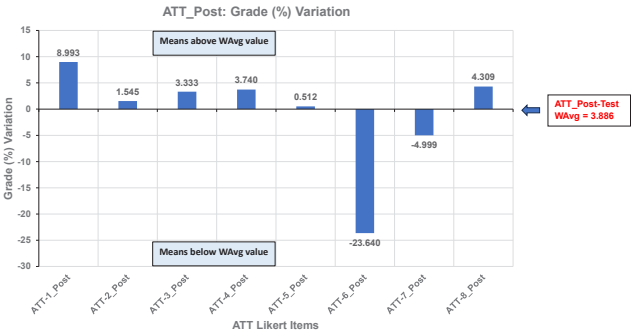
36

ATT: Post-Test Descriptive Statistics

Table 10 shows the post-test **Number** and **Percentage** of students out of the **244** participants who for each ATT_Post Liker item they evaluate their perception of it with the same Likert scale value, as well as, the calculated **Mean** and **Std. Deviation** for each ATT_Post Liker item. The **WAvg** of **3.886** value is also shown at the Table footnote. It is obtained by summing up all mean values and divide their sum by the number of Likert items. Its value provides an average student evaluation grade (1 to 5) for the post-test ATT Latent Variable. The **Grade (%) Variation** displayed at the table's last column, shows the percent variation of the calculated Mean from the WAvg value for each ATT_Post Likert item. It is a measure of how much the students' evaluation grade of a particular ATT_Post Likert item varies from their average evaluation grade of the post-test ATT Latent Variable**.**

ATT: Plot of Post-Test Grade (%) Variation

Chart 8



ATT: Plot of Post-Test Grade (%) Variation

Chart 8 plots the post-test **Grade Variation (%)** of all ATT_Post Likert items. A positive percent variation indicates that the Likert item's student grade is higher than the average grade of post-test ATT Latent Variable**.** Here, ATT-1_Post, ATT-2_Post, ATT-3_Post, ATT-4_Post, ATT-5_Post, and ATT-8_Post all have evaluation grades higher than **3.886** with **ATT-1_Post** having the greatest positive percent variation of (**8.993%**). On the other hand, a negative percent variation indicates that the Likert item's student grade is lower than the average grade of post-test ATT Latent Variable**.** Here, ATT-6_Post and ATT-7_Post both have grades lower than **3.886** with **ATT-6_Post** having the largest negative variation magnitude of (**23.640%**).

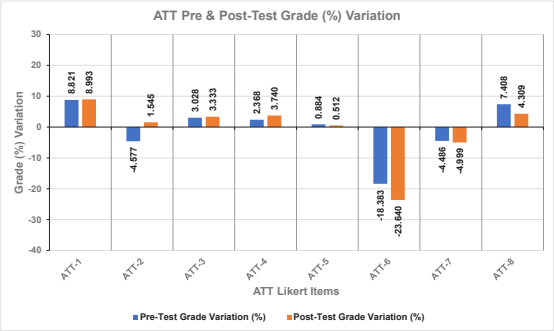
ATT: Pre & Post-Test Grade (%) Variation

Table 11

Likert Item	Pre-Test Grade (%) Variation	Post-Test Grade (%) Variation
ATT-1	8.821	8.993
ATT-2	-4.577	1.545
ATT-3	3.028	3.333
ATT-4	2.368	3.740
ATT-5	0.884	0.512
ATT-6	-18.383	-23.640
ATT-7	-4.486	-4.999
ATT-8	7.408	4.309

ATT: Plot of Pre & Post-Test Grade (%) Variation

Chart 9



ATT: Plot of Pre & Post-Test Grade (%) Variation

Chart 9 plots the pre-test and post-test **Grade Variation (%)** for all ATT Likert items.
The effect of CC training upon the students' responses is clearly demonstrated at the pre and post-test Grade Variation (%) values for ATT-2, ATT-6, and ATT-8 as follows:
ATT-2: Pre-test % Var = **-4.577%**; Post-test % Var = **1.545%**
ATT-6: Pre-test % Var = **-18.383%**; Post-test % Var = **-23.640%**
ATT-8: Pre-test % Var = **7.408%**; Post-test % Var = **4.309%**

ATT: Pre & Post-Test Mean Values

Table 12

Likert Item	Pre-Test Mean	Post-Test Mean	Mean (%) Variation
ATT-1	3.934	4.270	7.869
ATT-2	3.430	3.947	13.099
ATT-3	3.699	4.020	7.985
ATT-4	3.674	4.037	8.992
ATT-5	3.619	3.906	7.348
ATT-6	3.030	3.143	3.595
ATT-7	3.433	3.701	7.241
ATT-8	3.874	4.061	4.605

Table 12 summarizes the pre-test and post-test **Mean** values and their corresponding **Mean (%) Variation** for all ATT Likert Items.

ATT: Plot of Pre & Post-Test Mean Values

Chart 10

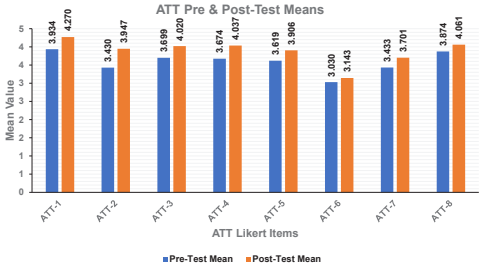


Chart 10 plots the pre and post-test **Mean Values** for all ATT Likert Items. It shows that all post-test values are greater than their corresponding pre-test values which indicates that the **applied CC training increased** the overall students' perception of their **CC Attitude**.

44

ATT: Plot of Pre & Post-Test Mean (%) Variation

Chart 11

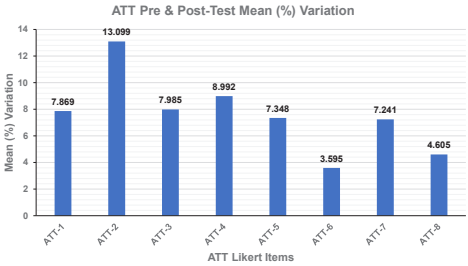


Chart 11 plots the pre and post-test **Mean (%) Variation** for all ATT Likert Items. It shows that all percent variations are positive which indicates that the **applied CC training increased** the overall students' perception of their **CC Attitude**

45

BEH: Pre-Test Descriptive Statistics

Table 13

Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade Variation (%)
BEH-1_Pre	57 (15.616)	53 (14.521)	100 (27.397)	86 (23.562)	69 (18.904)	**3.156**	1.320	**9.632**
BEH-2_Pre	54 (14.795)	70 (19.178)	104 (28.493)	81 (22.192)	56 (15.342)	**3.041**	1.274	**6.215**
BEH-3_Pre	75 (20.548)	61 (16.712)	100 (27.397)	71 (19.452)	58 (15.890)	**2.934**	1.349	**2.795**
BEH-4_Pre	82 (22.466)	62 (16.986)	103 (28.219)	72 (19.726)	46 (12.603)	**2.830**	1.321	**-0.777**
BEH-5_Pre	103 (28.219)	73 (20.000)	92 (25.205)	54 (14.795)	43 (11.781)	**2.619**	1.345	**-8.897**
BEH-6_Pre	104 (28.493)	49 (13.425)	82 (22.466)	50 (13.699)	23 (6.301)	**2.493**	1.338	**-14.400**
BEH-7_Pre	60 (16.438)	58 (15.890)	80 (21.918)	66 (18.082)	44 (12.055)	**2.893**	1.36	**1.417**

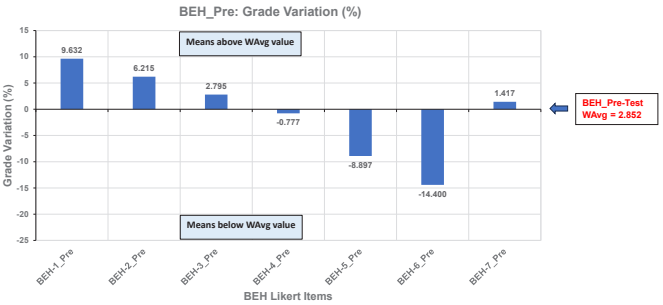
Table 13 Foot Note:
N=365
BEH_Pre: Weighted Average (WAvg) = 2.852
SD = Strongly Disagree, D = Disagree,
N = Neither, A = Agree, SA = Strongly Agree.

BEH: Pre-Test Descriptive Statistics

Table 13 shows the pre-test **Number** and **Percentage** of students out of the **365** participants who for each BEH_Pre Liker item they evaluate their perception of it with the same Likert scale value, as well as, the calculated **Mean** and **Std. Deviation** for each BEH_Pre Liker item. The **WAvg** value of **2.852** is also shown at the Table footnote. It is obtained by summing up all mean values and divide their sum by the number of Likert items. Its value provides an average student evaluation grade (1 to 5) for the pre-test BEH Latent Variable. The **Grade (%) Variation** displayed at the table's last column, shows the percent variation of the calculated Mean from the WAvg value for each BEH_Pre Likert item. It is a measure of how much the students' evaluation grade of a particular BEH_Pre Likert item varies from their average evaluation grade of the pre-test BEH Latent Variable**.**

BEH: Pre-Test Grade (%) Variation

Chart 12



48

BEH: Pre-Test Grade (%) Variation

Chart 12 plots the pre-test **Grade (%) Variation** of all BEH_Pre Likert items. A positive percent variation indicates that the Likert item's student grade is higher than the average grade of pre-test BEH Latent Variable**.** Here, BEH-1_Pre, BEH-2_Pre, BEH-3_Pre, and BEH-7_Pre all have evaluation grades higher than **2.852** with **BEH-1_Pre** having the greatest positive percent variation of (**9.632%**). On the other hand, a negative percent variation indicates that the Likert item's student grade is lower than the average grade of pre-test BEH Latent Variable**.** Here, BEH-4_Pre, BEH-5_Pre and BEH-6_Pre both have grades lower than **2.852** with **BEH-6_Pre** having the largest negative variation magnitude of (**14.400%**).

BEH: Post-Test Descriptive Statistics

Table 14

Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade (%) Variation
BEH-1_Post	19 (7.787)	20 (8.197)	73 (29.918)	73 (29.918)	59 (24.180)	**3.545**	1.170	**7.165**
BEH-2_Post	22 (9.016)	32 (13.115)	62 (25.410)	86 (35.246)	42 (17.213)	**3.385**	1.179	**2.777**
BEH-3_Post	23 (9.426)	28 (11.475)	62 (25.410)	67 (27.459)	64 (26.230)	**3.496**	1.255	**5.864**
BEH-4_Post	32 (13.115)	28 (11.475)	55 (22.541)	77 (31.557)	52 (21.311)	**3.365**	1.297	**2.199**
BEH-5_Post	32 (13.115)	25 (10.246)	73 (29.918)	77 (31.557)	37 (15.164)	**3.254**	1.221	**-1.137**
BEH-6_Post	53 (21.721)	33 (13.525)	35 (14.344)	44 (18.033)	22 (9.016)	**2.693**	1.423	**-22.206**
BEH-7_Post	19 (7.787)	14 (5.738)	52 (21.311)	64 (26.230)	38 (15.574)	**3.299**	1.316	**0.242**

Table 14 Foot Note:
N=244
BEH_Post: Weighted Average (WAvg) = 3.291
SD = Strongly Disagree, D = Disagree,
N = Neither, A = Agree, SA = Strongly Agree.

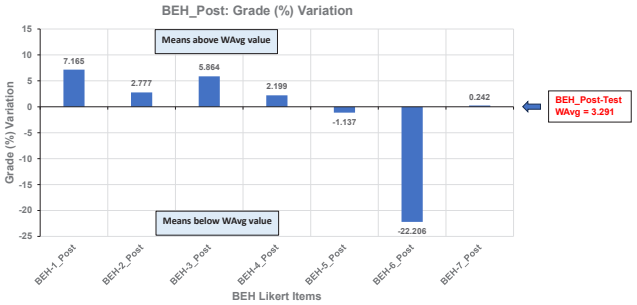
50

BEH: Post-Test Descriptive Statistics

Table 14 shows the post-test **Number** and **Percentage** of students out of the **244** participants who for each BEH_Post Liker item they evaluate their perception of it with the same Likert scale value, as well as, the calculated **Mean** and **Std. Deviation** for each BEH_Post Liker item. The **WAvg** value of **3.291** is also shown at the Table footnote. It is obtained by summing up all mean values and divide their sum by the number of Likert items. Its value provides an average student evaluation grade (1 to 5) for the post-test BEH Latent Variable. The **Grade (%) Variation** displayed at the table's last column, shows the percent variation of the calculated Mean from the WAvg value for each BEH_Post Likert item. It is a measure of how much the students' evaluation grade of a particular BEH_Post Likert item varies from their average evaluation grade of the post-test BEH Latent Variable.

BEH: Post-Test Grade (%) Variation

Chart 13



BEH: Post-Test Grade (%) Variation

Chart 13 plots the post-test **Grade Variation (%)** of all BEH_Post Likert items. A positive percent variation indicates that the Likert item's student grade is higher than the average grade of post-test BEH Latent Variable**.** Here, BEH-1_Post, BEH-2_Post, BEH-3_Post, BEH-4_Post, and BEH-7_Post all have evaluation grades higher than **3.291** with **BEH-1_Post** having the greatest positive percent variation of (**7.165%**). On the other hand, a negative percent variation indicates that the Likert item's student grade is lower than the average grade of post-test BEH Latent Variable**.** Here, BEH-5_Post and BEH-6_Post both have grades lower than **3.291** with **BEH-6_Post** having the largest negative variation magnitude of (**22.206%**).

BEH: Pre & Post-Test Grade (%) Variation

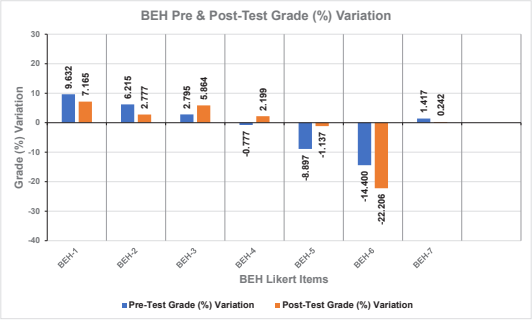
Table 15

Likert Item	Pre-Test Grade (%) Variation	Post-Test Grade (%) Variation
BEH-1	9.632	7.165
BEH-2	6.215	2.777
BEH-3	2.795	5.864
BEH-4	-0.777	2.199
BEH-5	-8.897	-1.137
BEH-6	-14.400	-22.206
BEH-7	1.417	0.242

54

BEH: Plot of Pre & Post-Test Grade (%) Variation

Chart 14



55

BEH: Plot of Pre & Post-Test Grade (%) Variation

Chart 14 plots the pre-test and post-test **Grade (%) Variation** for all BEH Likert items. The effect of CC training upon the students' responses is clearly demonstrated at the pre and post-test Grade (%) Variation values for BEH-1, BEH-2, BEH-3, BEH-5, and BEH-6 as follows:
BEH-1: Pre-test % Var = **9.632%**; Post-test % Var = **7.165%**
BEH-2: Pre-test % Var = **6.215%**; Post-test % Var = **2.777%**
BEH-3: Pre-test % Var = **2.795%**; Post-test % Var = **5.864%**
BEH-5: Pre-test % Var = **-8.897%**; Post-test % Var = **-1.137%**
BEH-6: Pre-test % Var = **-14.400%**; Post-test % Var = **-22.206%**

BEH: Pre & Post-Test Mean Values

Table 16

Likert Item	Pre-Test Mean	Post-Test Mean	Mean (%) Variation
BEH-1	3.156	3.545	10.973
BEH-2	3.041	3.385	10.162
BEH-3	2.934	3.496	16.076
BEH-4	2.830	3.365	15.899
BEH-5	2.619	3.254	19.514
BEH-6	2.493	2.693	7.427
BEH-7	2.893	3.299	12.307

BEH: Plot of Pre & Post-Test Mean Values

Chart 15

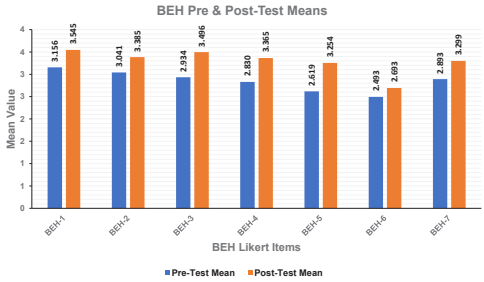


Chart 15 plots the pre and post-test **Mean Values** for all BEH Likert Items. It shows that all post-test values are greater than their corresponding pre-test values which indicates that the **applied CC training increased** the overall students' perception of their **CC Behaviour**.

58

BEH: Plot of Pre & Post-Test Mean (%) Variation

Chart 16

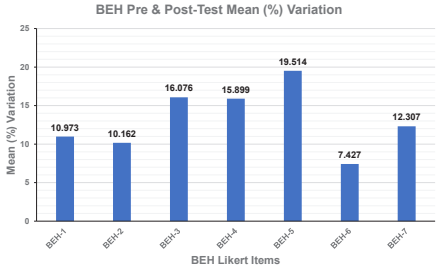


Chart 16 plots the pre and post-test **Mean (%) Variation** for all BEH Likert Items. It shows that all percent variations are positive which indicates that the **applied CC training increased** the overall students' perception of their **CC Behaviour**.

59

Latent Variable Pre & Post-Test WAvg Values

Table 17

CC Latent Variable	Pre-Test WAvg	Post-Test WAvg	WAvg (%) Variation
KNO	3.089	3.730	17.185
ATT	3.587	3.886	7.694
BEH	2.852	3.291	13.339

60

Plot of Pre & Post-Test WAvg Values

Chart 17

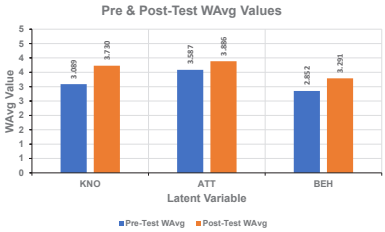


Chart 17 plots the pre-test and post-test **WAvg** values for **KNO**, **ATT**, & **BEH** Latent Variables. It shows that all **post-test WAvg values** are **greater** than their corresponding **pre-test WAvg values**. That means, the **applied CC training increased** the students' average evaluation grade for all Latent Variables.

61

Plot of Pre & Post-Test WAvg (%) Variation

Chart 18

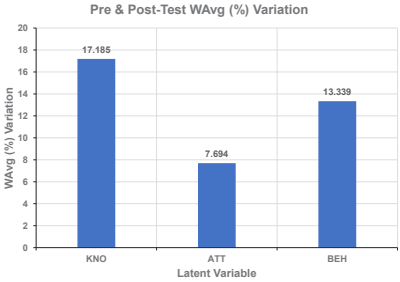


Chart 18 plots the pre and post-test **WAvg (%) Variation** for **KNO**, **ATT**, & **BEH** Latent Variables. Since all WAvg Variation (%) values are positive, it implies that the **applied CC training increased** the overall students' perception of their **CC Knowledge, CC Attitude, and CC Behaviour**

62

Latent Variable Average Response Analysis

In the second part of the conducted study, the effect of CC training upon the students' **Latent Variable Average Response (SAvg)** was analyzed and evaluated. The SAvg response was obtained by summing up the student responses of all latent variable Likert items and dividing the obtained sum by the number of Likert items. As such, the following **Parameter Transformations** were implemented:

1. **KNO-SAvg_Pre** = [(KNO1_Pre) + (KNO2_Pre) + (KNO3_Pre) + (KNO4_Pre) + (KNO5_Pre) + (KNO_Pre) + (KNO7_Pre)] / (7)
2. **KNO-SAvg_Post** = [(KNO1_Post) + (KNO2_Post) + (KNO3_Post) + (KNO4_Post) + (KNO5_Post) + (KNO6_Post) + (KNO7_Post)] / (7)
3. **ATT-SAvg_Pre** = [(ATT1_Pre) + (ATT2_Pre) + (ATT3_Pre) + (ATT4_Pre) + (ATT5_Pre) + (ATT6_Pre) + (ATT7_Pre) + (ATT8_Pre)] / (8)
4. **ATT-SAvg_Post** = [(ATT1_Post) + (ATT2_Post) + (ATT3_Post) + (ATT4_Post) + (ATT5_Post) + (ATT_Post) + (ATT7_Post) + (ATT8_Post)] / (8)
5. **BEH-SAvg_Pre** = [(BEH1_Pre) + (BEH2_Pre) + (BEH3_Pre) + (BEH4_Pre) + (BEH5_Pre) + (BEH6_Pre) + (BEH7_Pre)] / (7)
6. **BEH-SAvg_Post** = [(BEH1_Post) + (BEH2_Post) + (BEH3_Post) + (BEH4_Post) + (BEH5_Post) + (BEH6_Post) + (BEH7_Post)] / (7)

Here, the students' responses were treated as **scale measures** and therefore, the data analysis focuses on the calculated **Mean**, **Median and Standard Deviation**.

63

KNO-SAvg: Pre & Post Descriptive Statistics

Table 18

Parameter	KNO-SAvg_Pre
Valid	365
Missing	0
Median	3.286
Mean	3.089
Std. Deviation	0.987
Skewness	-0.352
Std. Error of Skewness	0.128
Kurtosis	-0.738
Std. Error of Kurtosis	0.255
Shapiro-Wilk	0.967
P-value of Shapiro-Wilk	< .001
Minimum	1
Maximum	5

Parameter	KNO-SAvg_Post
Valid	244
Missing	0
Median	3.857
Mean	3.730
Std. Deviation	0.840
Skewness	-0.986
Std. Error of Skewness	0.156
Kurtosis	1.179
Std. Error of Kurtosis	0.310
Shapiro-Wilk	0.934
P-value of Shapiro-Wilk	< .001
Minimum	1
Maximum	5

KNO-SAvg: Pre & Post Histogram Plots

Chart 19

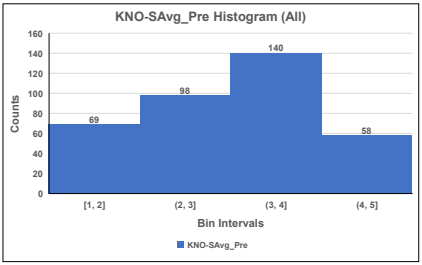
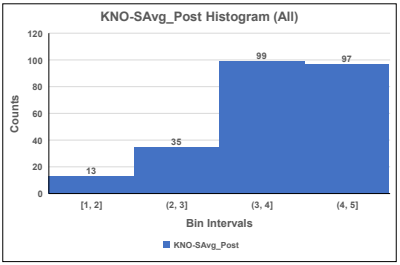


Chart 20



KNO-SAvg: Pre & Post Box Plots

Chart 21

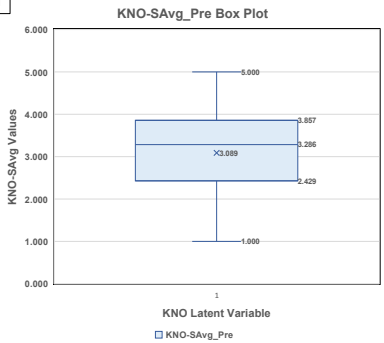
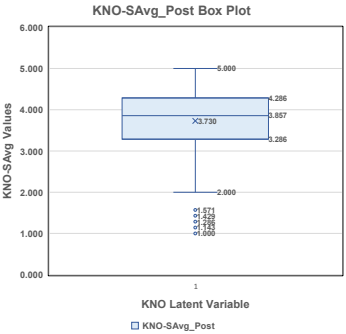


Chart 22



66

ATT-SAvg: Pre & Post Descriptive Statistics

Table 20

Parameter	ATT-SAvg_Pre
Valid	365
Missing	0
Median	3.75
Mean	3.587
Std. Deviation	0.829
Skewness	-0.614
Std. Error of Skewness	0.128
Kurtosis	-0.032
Std. Error of Kurtosis	0.255
Shapiro-Wilk	0.965
P-value of Shapiro-Wilk	< .001
Minimum	1
Maximum	5

Parameter	ATT-SAvg_Post
Valid	244
Missing	0
Median	4
Mean	3.886
Std. Deviation	0.740
Skewness	-0.859
Std. Error of Skewness	0.156
Kurtosis	0.938
Std. Error of Kurtosis	0.310
Shapiro-Wilk	0.950
P-value of Shapiro-Wilk	< .001
Minimum	1
Maximum	5

67

ATT-SAvg: Pre & Post Histogram Plots

Chart 23

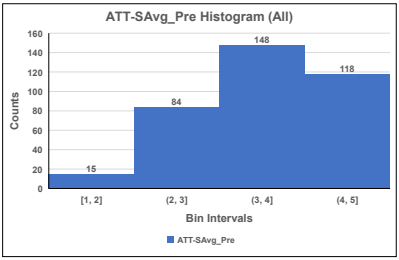
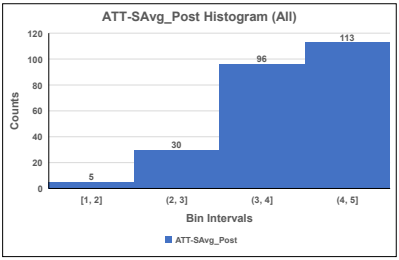


Chart 24



ATT-SAvg: Pre & Post Box Plots

Chart 25

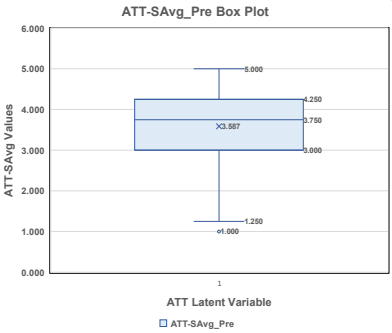
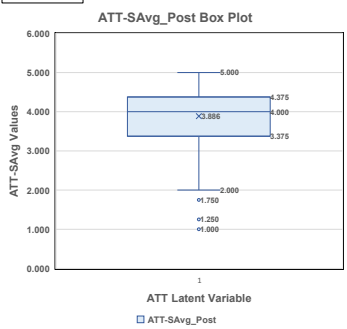


Chart 26



BEH-SAvg: Pre & Post Descriptive Statistics

Table 22

Parameter	BEH-SAvg_Pre
Valid	365
Missing	0
Median	3.000
Mean	2.852
Std. Deviation	0.968
Skewness	-0.088
Std. Error of Skewness	0.128
Kurtosis	-0.800
Std. Error of Kurtosis	0.255
Shapiro-Wilk	0.979
P-value of Shapiro-Wilk	< .001
Minimum	1
Maximum	5

Parameter	BEH-SAvg_Post
Valid	244
Missing	0
Median	3.286
Mean	3.291
Std. Deviation	0.939
Skewness	-0.406
Std. Error of Skewness	0.156
Kurtosis	-0.360
Std. Error of Kurtosis	0.310
Shapiro-Wilk	0.973
P-value of Shapiro-Wilk	< .001
Minimum	1
Maximum	5

BEH-SAvg: Pre & Post Histogram Plots

Chart 27

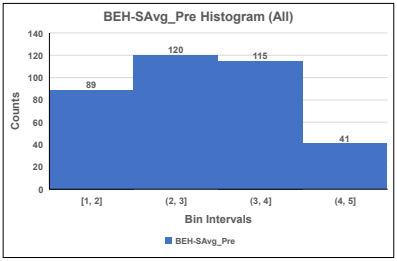
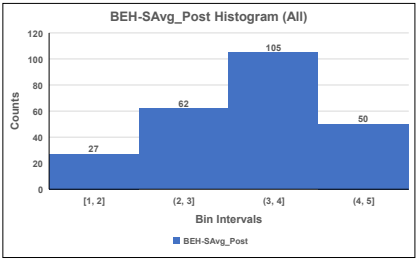


Chart 28



BEH-SAvg: Pre & Post Box Plots

Chart 29

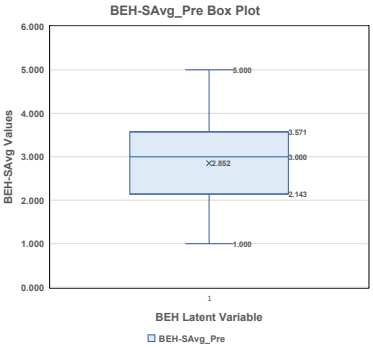
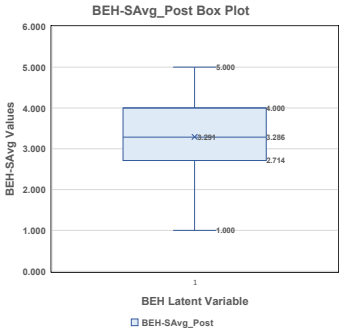


Chart 30



Pre & Post-Test SAvg Mean Values

Table 24

CC Latent Variable	Pre-Test SAvg Mean Value	Post-Test SAvg Mean Value	SAvg Mean Value (%) Variation
KNO	3.089	3.730	17.185
ATT	3.587	3.886	7.694
BEH	2.852	3.291	13.339

Plot of Pre & Post-Test SAvg Mean Values

Chart 31

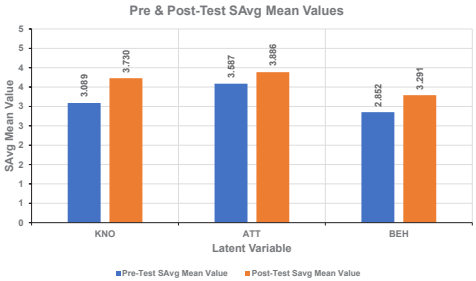


Chart 31 plots the pre-test and post-test **SAvg Mean** values for **KNO**, **ATT**, & **BEH** Latent Variables. It shows that all **post-test SAvg Mean** values are **greater** than their corresponding **pre-test SAvg Mean** values. That means, the **applied CC training increased** the students' **SAvg Mean** evaluation grade for all Latent Variables.

74

Plot of SAvg Mean Value (%) Variation

Chart 32

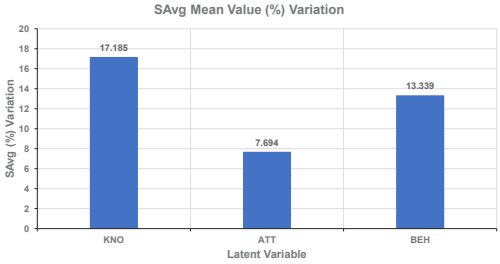


Chart 32 plots the pre and post-test **SAvg Mean Value (%) Variation** for **KNO**, **ATT**, & **BEH** Latent Variables. Since all SAvg Mean (%) Variation values are positive, it implies that the **applied CC training increased** the overall students' perception of their **CC Knowledge, CC Attitude, and CC Behaviour**

75

Comparison of WAvg & SAvg Mean Values

Table 25

CC Latent Variable	Pre-Test WAvg Mean Value	Post-Test WAvg Mean Value	WAvg (%) Variation
KNO	3.089	3.730	17.185
ATT	3.587	3.886	7.694
BEH	2.852	3.291	13.339

CC Latent Variable	Pre-Test SAvg Mean Value	Post-Test SAvg Mean Value	SAvg Mean Value (%) Variation
KNO	3.089	3.730	17.185
ATT	3.587	3.886	7.694
BEH	2.852	3.291	13.339

WAvg = SAvg Mean Value

76

Annex 2
Teacher Pilot Survey
Pre- & Post-Test Data Analysis (2)

Miracle Climate Change Project
Teacher Pilot Survey
Pre- & Post-Test Data Analysis (2)

Orestes J. Varonis, Ph.D.
PARAGON-eduTech
2024-08-23

Introduction
(Teachers)

A teacher pilot survey for the Miracle's **Climate Change (CC)** Project was conducted at several schools in **Croatia, Spain, Greece, Malta, and Portugal**. A total of **40 teachers** participated in the pre-test survey and **22 teachers** participated in the post-test survey. The objective of this study was to acquire relevant data for the development of suitable Statistical Analysis Methods capable of evaluating the teachers' perception of their **CC Knowledge**, **CC Attitude**, and **CC Behaviour**, prior to and post their CC training.

Pilot-Survey Participants
(Teachers)

Table T1

Country	Pre-Test Teachers	Post-Test Teachers
Croatia	6	3
Spain	3	3
Greece	13	9
Malta	14	4
Portugal	4	3
Total	40	22

5-Point Likert Scale (Teachers)

Table T2

5-Point Likert Scale	Symbol	Assigned Value	Assigned Interval
Strongly Disagree	(SD)	1	(1.00 – 1.80)
Disagree	(D)	2	(1.81 – 2.60)
Neither Agree Nor Disagree	(N)	3	(2.61 – 3.40)
Agree	(A)	4	(3.41 – 4.20)
Strongly Agree	(SA)	5	(4.21 – 5.00)

4

Conducted Data Analysis Remarks (Teachers)

1. The teachers' responses for their **CC Knowledge**, **CC Attitude**, and **CC Behaviour** were examined and evaluated separately.
2. In the following work, the effect of CC training upon each one of the teachers' **Likert Item** responses was analyzed and evaluated. Here, the teachers' responses were treated as **ordinal measures** and therefore, the data analysis focuses on **frequencies and proportions** as provided by the generated Descriptive Statistics Frequency Tables.

KNO: Pre-Test Descriptive Statistics (40 Teachers)

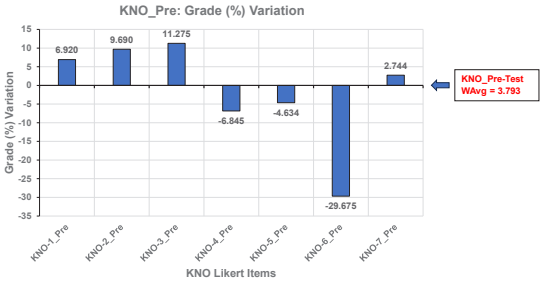
Table T3

Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade (%) Variation
KNO-1_Pre	1 (2.5)	2 (5)	4 (10)	19 (47.5)	14 (35)	4.075	0.944	6.920
KNO-2_Pre	0 (0)	2 (5)	5 (12.5)	16 (40)	17 (42.5)	4.200	0.853	9.690
KNO-3_Pre	0 (0)	1 (2.5)	7 (17.5)	12 (30)	20 (50)	4.275	0.847	11.275
KNO-4_Pre	4 (10)	4 (10)	11 (27.5)	8 (20)	13 (32.5)	3.550	1.319	-6.845
KNO-5_Pre	1 (2.5)	3 (7.5)	12 (30)	18 (45)	6 (15)	3.625	0.925	-4.634
KNO-6_Pre	7 (17.5)	7 (17.5)	14 (35)	6 (15)	6 (15)	2.925	1.289	-29.675
KNO-7_Pre	2 (5)	1 (2.5)	7 (17.5)	19 (47.5)	11 (27.5)	3.900	1.008	2.744
			N_Pre: 40		Weighted Avg:	3.793		

6

KNO: Plot of Pre-Test Grade (%) Variation
(40 Teachers)

Chart T1



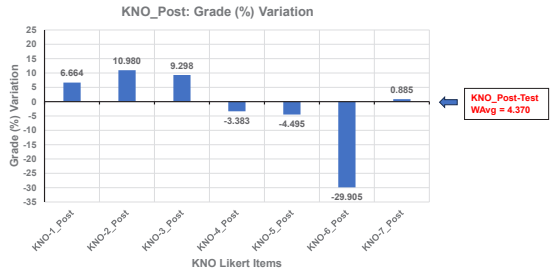
KNO: Post-Test Descriptive Statistics
(22 Teachers)

Table T4

Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade (%) Variation
KNO-1_Post	0 (0)	0 (0)	1 (4.545)	5 (22.727)	16 (72.727)	4.682	0.568	6.664
KNO-2_Post	0 (0)	0 (0)	1 (4.545)	0 (0)	21 (95.455)	4.909	0.426	10.980
KNO-3_Post	0 (0)	0 (0)	1 (4.545)	2 (9.091)	19 (86.364)	4.818	0.501	9.298
KNO-4_Post	0 (0)	2 (9.091)	2 (9.091)	7 (31.818)	11 (50)	4.227	0.973	-3.383
KNO-5_Post	0 (0)	1 (4.545)	5 (22.727)	5 (22.727)	11 (50)	4.182	0.958	-4.495
KNO-6_Post	2 (9.091)	5 (22.727)	5 (22.727)	3 (13.636)	7 (31.818)	3.364	1.399	-29.905
KNO-7_Post	0 (0)	0 (0)	3 (13.636)	7 (31.818)	12 (54.545)	4.409	0.734	0.885
			N_Post: 22		Weighted Avg:	4.370		

KNO: Plot of Post-Test Grade (%) Variation
(22 Teachers)

Chart T2



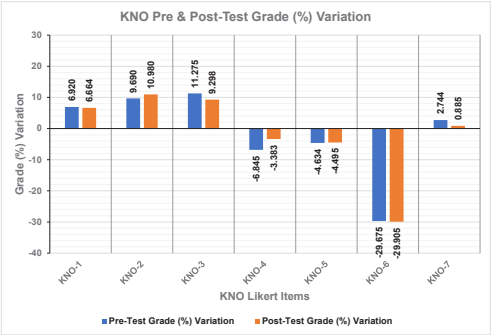
KNO: Pre & Post-Test Grade (%) Variation (Teachers)

Table T5

Likert Item	Pre-Test Grade (%) Variation	Post-Test Grade (%) Variation
KNO-1	6.920	6.664
KNO-2	9.690	10.980
KNO-3	11.275	9.298
KNO-4	-6.845	-3.383
KNO-5	-4.634	-4.495
KNO-6	-29.675	-29.905
KNO-7	2.744	0.885

KNO: Plot of Pre & Post-Test Grade (%) Variation (Teachers)

Chart T3



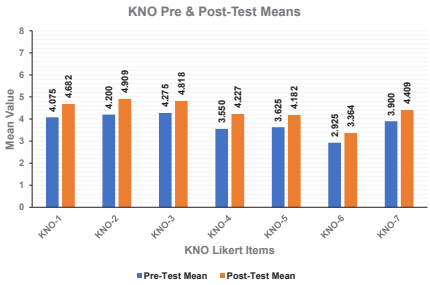
KNO: Pre & Post-Test Mean Values (Teachers)

Table T6

Likert Item	Pre-Test Mean	Post-Test Mean	Mean (%) Variation
KNO-1	4.075	4.682	12.965
KNO-2	4.200	4.909	14.443
KNO-3	4.275	4.818	11.270
KNO-4	3.550	4.227	16.016
KNO-5	3.625	4.182	13.319
KNO-6	2.925	3.364	13.050
KNO-7	3.900	4.409	11.545

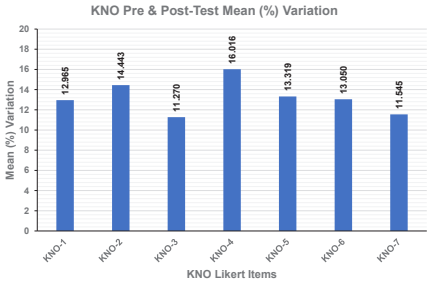
KNO: Plot of Pre & Post-Test Mean Values (Teachers)

Chart T4



KNO: Plot of Pre & Post-Test Mean (%) Variation - (Teachers)

Chart T5



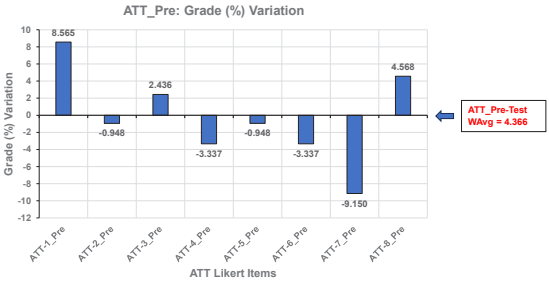
ATT: Pre-Test Descriptive Statistics (40 Teachers)

Table T7

Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade (%) Variation
ATT-1_Pre	0 (0)	0 (0)	0 (0)	9 (22.5)	31 (77.5)	4.775	0.423	8.565
ATT-2_Pre	0 (0)	2 (5)	4 (10)	13 (32.5)	21 (52.5)	4.325	0.859	-0.948
ATT-3_Pre	0 (0)	1 (2.5)	1 (2.5)	16 (40)	22 (55)	4.475	0.679	2.436
ATT-4_Pre	0 (0)	1 (2.5)	6 (15)	16 (40)	17 (42.5)	4.225	0.800	-3.337
ATT-5_Pre	0 (0)	1 (2.5)	4 (10)	16 (40)	19 (47.5)	4.325	0.764	-0.948
ATT-6_Pre	0 (0)	0 (0)	7 (17.5)	17 (42.5)	16 (40)	4.225	0.733	-3.337
ATT-7_Pre	0 (0)	1 (2.5)	10 (25)	17 (42.5)	12 (30)	4.000	0.816	-9.150
ATT-8_Pre	0 (0)	0 (0)	2 (5)	13 (32.5)	25 (62.5)	4.575	0.594	4.568
			N_Pre: 40		Weighted Avg:	4.366		

ATT: Plot of Pre-Test Grade (%) Variation
(40 Teachers)

Chart T6



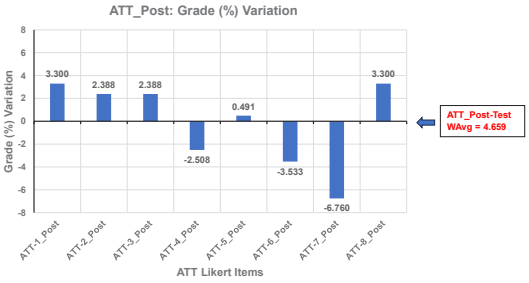
ATT: Post-Test Descriptive Statistics
(22 Teachers)

Table T8

Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade (%) Variation
ATT-1_Post	0 (0)	0 (0)	0 (0)	4 (18.182)	18 (81.818)	4.818	0.395	3.300
ATT-2_Post	0 (0)	0 (0)	0 (0)	5 (22.727)	17 (77.273)	4.773	0.429	2.388
ATT-3_Post	0 (0)	0 (0)	0 (0)	5 (22.727)	17 (77.273)	4.773	0.429	2.388
ATT-4_Post	0 (0)	0 (0)	2 (9.091)	6 (27.273)	14 (63.636)	4.545	0.671	-2.508
ATT-5_Post	0 (0)	0 (0)	1 (4.545)	5 (22.727)	16 (72.727)	4.682	0.568	0.491
ATT-6_Post	0 (0)	1 (4.545)	2 (9.091)	4 (18.182)	15 (68.182)	4.500	0.859	-3.533
ATT-7_Post	0 (0)	1 (4.545)	2 (9.091)	7 (31.818)	12 (54.545)	4.364	0.848	-6.760
ATT-8_Post	0 (0)	0 (0)	1 (4.545)	2 (9.091)	19 (86.364)	4.818	0.501	3.300
			N_Post: 22		Weighted Avg:	4.659		

ATT: Plot of Post-Test Grade (%) Variation
(22 Teachers)

Chart T7



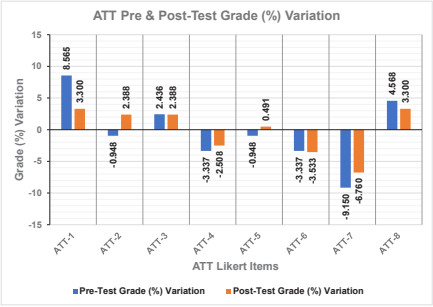
ATT: Pre & Post-Test Grade (%) Variation (Teachers)

Table T9

Likert Item	Pre-Test Grade (%) Variation	Post-Test Grade (%) Variation
ATT-1	8.565	3.300
ATT-2	-0.948	2.388
ATT-3	2.436	2.388
ATT-4	-3.337	-2.508
ATT-5	-0.948	0.491
ATT-6	-3.337	-3.533
ATT-7	-9.150	-6.760
ATT-8	4.568	3.300

ATT: Plot of Pre & Post-Test Grade (%) Variation (Teachers)

Chart T8



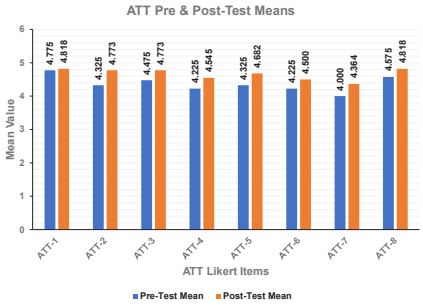
ATT: Pre & Post-Test Mean Values (Teachers)

Table T10

Likert Item	Pre-Test Mean	Post-Test Mean	Mean (%) Variation
ATT-1	4.775	4.818	0.892
ATT-2	4.325	4.773	9.386
ATT-3	4.475	4.773	6.243
ATT-4	4.225	4.545	7.041
ATT-5	4.325	4.682	7.625
ATT-6	4.225	4.500	6.111
ATT-7	4.000	4.364	8.341
ATT-8	4.575	4.818	5.044

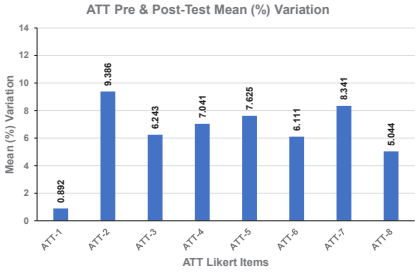
ATT: Plot of Pre & Post-Test Mean Values (Teachers)

Chart T9



ATT: Plot of Pre & Post-Test Mean (%) Variation - (Teachers)

Chart T10



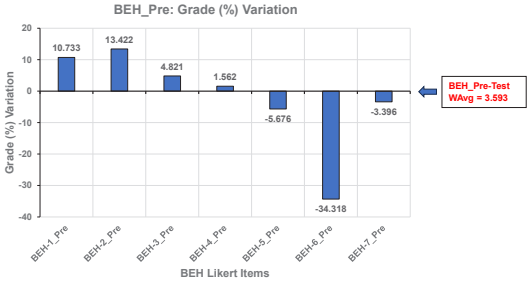
BEH: Pre-Test Descriptive Statistics (40 Teachers)

Table T11

Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade (%) Variation
BEH-1_Pre	0 (0)	1 (2.5)	9 (22.5)	18 (45)	12 (30)	4.025	0.800	10.733
BEH-2_Pre	0 (0)	2 (5)	8 (20)	12 (30)	18 (45)	4.150	0.921	13.422
BEH-3_Pre	1 (2.5)	3 (7.5)	9 (22.5)	18 (45)	9 (22.5)	3.775	0.974	4.821
BEH-4_Pre	1 (2.5)	4 (10)	11 (27.5)	16 (40)	8 (20)	3.650	1.001	1.562
BEH-5_Pre	4 (10)	3 (7.5)	13 (32.5)	13 (32.5)	7 (17.5)	3.400	1.172	-5.676
BEH-6_Pre	8 (20)	11 (27.5)	11 (27.5)	6 (15)	4 (10)	2.675	1.248	-34.318
BEH-7_Pre	3 (7.5)	2 (5)	12 (30)	19 (47.5)	4 (10)	3.475	1.012	-3.396
			N_Pre: 40		Weighted Avg:	3.593		

BEH: Plot of Pre-Test Grade (%) Variation
(40 Teachers)

Chart T11



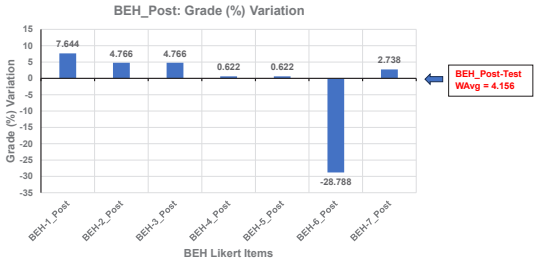
BEH: Post-Test Descriptive Statistics
(22 Teachers)

Table T12

Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade (%) Variation
BEH-1_Post	0 (0)	0 (0)	2 (9.091)	7 (31.818)	13 (59.091)	4.500	0.673	7.644
BEH-2_Post	0 (0)	0 (0)	4 (18.182)	6 (27.273)	12 (54.545)	4.364	0.790	4.766
BEH-3_Post	0 (0)	0 (0)	3 (13.636)	8 (36.364)	11 (50)	4.364	0.727	4.766
BEH-4_Post	0 (0)	0 (0)	7 (31.818)	4 (18.182)	11 (50)	4.182	0.907	0.622
BEH-5_Post	1 (4.545)	2 (9.091)	1 (4.545)	6 (27.273)	12 (54.545)	4.182	1.181	0.622
BEH-6_Post	3 (13.636)	5 (22.727)	3 (13.636)	6 (27.273)	5 (22.727)	3.227	1.412	-28.788
BEH-7_Post	0 (0)	0 (0)	5 (22.727)	6 (27.273)	11 (50)	4.273	0.827	2.738
			N_Post: 22		Weighted Avg:	4.156		

BEH: Plot of Post-Test Grade (%) Variation
(22 Teachers)

Chart T12



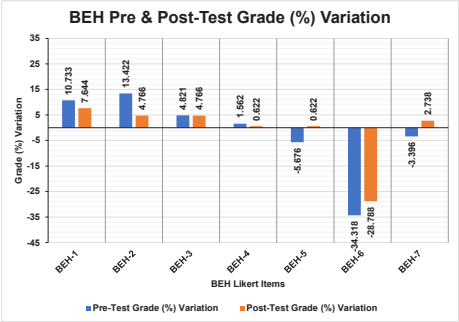
BEH: Pre & Post-Test Grade (%) Variation (Teachers)

Table T13

Likert Item	Pre-Test Grade (%) Variation	Post-Test Grade (%) Variation
BEH-1	10.733	7.644
BEH-2	13.422	4.766
BEH-3	4.821	4.766
BEH-4	1.562	0.622
BEH-5	-5.676	0.622
BEH-6	-34.318	-28.788
BEH-7	-3.396	2.738

BEH: Plot of Pre & Post-Test Grade (%) Variation (Teachers)

Chart T13



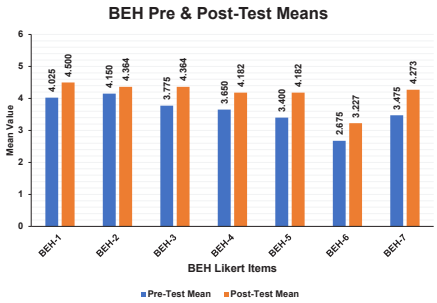
BEH: Pre & Post-Test Mean Values (Teachers)

Table T14

Likert Item	Pre-Test Mean	Post-Test Mean	Mean (%) Variation
BEH-1	4.025	4.500	10.556
BEH-2	4.150	4.364	4.904
BEH-3	3.775	4.364	13.497
BEH-4	3.650	4.182	12.721
BEH-5	3.400	4.182	18.699
BEH-6	2.675	3.227	17.106
BEH-7	3.475	4.273	18.675

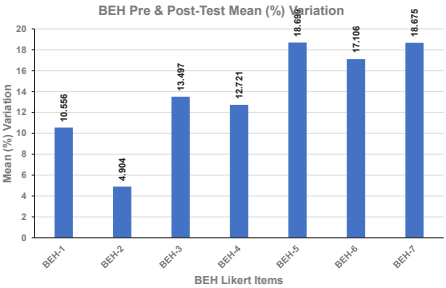
BEH: Plot of Pre & Post-Test Mean Values (Teachers)

Chart T14



BEH: Plot of Pre & Post-Test Mean (%) Variation - (Teachers)

Chart T15



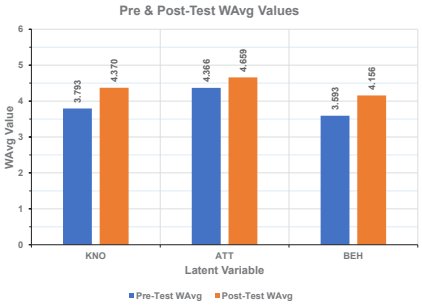
Pre & Post-Test WAvg Values (Teachers)

Table T15

CC Latent Variable	Pre-Test WAvg	Post-Test WAvg	WAvg (%) Variation
KNO	3.793	4.370	13.204
ATT	4.366	4.659	6.289
BEH	3.593	4.156	13.547

Plot of Pre & Post-Test WAvg Values (Teachers)

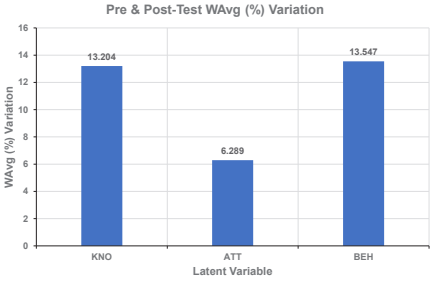
Chart T16



34

Plot of Pre & Post WAvg Value (%) Variation (Teachers)

Chart T17



35

Annex 3
ES Pilot Student Survey
Pre- & Post-Test Data Analysis (5)

Appendix
Miracle Climate Change Project
ES Pilot Student Survey
Pre- & Post-Test Data Analysis (5)

Orestes J. Varonis, Ph.D.
PARAGON-eduTech
2024-08-18

Introduction
(Spanish Students)

A student pilot survey for the Miracle's **Climate Change (CC)** Project was conducted at several schools in **Spain**. A total of **57 students** participated in both the pre-test and the post-test conducted surveys. The objective of this pilot survey was to acquire relevant data for the development of suitable Statistical Analysis Methods capable of evaluating the students' perception of their **CC Knowledge**, **CC Attitude**, and **CC Behaviour**, prior to and post their CC training.

5-Point Likert Scale
(Spanish Students)

Table S1

5-Point Likert Scale	Symbol	Assigned Value	Assigned Interval
Strongly Disagree	(SD)	1	(1.00 – 1.80)
Disagree	(D)	2	(1.81 – 2.60)
Neither Agree Nor Disagree	(N)	3	(2.61 – 3.40)
Agree	(A)	4	(3.41 – 4.20)
Strongly Agree	(SA)	5	(4.21 – 5.00)

Conducted Data Analysis Remarks
(Spanish Students)

1. The students' responses for their **CC Knowledge**, **CC Attitude**, and **CC Behaviour** were examined and evaluated separately.
2. Two methods of analysis were implemented for evaluating the effect of students' CC training upon their pilot survey responses.
   a. In the **1st Method of Analysis**, the effect of CC training upon each one of the student's **Likert Item** responses was analyzed and evaluated. Here, the students' responses were treated as **ordinal measures** and therefore, the data analysis focuses on **frequencies and proportions** as provided by the generated Descriptive Statistics Frequency Tables.
   b. In the **2nd Method of Analysis**, the effect of CC training upon the student's **Latent Variable** average responses was analyzed and evaluated. Here, the students' responses were treated as **scale measures** and therefore, the data analysis focuses on the obtained **Mean**, **Median and Standard Deviation**.

Data Reliability
(Spanish Students)

Prior to implementation of the chosen data analysis technique, examination of the **Reliability** of all Likert items assigned to the measurement of a latent variable was conducted. For an effective measurement, the corresponding Likert items must be highly correlated with each other.

The so-called **Cronbach's alpha** is an estimate of how well the assigned Likert items measure the latent variable and therefore, is an indication of the measurement accuracy. A **qualitative interpretation** of Cronbach's alpha value is given below as follows:

Cronbach's Alpha Value Ranges
(Spanish Students)

Table S2

Qualitative Interpretation of Cronbach's Alpha Value	Cronbach's Alpha Value Range
Excellent	Alpha ≥ 0.9
Good	0.9 > Alpha ≥ 0.8
Acceptable	0.8 > Alpha ≥ 0.7
Questionable	0.7 > Alpha ≥ 0.6
Poor	0.6 > Alpha ≥ 0.5
Unacceptable	0.5 > Alpha

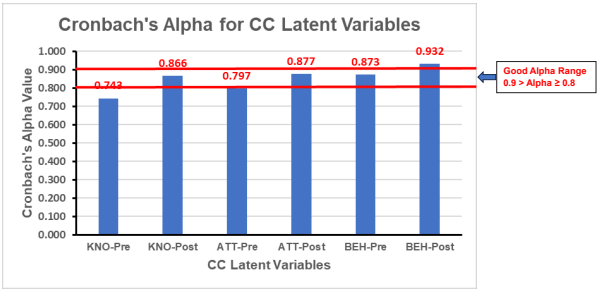
Computed Cronbach's Alpha Values & Reliability of Likert Items for CC Latent Variables (Spanish Students)

Table S3

CC Latent Variable	Cronbach's Alpha	Qualitative Interpretation
KNO-Pre	0.743	Acceptable
KNO-Post	0.866	Good
ATT-Pre	0.797	Acceptable
ATT-Post	0.877	Good
BEH-Pre	0.873	Good
BEH-Post	0.932	Excellent

Plot of Computed Cronbach's Alpha Values (Spanish Students)

Chart S1



KNO: Pre-Test Descriptive Statistics (Spanish Students)

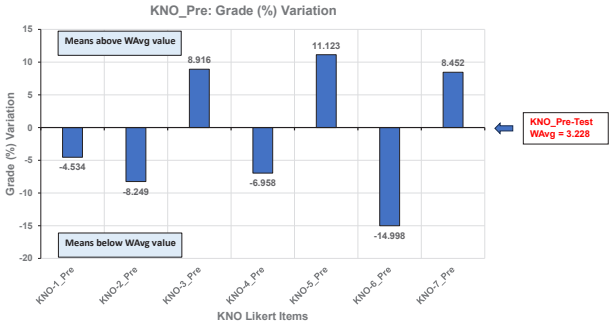
Table S4

Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade (%) Variation
KNO-1_Pre	8 (14.035)	12 (21.053)	14 (24.561)	13 (22.807)	10 (17.544)	**3.088**	1.313	**-4.534**
KNO-2_Pre	11 (19.298)	13 (22.807)	11 (19.298)	10 (17.544)	12 (21.053)	**2.982**	1.433	**-8.249**
KNO-3_Pre	6 (10.526)	4 (7.018)	16 (28.070)	15 (26.316)	16 (28.070)	**3.544**	1.269	**8.916**
KNO-4_Pre	13 (22.807)	8 (14.035)	15 (26.316)	7 (12.281)	14 (24.561)	**3.018**	1.482	**-6.958**
KNO-5_Pre	5 (8.772)	7 (12.281)	12 (21.053)	13 (22.807)	20 (35.088)	**3.632**	1.318	**11.123**
KNO-6_Pre	18 (31.579)	8 (14.035)	11 (19.298)	7 (12.281)	13 (22.807)	**2.807**	1.563	**-14.998**
KNO-7_Pre	5 (8.772)	11 (19.298)	11 (19.298)	9 (15.789)	21 (36.842)	**3.526**	1.390	**8.452**

Table S4 Footnote:
N=57
KNO_Pre: Weighted Average (WAvg) = 3.228
SD = Strongly Disagree, D = Disagree,
N = Neither, A = Agree, SA = Strongly Agree.

KNO: Plot of Pre-Test Grade (%) Variation
(Spanish Students)

Chart S2



KNO: Post-Test Descriptive Statistics
(Spanish Students)

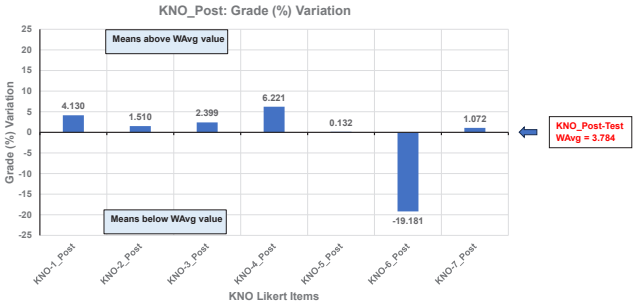
Table S5

Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade (%) Variation
KNO-1_Post	3 (5.263)	3 (5.263)	13 (22.807)	13 (22.807)	25 (43.860)	**3.947**	1.171	**4.130**
KNO-2_Post	2 (3.509)	6 (10.526)	14 (24.561)	12 (21.053)	23 (40.351)	**3.842**	1.177	**1.510**
KNO-3_Post	2 (3.509)	3 (5.263)	15 (26.316)	17 (29.825)	20 (35.088)	**3.877**	1.070	**2.399**
KNO-4_Post	3 (5.263)	2 (3.509)	10 (17.544)	17 (29.825)	25 (43.860)	**4.035**	1.117	**6.221**
KNO-5_Post	3 (5.263)	2 (3.509)	16 (28.070)	19 (33.333)	17 (29.825)	**3.789**	1.081	**0.132**
KNO-6_Post	8 (14.035)	14 (24.561)	11 (19.298)	8 (14.035)	16 (28.070)	**3.175**	1.441	**-19.181**
KNO-7_Post	3 (5.263)	4 (7.018)	15 (26.316)	13 (22.807)	22 (38.596)	**3.825**	1.182	**1.072**

Table S5 Foot Note:
N = 57
KNO_Post: Weighted Average (WAvg) = 3.784
SD = Strongly Disagree, D = Disagree,
N = Neither, A = Agree, SA = Strongly Agree.

KNO: Plot of Post-Test Grade (%) Variation
(Spanish Students)

Chart S3



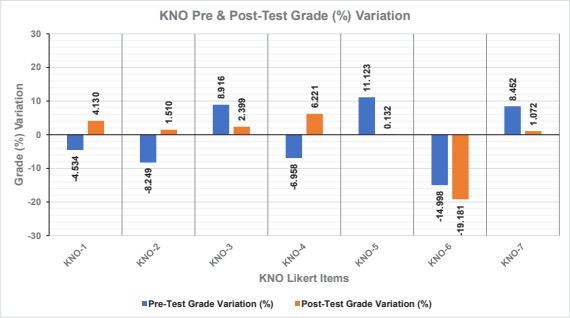
KNO: Pre & Post-Test Grade (%) Variation (Spanish Students)

Table S6

Likert Item	Pre-Test Grade (%) Variation	Post-Test Grade (%) Variation
KNO-1	-4.534	4.130
KNO-2	-8.249	1.510
KNO-3	8.916	2.399
KNO-4	-6.958	6.221
KNO-5	11.123	0.132
KNO-6	-14.998	-19.181
KNO-7	8.452	1.072

KNO: Plot of Pre & Post-Test Grade (%) Variation – (Spanish Students)

Chart S4



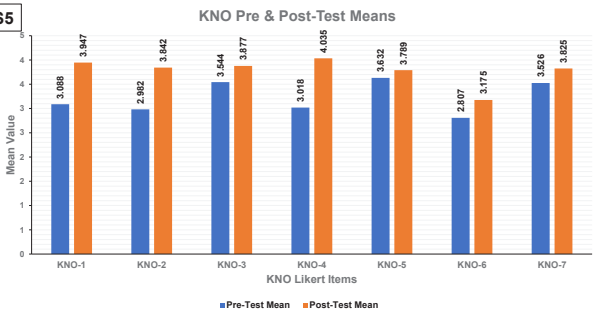
KNO: Pre & Post-Test Mean Values (Spanish Students)

Table S7

Likert Item	Pre-Test Mean	Post-Test Mean	Mean (%) Variation
KNO-1	3.088	3.947	21.763
KNO-2	2.982	3.842	22.384
KNO-3	3.544	3.877	8.589
KNO-4	3.018	4.035	25.204
KNO-5	3.632	3.789	4.144
KNO-6	2.807	3.175	11.591
KNO-7	3.526	3.825	7.817

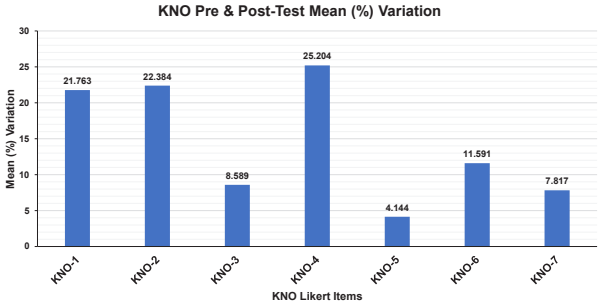
KNO: Plot of Pre & Post-Test Mean Values
(Spanish Students)

Chart S5



KNO: Plot of Pre & Post-Test Mean (%) Variation - (Spanish Students)

Chart S6



ATT: Pre-Test Descriptive Statistics
(Spanish Students)

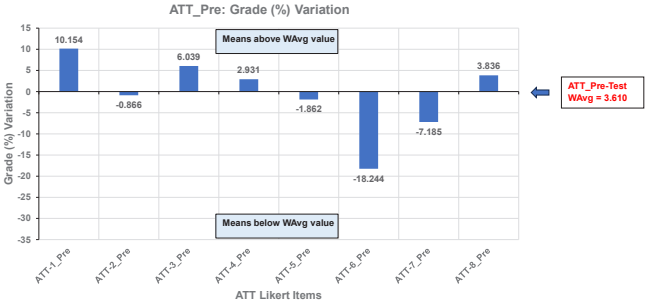
Table S8

Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade (%) Variation
ATT-1_Pre	0 (0.000)	5 (8.772)	13 (22.807)	15 (26.316)	24 (42.105)	**4.018**	1.009	**10.154**
ATT-2_Pre	5 (8.772)	8 (14.035)	12 (21.053)	13 (22.807)	19 (33.333)	**3.579**	1.322	**-0.866**
ATT-3_Pre	4 (7.018)	10 (17.544)	5 (8.772)	10 (17.544)	28 (49.123)	**3.842**	1.386	**6.039**
ATT-4_Pre	3 (5.263)	8 (14.035)	14 (24.561)	9 (15.789)	23 (40.351)	**3.719**	1.278	**2.931**
ATT-5_Pre	3 (5.263)	10 (17.544)	12 (21.053)	17 (29.825)	15 (26.316)	**3.544**	1.211	**-1.862**
ATT-6_Pre	10 (17.544)	12 (21.053)	11 (19.298)	13 (22.807)	11 (19.298)	**3.053**	1.394	**-18.244**
ATT-7_Pre	8 (14.035)	10 (17.544)	11 (19.298)	9 (15.789)	19 (33.333)	**3.368**	1.459	**-7.185**
ATT-8_Pre	3 (5.263)	5 (8.772)	16 (28.070)	12 (21.053)	21 (36.842)	**3.754**	1.199	**3.836**

Table S8 Foot Note:
N = 57
ATT_Pre: Weighted Average (WAvg) = 3.610
SD = Strongly Disagree, D = Disagree,
N = Neither, A = Agree, SA = Strongly Agree.

ATT: Plot of Pre-Test Grade (%) Variation
(Spanish Students)

Chart S7



ATT: Post-Test Descriptive Statistics
(Spanish Students)

Table S9

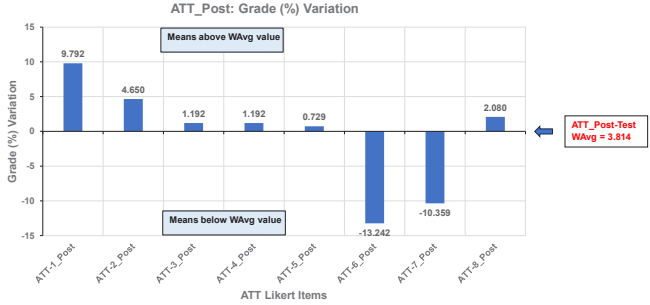
Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade Variation (%)
ATT-1_Post	1 (1.754)	2 (3.509)	7 (12.281)	20 (35.088)	27 (47.368)	**4.228**	0.926	**9.792**
ATT-2_Post	0 (0000)	3 (5.263)	17 (29.825)	14 (24.561)	23 (40.351)	**4.000**	0.964	**4.650**
ATT-3_Post	1 (1.754)	8 (14.035)	13 (22.807)	11 (19.298)	24 (42.105)	**3.860**	1.172	**1.192**
ATT-4_Post	2 (3.509)	5 (8.772)	14 (24.561)	14 (24.561)	22 (38.596)	**3.860**	1.141	**1.192**
ATT-5_Post	3 (5.263)	4 (7.018)	16 (28.070)	10 (17.544)	24 (42.105)	**3.842**	1.207	**0.729**
ATT-6_Post	7 (12.281)	7 (12.281)	18 (31.579)	8 (14.035)	17 (29.825)	**3.368**	1.358	**-13.242**
ATT-7_Post	4 (7.018)	9 (15.789)	18 (31.579)	9 (15.789)	17 (29.825)	**3.456**	1.269	**-10.359**
ATT-8_Post	1 (1.754)	4 (7.018)	21 (36.842)	5 (8.772)	26 (45.614)	**3.895**	1.129	**2.080**

Table S9 Foot Note:
N = 57
ATT_Post: Weighted Average (WAvg) = 3.814
SD = Strongly Disagree, D = Disagree,
N = Neither, A = Agree, SA = Strongly Agree.

20

ATT: Plot of Post-Test Grade (%) Variation
(Spanish Students)

Chart S8



21

ATT: Pre & Post-Test Grade (%) Variation
(Spanish Students)

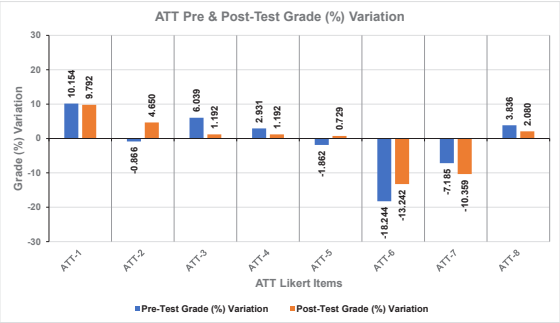
Table S10

Likert Item	Pre-Test Grade (%) Variation	Post-Test Grade (%) Variation
ATT-1	10.154	9.792
ATT-2	-0.866	4.650
ATT-3	6.039	1.192
ATT-4	2.931	1.192
ATT-5	-1.862	0.729
ATT-6	-18.244	-13.242
ATT-7	-7.185	-10.359
ATT-8	3.836	2.080

22

ATT: Plot of Pre & Post-Test Grade (%) Variation – (Spanish Students)

Chart S9



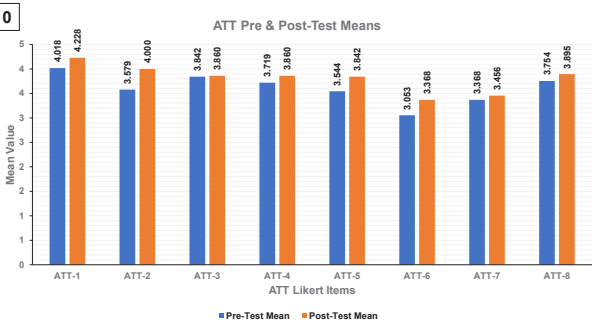
ATT: Pre & Post-Test Mean Values
(Spanish Students)

Table S11

Likert Item	Pre-Test Mean	Post-Test Mean	Mean (%) Variation
ATT-1	4.018	4.228	4.967
ATT-2	3.579	4.000	10.525
ATT-3	3.842	3.860	0.466
ATT-4	3.719	3.860	3.653
ATT-5	3.544	3.842	7.756
ATT-6	3.053	3.368	9.353
ATT-7	3.368	3.456	2.546
ATT-8	3.754	3.895	3.620

ATT: Plot of Pre & Post-Test Mean Values
(Spanish Students)

Chart S10



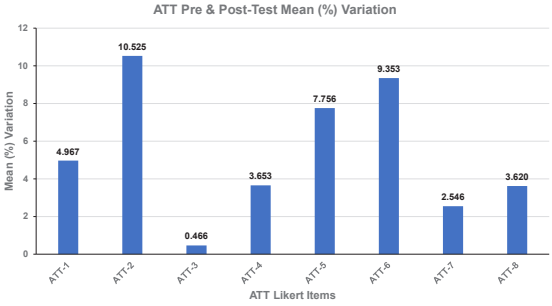
ATT: Pre & Post-Test Mean Values
(Spanish Students)

Table S11

Likert Item	Pre-Test Mean	Post-Test Mean	Mean (%) Variation
ATT-1	4.018	4.228	4.967
ATT-2	3.579	4.000	10.525
ATT-3	3.842	3.860	0.466
ATT-4	3.719	3.860	3.653
ATT-5	3.544	3.842	7.756
ATT-6	3.053	3.368	9.353
ATT-7	3.368	3.456	2.546
ATT-8	3.754	3.895	3.620

ATT: Plot of Pre & Post-Test
Mean (%) Variation - (Spanish Students)

Chart S11



BEH: Pre-Test Descriptive Statistics
(Spanish Students)

Table S12

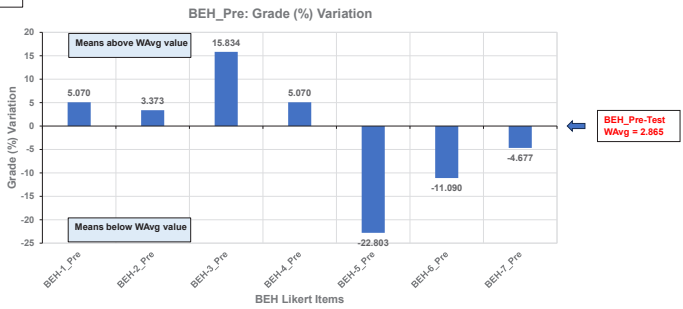
Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade (%) Variation
BEH-1_Pre	8 (14.035)	13 (22.807)	17 (29.825)	8 (14.035)	11 (19.298)	**3.018**	1.316	**5.070**
BEH-2_Pre	10 (17.544)	10 (17.544)	19 (33.333)	8 (14.035)	10 (17.544)	**2.965**	1.322	**3.373**
BEH-3_Pre	6 (10.526)	10 (17.544)	13 (22.807)	11 (19.298)	17 (29.825)	**3.404**	1.361	**15.834**
BEH-4_Pre	6 (10.526)	18 (31.579)	12 (21.053)	11 (19.298)	10 (17.544)	**3.018**	1.289	**5.070**
BEH-5_Pre	22 (38.596)	15 (26.316)	7 (12.281)	5 (8.772)	8 (14.035)	**2.333**	1.431	**-22.803**
BEH-6_Pre	21 (36.842)	8 (14.035)	12 (21.053)	6 (10.526)	10 (17.544)	**2.579**	1.511	**-11.090**
BEH-7_Pre	16 (28.070)	15 (26.316)	7 (12.281)	6 (10.526)	13 (22.807)	**2.737**	1.541	**-4.677**

Table S12 Foot Note:
N = 57
BEH_Pre: Weighted Average (WAvg) = 2.865
SD = Strongly Disagree, D = Disagree,
N = Neither, A = Agree, SA = Strongly Agree.

27

BEH: Plot of Pre-Test Grade (%) Variation
(Spanish Students)

Chart S12



BEH: Post-Test Descriptive Statistics
(Spanish Students)

Table S13

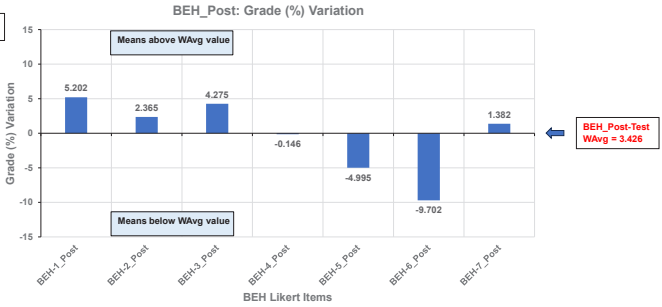
Likert Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation	Grade (%) Variation
BEH-1_Post	5 (8.772)	7 (12.281	12 (21.053)	14 (24.561)	19 (33.333)	**3.614**	1.306	**5.202**
BEH-2_Post	5 (8.772)	8 (14.035)	16 (28.070)	9 (15.789)	19 (33.333)	**3.509**	1.325	**2.365**
BEH-3_Post	4 (7.018)	7 (12.281	17 (29.825)	10 (17.544)	19 (33.333)	**3.579**	1.267	**4.275**
BEH-4_Post	6 (10.526)	9 (15.789)	11 (19.298)	17 (29.825)	14 (24.561)	**3.421**	1.309	**-0.146**
BEH-5_Post	10 (17.544)	8 (14.035)	11 (19.298)	13 (22.807)	15 (26.316)	**3.263**	1.446	**-4.995**
BEH-6_Post	11 (19.298)	10 (17.544)	11 (19.298)	11 (19.298)	14 (24.561)	**3.123**	1.465	**-9.702**
BEH-7_Post	6 (10.526)	7 (12.281	15 (26.316)	12 (21.053)	17 (29.825)	**3.474**	1.324	**1.382**

Table S13 Foot Note:
N = 57
BEH_Post: Weighted Average (WAvg) = 3.426
SD = Strongly Disagree, D = Disagree,
N = Neither, A = Agree, SA = Strongly Agree.

29

BEH: Plot of Post-Test Grade (%) Variation
(Spanish Students)

Chart S13



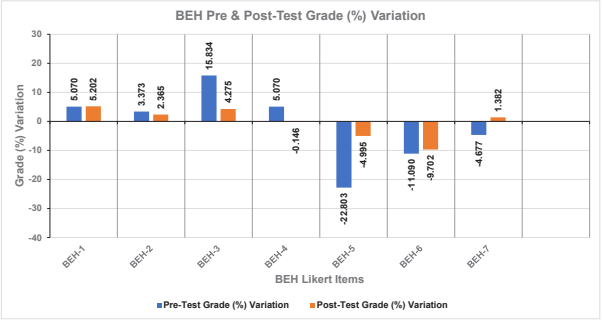
BEH: Pre & Post-Test Grade (%) Variation
(Spanish Students)

Table S14

Likert Item	Pre-Test Grade (%) Variation	Post-Test Grade (%) Variation
BEH-1	5.070	5.202
BEH-2	3.373	2.365
BEH-3	15.834	4.275
BEH-4	5.070	-0.146
BEH-5	-22.803	-4.995
BEH-6	-11.090	-9.702
BEH-7	-4.677	1.382

BEH: Plot of Pre & Post-Test Grade (%) Variation – (Spanish Students)

Chart S14



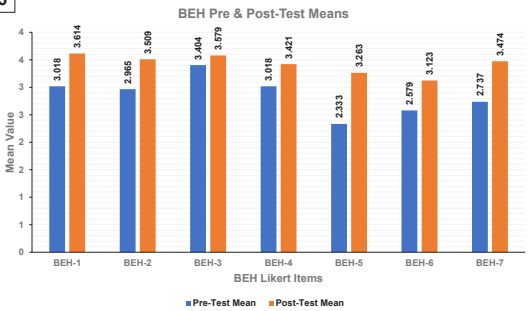
BEH: Pre & Post-Test Mean Values
(Spanish Students)

Table S15

Likert Item	Pre-Test Mean	Post-Test Mean	Mean (%) Variation
BEH-1	3.018	3.614	16.491
BEH-2	2.965	3.509	15.503
BEH-3	3.404	3.579	4.890
BEH-4	3.018	3.421	11.780
BEH-5	2.333	3.263	28.501
BEH-6	2.579	3.123	17.419
BEH-7	2.737	3.474	21.215

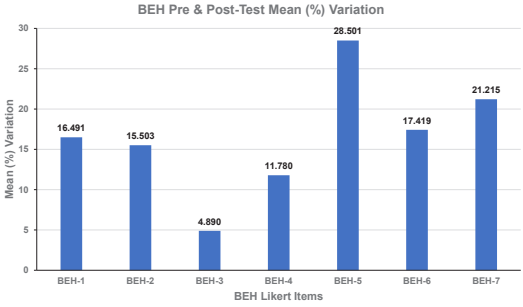
BEH: Plot of Pre & Post-Test Mean Values
(Spanish Students)

Chart S15



BEH: Plot of Pre & Post-Test Mean (%) Variation - (Spanish Students)

Chart S16



Pre & Post-Test WAvg Mean Values
(Spanish Students)

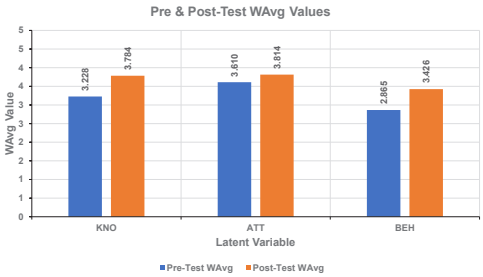
Table S16

CC Latent Variable	Pre-Test WAvg	Post-Test WAvg	WAvg Variation (%)
KNO	3.228	3.784	14.693
ATT	3.610	3.814	5.349
BEH	2.865	3.426	16.375

36

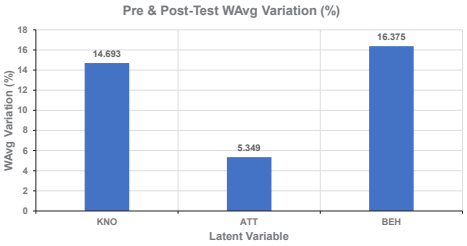
Plot of Pre & Post-Test WAvg Values
(Spanish Students)

Chart S17



Plot of Pre & Post WAvg Value (%) Variation
(Spanish Students)

Chart S18



38

Inference Statistics Remarks
(Spanish Students)

1. Further insight into the CC training effect upon the students' responses, was obtained by conducting a statistical **inference analysis**. The underlining principle of an inference analysis is that the obtained pre-test and post-test survey responses are respectively collected from small samples of a much larger student population. The inference analysis seeks to characterize the statistical properties of the larger population based on the small sample's test results.
2. Examination of whether there is a **statistically significant difference** between the pre-test responses and the post-test responses for each Likert item was done using the **Non-parametric Paired-Samples Wilcoxon-Test**. Here, the use of a non-parametric test is required since all Likert item responses were treated as **ordinal measures.**

KNO: Paired-Samples t-Test
(Spanish Students)

Null Hypothesis: There is not a statistically significant difference between the Pre & Post-Training responses for **Knowledge (KNO)**

Table S17

Paired Samples T-Test

Measure 1		Measure 2	W	z	df	p
KNO-1_Pre	-	KNO-1_Post	169.000	−3.671		< .001
KNO-2_Pre	-	KNO-2_Post	161.500	−3.626		< .001
KNO-3_Pre	-	KNO-3_Post	212.000	−1.687		0.079
KNO-4_Pre	-	KNO-4_Post	104.500	−4.339		< .001
KNO-5_Pre	-	KNO-5_Post	391.500	−0.505		0.607
KNO-6_Pre	-	KNO-6_Post	265.500	−1.297		0.193
KNO-7_Pre	-	KNO-7_Post	297.000	−1.298		0.182

Note. Wilcoxon signed-rank test.

Decision: For every **Knowledge (KNO)** Likert item whose computed **P-Value ≤ 0.05**, **there is** a statistically significant difference between its pre-training and post-training responses and **we reject** the Null Hypothesis.

KNO: Paired-Samples t-Test
(Spanish Students)

Table S18

Measure 1	Measure 2	t-Test P-Value	Decision Outcome
KNO-1_Pre	KNO-1_Post	**< 0.001**	There is a statistically significant difference
KNO-2_Pre	KNO-2_Post	**< 0.001**	There is a statistically significant difference
KNO-3_Pre	KNO-3_Post	**0.079**	There is not a statistically significant difference
KNO-4_Pre	KNO-4_Post	**< 0.001**	There is a statistically significant difference
KNO-5_Pre	KNO-5_Post	**0.607**	There is not a statistically significant difference
KNO-6_Pre	KNO-6_Post	**0.193**	There is not a statistically significant difference
KNO-7_Pre	KNO-7_Post	**0.182**	There is not a statistically significant difference

41

ATT: Paired-Samples t-Test
(Spanish Students)

Null Hypothesis: There is not a statistically significant difference between the Pre & Post-Training responses for **Attitude (ATT)**

Table S19

Paired Samples T-Test

Measure 1		Measure 2	W	z	df	p
ATT-1_Pre	-	ATT-1_Post	183.000	−1.274		0.189
ATT-2_Pre	-	ATT-2_Post	133.000	−2.047		0.037
ATT-3_Pre	-	ATT-3_Post	228.500	−0.082		0.941
ATT-4_Pre	-	ATT-4_Post	259.000	−0.658		0.497
ATT-5_Pre	-	ATT-5_Post	299.000	−1.270		0.196
ATT-6_Pre	-	ATT-6_Post	315.500	−1.270		0.199
ATT-7_Pre	-	ATT-7_Post	352.000	−0.268		0.789
ATT-8_Pre	-	ATT-8_Post	181.500	−0.778		0.432

Note. Wilcoxon signed-rank test.

Decision: For every **Attitude (ATT)** Likert item whose computed **P-Value ≤ 0.05**, **there is** a statistically significant difference between its pre-training and post-training responses and **we reject** the Null Hypothesis.

ATT: Paired-Samples t-Test
(Spanish Students)

Table S20

Measure 1	Measure 2	t-Test P-Value	Decision Outcome
ATT-1_Pre	ATT-1_Post	**0.189**	There is not a statistically significant difference
ATT-2_Pre	ATT-2_Post	**0.037**	There is a statistically significant difference
ATT-3_Pre	ATT-3_Post	**0.941**	There is not a statistically significant difference
ATT-4_Pre	ATT-4_Post	**0.497**	There is not a statistically significant difference
ATT-5_Pre	ATT-5_Post	**0.196**	There is not a statistically significant difference
ATT-6_Pre	ATT-6_Post	**0.199**	There is not a statistically significant difference
ATT-7_Pre	ATT-7_Post	**0.789**	There is not a statistically significant difference
ATT-8_Pre	ATT-8_Post	**0.432**	There is not a statistically significant difference

BEH: Paired-Samples t-Test
(Spanish Students)

Null Hypothesis: There is not a statistically significant difference between the Pre & Post-Training responses for **Behaviour (BEH)**

Table S21

Paired Samples T-Test

Measure 1		Measure 2	W	z	df	p
BEH-1_Pre	-	BEH-1_Post	185.500	−2.854		0.003
BEH-2_Pre	-	BEH-2_Post	214.500	−2.449		0.012
BEH-3_Pre	-	BEH-3_Post	219.000	−0.841		0.397
BEH-4_Pre	-	BEH-4_Post	149.500	−2.141		0.029
BEH-5_Pre	-	BEH-5_Post	98.000	−3.824		< .001
BEH-6_Pre	-	BEH-6_Post	219.000	−1.999		0.044
BEH-7_Pre	-	BEH-7_Post	201.000	−2.974		0.003

Note. Wilcoxon signed-rank test.

Decision: For every **Behaviour (BEH)** Likert item whose computed **P-Value ≤ 0.05**, **there is** a statistically significant difference between its pre-training and post-training responses and **we reject** the Null Hypothesis.

BEH: Paired-Samples t-Test
(Spanish Students)

Table S22

Measure 1	Measure 2	t-Test P-Value	Decision Outcome
BEH-1_Pre	BEH-1_Post	**0.003**	There is a statistically significant difference
BEH-2_Pre	BEH-2_Post	**0.012**	There is a statistically significant difference
BEH-3_Pre	BEH-3_Post	**0.397**	There is not a statistically significant difference
BEH-4_Pre	BEH-4_Post	**0.029**	There is a statistically significant difference
BEH-5_Pre	BEH-5_Post	**< 0.001**	There is a statistically significant difference
BEH-6_Pre	BEH-6_Post	**0.044**	There is a statistically significant difference
BEH-7_Pre	BEH-7_Post	**0.003**	There is a statistically significant difference

Average Response Analysis
(Spanish Students)

In the second part of the conducted study, the effect of CC training upon the students' **Latent Variable Average Response (SAvg)** was analyzed and evaluated. The SAvg response was obtained by summing up the student responses of all latent variable Likert items and dividing the obtained sum by the number of Likert items. As such, the following **Parameter Transformations** were implemented:

1. **KNO-SAvg_Pre** = [(KNO1_Pre) + (KNO2_Pre) + (KNO3_Pre) + (KNO4_Pre) + (KNO5_Pre) + (KNO_Pre) + (KNO7_Pre)] / (7)
2. **KNO-SAvg_Post** = [(KNO1_Post) + (KNO2_Post) + (KNO3_Post) + (KNO4_Post) + (KNO5_Post) + (KNO6_Post) + (KNO7_Post)] / (7)
3. **ATT-SAvg_Pre** = [(ATT1_Pre) + (ATT2_Pre) + (ATT3_Pre) + (ATT4_Pre) + (ATT5_Pre) + (ATT6_Pre) + (ATT7_Pre) + (ATT8_Pre)] / (8)
4. **ATT-SAvg_Post** = [(ATT1_Post) + (ATT2_Post) + (ATT3_Post) + (ATT4_Post) + (ATT5_Post) + (ATT_Post) + (ATT7_Post) + (ATT8_Post)] / (8)
5. **BEH-SAvg_Pre** = [(BEH1_Pre) + (BEH2_Pre) + (BEH3_Pre) + (BEH4_Pre) + (BEH5_Pre) + (BEH6_Pre) + (BEH7_Pre)] / (7)
6. **BEH-SAvg_Post** = [(BEH1_Post) + (BEH2_Post) + (BEH3_Post) + (BEH4_Post) + (BEH5_Post) + (BEH6_Post) + (BEH7_Post)] / (7)

Here, the students' responses were treated as **scale measures** and therefore, the data analysis focuses on the calculated **Mean**, **Median and Standard Deviation**.

KNO-SAvg: Pre & Post Descriptive Statistics
(Spanish Students)

Table S23

Parameter	KNO-SAvg_Pre	KNO-SAvg_Post
Valid	**57**	**57**
Missing	**0**	**0**
Median	**3**	**3.857**
Mean	**3.228**	**3.784**
Std. Deviation	**0.877**	**0.881**
Skewness	**-0.008**	**-0.526**
Std. Error of Skewness	**0.316**	**0.316**
Kurtosis	**-0.18**	**0.289**
Std. Error of Kurtosis	**0.623**	**0.623**
Shapiro-Wilk	**0.977**	**0.947**
P-value of Shapiro-Wilk	**0.345**	**0.015**
Minimum	**1**	**1**
Maximum	**5**	**5**

KNO-SAvg: Pre & Post Histogram Plots
(Spanish Students)

Chart S19

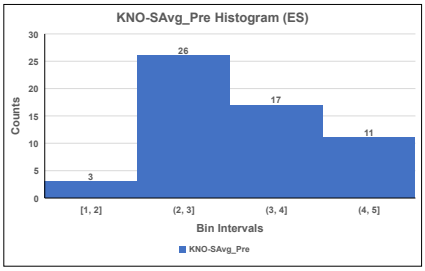
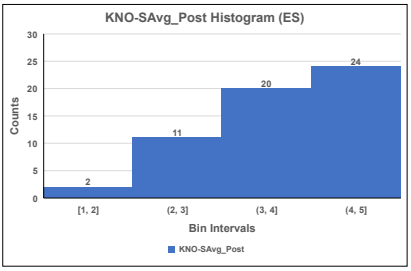
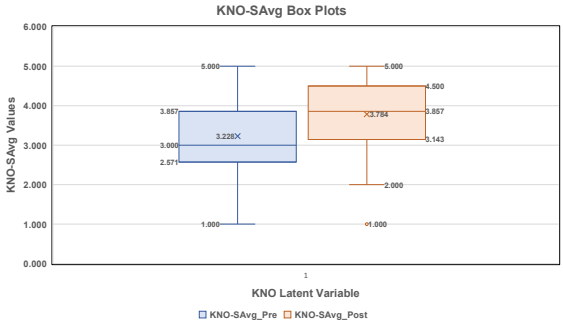


Chart S20



KNO-SAvg: Pre & Post Box Plots
(Spanish Students)

Chart S21



49

ATT-SAvg: Pre & Post Descriptive Statistics
(Spanish Students)

Table S24

Parameter	ATT-SAvg_Pre	ATT-SAvg_Post
Valid	57	57
Missing	0	0
Median	3.625	3.625
Mean	3.610	3.814
Std. Deviation	0.829	0.845
Skewness	-0.097	0.104
Std. Error of Skewness	0.316	0.316
Kurtosis	-0.413	-1.411
Std. Error of Kurtosis	0.623	0.623
Shapiro-Wilk	0.972	0.911
P-value of Shapiro-Wilk	0.213	< .001
Minimum	1.375	2.375
Maximum	5	5

50

ATT-SAvg: Pre & Post Histogram Plots
(Spanish Students)

Chart S22

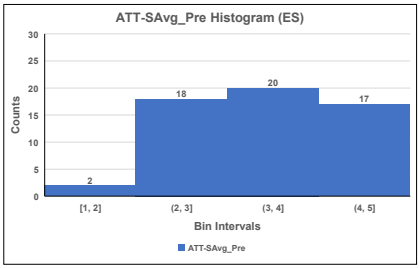
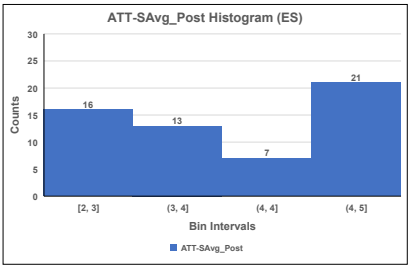
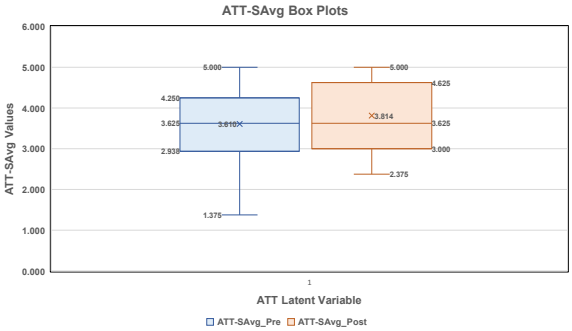


Chart S23



ATT-SAvg: Pre & Post Box Plots
(Spanish Students)

Chart 24



BEH-SAvg: Pre & Post Descriptive Statistics
(Spanish Students)

Table S25

Parameter	BEH-SAvg_Pre	BEH-SAvg_Post
Valid	57	57
Missing	0	0
Median	2.714	3.429
Mean	2.865	3.426
Std. Deviation	1.055	1.139
Skewness	0.393	-0.172
Std. Error of Skewness	0.316	0.316
Kurtosis	-0.666	-1.035
Std. Error of Kurtosis	0.623	0.623
Shapiro-Wilk	0.961	0.946
P-value of Shapiro-Wilk	0.061	0.012
Minimum	1	1
Maximum	5	5

BEH-SAvg: Pre & Post Histogram Plots
(Spanish Students)

Chart S25

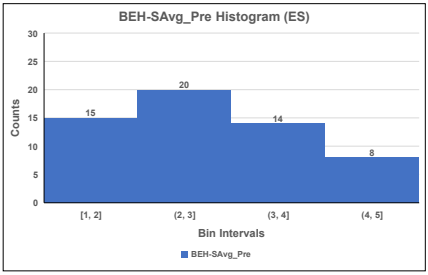
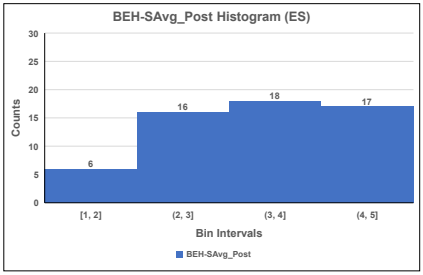
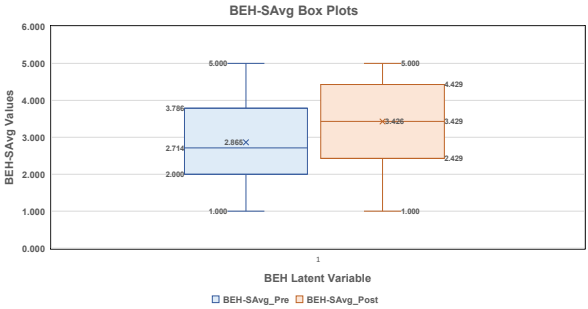


Chart S26



Box Plots for BEH-SAvg_Pre & BEH-SAvg_Post
(Spanish Students)

Chart 27



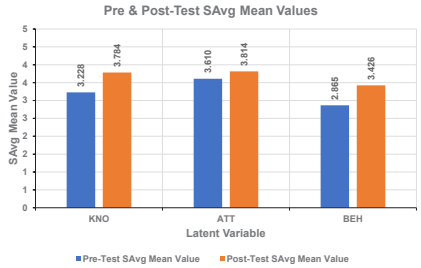
Pre & Post-Test SAvg Mean Values
(Spanish Students)

Table S26

CC Latent Variable	Pre-Test SAvg Mean Value	Post-Test SAvg Mean Value	SAvg Mean Value (%) Variation
KNO	3.228	3.784	14.693
ATT	3.610	3.814	5.349
BEH	2.865	3.426	16.375

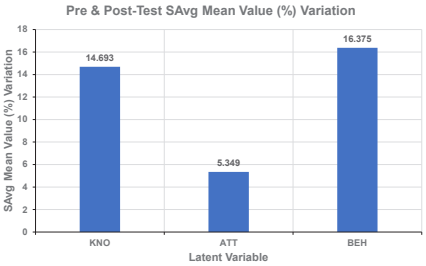
Plot of Pre & Post-Test SAvg Mean Values
(Spanish Students)

Chart S28



Plot of Pre & Post SAvg Mean Value (%) Variation
(Spanish Students)

Chart S29



Comparison of WAvg & SAvg Mean Values
(Spanish Students)

Table S27

CC Latent Variable	Pre-Test WAvg	Post-Test WAvg	WAvg Variation (%)
KNO	3.228	3.784	14.693
ATT	3.610	3.814	5.349
BEH	2.865	3.426	16.375

CC Latent Variable	Pre-Test SAvg Mean Value	Post-Test SAvg Mean Value	SAvg Mean Value (%) Variation
KNO	3.228	3.784	14.693
ATT	3.610	3.814	5.349
BEH	2.865	3.426	16.375

WAvg = SAvg Mean Value

59

Test of Normality for KNO-SAvg, ATT-SAvg & BEH-SAvg - (Spanish Students)

Table S28

Test of Normality (Shapiro-Wilk)

			W	p
KNO-SAvg_Pre	-	KNO-SAvg_Post	0.970	0.168
ATT-SAvg_Pre	-	ATT-SAvg_Post	0.914	< .001
BEH-SAvg_Pre	-	BEH-SAvg_Post	0.960	0.060

Note. Significant results suggest a deviation from normality.

Non-Parametric Paired-Samples t-Test for KNO-SAvg, ATT-SAvg, & BEH-SAvg - (Spanish Students)

Null Hypothesis for **CC Knowledge**: There is not a statistically significant difference between the **KNO-SAvg_Pre** and **KNO-SAvg_Post** computed data sets.

Null Hypothesis for **CC Attitude**: There is not a statistically significant difference between the **ATT-SAvg_Pre** and **ATT-SAvg_Post** computed data sets.

Null Hypothesis for **CC Behaviour**: There is not a statistically significant difference between the **BEH-SAvg_Pre** and **BEH-SAvg_Post** computed data sets.

Decision Criteria for Non-Parametric Paired-Samples t-Test

If the t-Test **P-Value > 0.05**, then **there is not** a statistically significant difference between the Avg_Pre & Avg_Post computed values, and **we accept** the Null Hypothesis.

If the t-Test **P-Value ≤ 0.05**, then **there is** a statistically significant difference between the Avg_Pre & Avg_Post computed values, and **we reject** the Null Hypothesis.

61

Non-Parametric Paired-Samples t-Test for KNO-SAvg, ATT-SAvg, & BEH-SAvg - (Spanish Students)

Table S29

Paired Samples T-Test

Measure 1	Measure 2	W	z	df	p
KNO-Avg_Pre	- KNO-Avg_Post	275.000	-3.637		< .001
ATT-Avg_Pre	- ATT-Avg_Post	550.000	-1.059		0.291
BEH-Avg_Pre	- BEH-Avg_Post	323.000	-3.333		< .001

Note. Wilcoxon signed-rank test.

Paired-Samples t-Test Decision Outcome for KNO-SAvg, ATT-SAvg, & BEH-SAvg Data Sets - (Spanish Students)

Table S30

Measure 1	Measure 2	t-Test P-Value	Decision Outcome
KNO-SAvg_Pre	KNO-SAvg_Post	**< 0.001**	There is a statistically significant difference
ATT-SAvg_Pre	ATT-SAvg_Post	**0.291**	There is not a statistically significant difference
BEH-SAvg_Pre	BEH-SAvg_Post	**< 0.001**	There is a statistically significant difference

63

A full accessibility friendly version of the Validation Report, with editable tables and text, is also available.

MIRACLE
Project Validation Report

The MIRACLE (coMics and IllustRations Augmented to tackle Climate change in primary Education) project develops inclusive strategies for teachers and students to learn about and engage with climate change (CC), a topic that at Primary Education level is perceived as abstract, distant, and complex, and at the same time contributes to growing feelings of sadness, hopelessness, and anxiety.

This Validation Report summarizes data from pre-test and post-test surveys administered to the students and teachers that took part in project pilot.