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TEACHER TRAINING ANALYSIS & RESULTS

Teacher Self-Efficacy for STEM

Awareness of Climate Change

Technological Pedagogical STEM Knowledge

INTRODUCTION

In this report, the effectiveness of the teacher trainings on STEM education conducted in the C1, C2and C3 Mobilities were investigated.

PROCEDURE

A 18-item self-efficacy scale for STEM applications was employed to assess the efficacy of STEM training programmes in Alanya, Turkey. A 25-item Awareness of Climate Change Scale was utilised to evaluate the impact of STEM training programmes in Subotice, Serbia. A 17-item Technological Pedagogical STEM Knowledge Survey was deployed to examine the effectiveness of STEM training programmes in Albacete, Spain.

Use of permissions for the scales were obtained. Voluntary participation consent was also obtained from the participants. Regarding the ethical considerations, all data were reported to anonymously.

The teachers of the partner countries were given a pre-test on the first day of each mobility before the trainings started. The post-test was administered on the last day after the STEM trainings ended. There were 5 days between the pre-test and post-test.

All analysis were conducted with Jamovi 2.4.8. In order to evaluate the suitability of the data for analysis, reliability analysis was first examined, and it was checked whether the data exhibited a normal distribution. We performed, internal consistency in order to determine the reliability of the scale. If the data were reliable and normally distributed, the effectiveness of the trainings was analyzed by Paired Samples t-test. However, Wilcoxon Signed-Rank Test was used for the cases that did not exhibit normal distribution.

FINDINGS AND RESULTS

C1 ALANYA MOBILITY (Teacher Self-Efficacy Scale for STEM Applications)

We measured the effectiveness of the trainings by using a semi-experimental research design. A 18-item Teacher Self-Efficacy Scale for STEM Applications (see Appendix 1) was used to measure the effectiveness of STEM trainings. All items were 5-point Likert Style from 1 (Never) to 5 (Always). The lowest score that can acquired from the test is 18 and the highest is 90.

We collected data from a total of 15 teachers from seven countries. For the Alanya data set, Cronbach's alpha of pre-test and post-test of the 18-item self-efficacy scale for STEM applications were .98 and .94 respectively. In this case, we can propose that the data was reliable.

A Paired samples t-test was conducted to determine the effect of training on science career interest test score.

Table 1

Paired Samples Correlations

		N	r	p.
Pair 1	PreTest & PostTest	15	,644	<,01

The correlation coefficient shows that there is a significant positive relationship between STEM Self Efficacy score before the training and STEM Self Efficacy score after the training [r(15) = .64, p = .01].

Table 2

Results of pair samples t-test of pre-test and post-test of science career interest

Parameter	Pre-test			Post-test			*t*(14)	*p*	Cohen's *d*
	N	*M*	*SD*	*N*	*M*	*SD*			
Self-efficacy scale for STEM applications	15	50.87	23, 98	15	78	8,98	5,40	<,001	-1,39

The results indicate a significant difference between STEM Self Efficacy score before training (M=36,1; SD=8,06) and STEM Self Efficacy score after training (M=43,7; SD=7,84); [t(29) = 5,036, p = <,01].

The 95% confidence interval of the difference between the means ranged from [-2,10 to -0,66] and indicated a significant difference between the means of the samples. After the training, science career interest of the students was increased significantly. We, therefore, conclude that there is a significant effect of the training on Teacher Self-Efficacy for STEM applications.

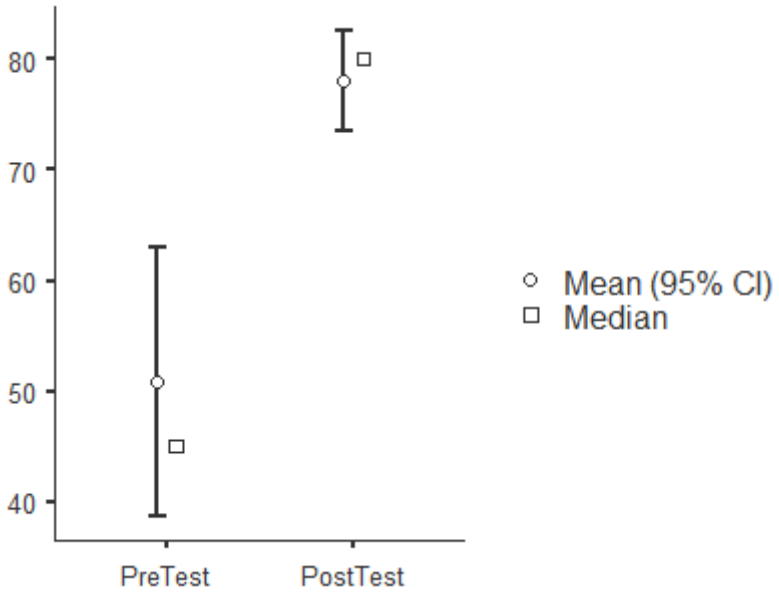

Figure 1. Descriptive Plots of Pre-test and Post-test

T2 SERBIA MOBILITY (Awareness of Climate Change)

We measured the effectiveness of the trainings by using a semi-experimental research design. A 25-item Awareness of Climate Change Scale was used to measure the effectiveness of STEM trainings. All items were 5-point Likert Style from 1 (Never) to 5 (Always). In this mobility we used mean scores for analysis. That's why, the lowest score that can acquired from the test is 1 and the highest is 5.

We collected data from a total of 11 teachers. For the Serbia data set, Cronbach's alpha of pre-test and post-test of the 25-item Awareness of Climate Change Scale were .74 and .65 respectively.

A Paired samples t-test was conducted to determine the effect of training on awareness of climate change test score.

Table 3

Paired Samples Correlations

		N	r	p.
Pair 1	PreTest & PostTest	11	,33	>,05

The correlation coefficient shows that there is not a significant relationship between awareness of climate change score before the training and after the training [r(11) = .33, p = .32].

Table 4

Results of pair samples t-test of pre-test and post-test of awareness of climate change

Parameter	Pre-test			Post-test			*t*(10)	*P*	Cohen's *d*
	N	*M*	*SD*	*N*	*M*	*SD*			
Awareness of Climate Change	11	3,45	,33	11	3,75	,25	2,92	<,05	-0,88

The results indicate a significant difference between awareness of climate change score before training (M=3,45; SD=,33) and after training (M=3,75; SD=,25); [t(10) = 2,92, p = <,05].

We, therefore, conclude that there is a significant effect of the training on awareness of climate change of the teachers.

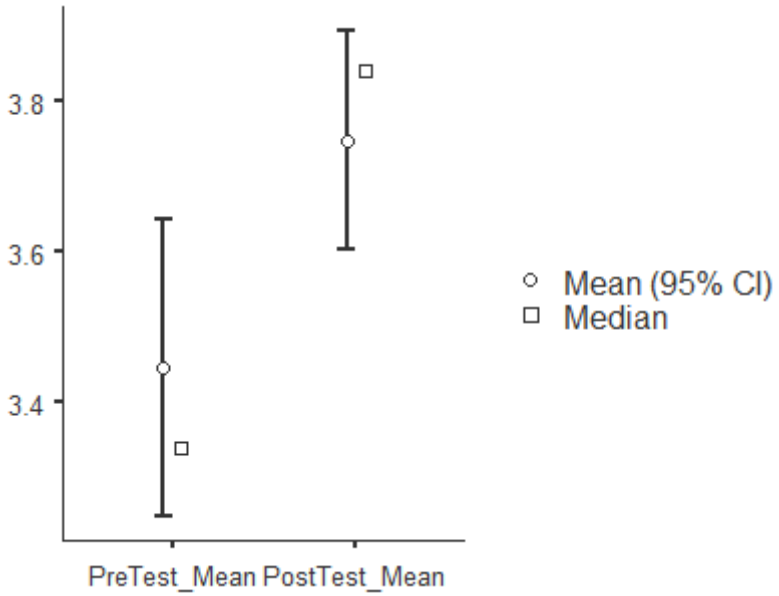

Figure 2. Descriptive Plots of Pre-test and Post-test

T3 SPAIN (Technological Pedagogical STEM Knowledge)

We measured the effectiveness of the trainings by using a semi-experimental research design. A 17-item Technological Pedagogical STEM Knowledge Survey was used to measure the effectiveness of STEM trainings. All items were 1-point Likert Style from 1 (Strongly Disagree) to 7 (Strongly Agree). We used mean scores. That's why the lowest score that can acquired from the test is 1 and the highest is 7.

We collected data from a total of 13 teachers from seven countries. For the Spain data set, Cronbach's alpha of pre-test and post-test of the 17-item Technological Pedagogical STEM Knowledge Survey were .96 and .95 respectively. In this case, we can propose that the data was reliable.

A Paired samples t-test was conducted to determine the effect of training on technological pedagogical STEM knowledge test score.

Table 5

Paired Samples Correlations

		N	r	p.
Pair 1	PreTest & PostTest	13	,20	>,05

The correlation coefficient shows that there is not a significant relationship between Technological Pedagogical STEM Knowledge score before the training and after the training [r(13) = .20, p = >.05].

Table 6

Results of pair samples t-test of pre-test and post-test of Technological Pedagogical STEM Knowledge

Parameter	Pre-test			Post-test			*t*(12)	*p*	Cohen's *d*
	N	*M*	*SD*	*N*	*M*	*SD*			
Technological Pedagogical STEM Knowledge	13	5,39	1,17	13	5,94	0,77	-1,57	>,05	1,26

The results indicate that there is no significant difference between Technological Pedagogical STEM Knowledge score before training (M=5,39; SD=1,17) and after training (M=5,94; SD=,77); [t(12) = 1,57, p = >,05]. Although there was no statistically significant increase in the post-test scores, the fact that there was a relative increase shows that the trainings were relatively useful. In this sense, we can relatively argue that the training was useful in increasing the technological pedagogical STEM knowledge of the teachers.

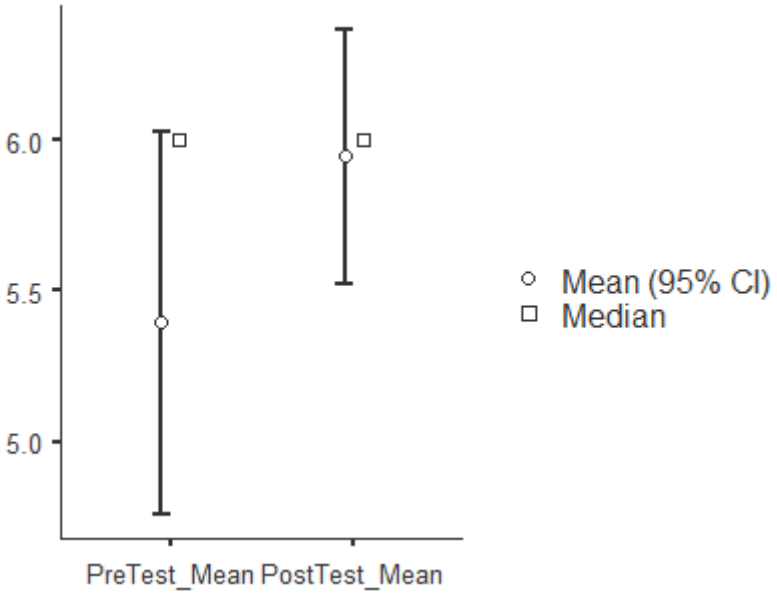

Figure 3. Descriptive Plots of Pre-test and Post-test

Appendix 1. Teacher Self-Efficacy Scale for STEM Applications

The purpose of this survey is to gather data regarding perceptions on teacher self-efficacy for STEM applications before the Teacher Training Course on STEM Education held in Alanya, Turkiye between the dates of 31 st October and 4th November, 2022. For the success of our project, it is important that you answer each question sincerely. Thank you for your contribution.

STEMAction for the Future Project Team
(ERASMUS+ KA220 | 2021-1-ES01-KA220-SCH-000029752)

Voluntary Participation Consent

Participation in the questionnaire is completely voluntary. The answers will be kept completely confidential and evaluated only by the researchers. The data will only be used for scientific purposes and will not be shared with the third parties. The questionnaire does not contain questions and situations that may cause personal discomfort. However, if you feel uncomfortable with the questions or any other reason during participation, you can stop answering.

☐ I voluntarily participate in this study, and I accept the use of my answers for scientific purposes.

Participant Demographics

1. Name of the School/Organisation:
2. Country:
3. What grade level do you teach?
4. What is your teaching subject?
5. How long have you been teaching?
6. How long have you been applying STEM education in your lessons?

Instructions:

For each of the following statements, please indicate the degree to which you agree or disagree. Even though some statements are very similar, please answer each statement. There are no 'right' or 'wrong* answers. The only correct responses are those that are true for you.

Never (1) Rarely (2) Sometimes (3) Often (4) Always (5)

Survey Items	1	2	3	4	5
1. I can achieve results unique to the STEM approach.	1	2	3	4	5
2. I am academically competent in the science process skills required when designing a STEM activity.	1	2	3	4	5
3. I can develop models and materials in order to use in STEM applications.	1	2	3	4	5
4. I can design a good STEM-related activity.	1	2	3	4	5
5. I can easily interpret the results of STEM-related activities.	1	2	3	4	5
6. I am able to take part in projects related to STEM applications.	1	2	3	4	5
7. I can answer students' questions about STEM.	1	2	3	4	5
8. I can adapt STEM activities to daily life.	1	2	3	4	5
9. I can design STEM activities that improve the field of intelligence.	1	2	3	4	5
10. I can determine the objectives to be gained in STEM activities in accordance with the characteristics of the student and the environment.	1	2	3	4	5
11. When I decide to do a STEM activity, I can immediately start to do it.	1	2	3	4	5
12. I feel competent in STEM applications.	1	2	3	4	5
13. I can provide critical thinking in STEM applications	1	2	3	4	5
14. I think I have a good command of STEM concepts and terms.	1	2	3	4	5
15. I can easily explain the steps I take in STEM activities to my students.	1	2	3	4	5
16. While making plans for STEM applications, I am confident that I can bring them to life.	1	2	3	4	5
17. I am confident in STEM applications.	1	2	3	4	5
18. Even if STEM applications seem very difficult, I try to do it.	1	2	3	4	5

Appendix 2. Awareness of Climate Change Scale

The purpose of this survey is to gather data regarding perceptions on Awareness of Climate Change before the Teacher Training Course on STEM Education held in Subotica, Sirbia between the dates 28th November and 2nd December, 2022. For the success of our project, it is important that you answer each question sincerely. Thank you for your contribution.

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Participant Demographics

1. Name of the School/Organisation:
2. Country:
3. What grade level do you teach?
4. What is your teaching subject?
5. How long have you been teaching?
6. How long have you been applying STEM education in your lessons?

Instructions:

For each of the following statements, please indicate the degree to which you agree or disagree. Even though some statements are very similar, please answer each statement. There are no 'right' or 'wrong* answers. The only correct responses are those that are true for you.

Strongly disagree (1) Disagree (2) Neither agree nor disagree (3) Agree (4) Strongly agree (5)

Survey Items	1	2	3	4	5
1. The Sun is the main source of energy for Earth's climate.	(1)	(2)	(3)	(4)	(5)
2. Human has very little effect on Earth's climate.	(1)	(2)	(3)	(4)	(5)
3. Earth's climate has probably changed little in the past	(1)	(2)	(3)	(4)	(5)
4. Burning of fossil fuels produces greenhouse gases.	(1)	(2)	(3)	(4)	(5)
5. Greenhouse gas levels are increasing in the atmosphere.	(1)	(2)	(3)	(4)	(5)
6. Greenhouse gases absorb some of the energy emitted by Earth's surface.	(1)	(2)	(3)	(4)	(5)
7. Many species have shifted their seasonal activities, migration patterns in response to ongoing climate change.	(1)	(2)	(3)	(4)	(5)
8. Glaciers have continued to expand almost worldwide	(1)	(2)	(3)	(4)	(5)
9. Average sea level is increasing.	(1)	(2)	(3)	(4)	(5)
10. We cannot know about ancient climate change.	(1)	(2)	(3)	(4)	(5)
11. Earth's climate is not currently changing.	(1)	(2)	(3)	(4)	(5)
12. Current climate change can only be explained by natural fluctuation.	(1)	(2)	(3)	(4)	(5)
13. Current climate change is caused by the ozone hole	(1)	(2)	(3)	(4)	(5)
14. Current climate change is caused by human activities.	(1)	(2)	(3)	(4)	(5)
15. Current climate change is caused by changes in Earth's orbit around the Sun.	(1)	(2)	(3)	(4)	(5)
16. Current climate change is caused by volcanic eruptions.	(1)	(2)	(3)	(4)	(5)
17. Current climate change is caused by increasing dust in the atmosphere.	(1)	(2)	(3)	(4)	(5)
18. Current climate change is caused by an increase in the Sun's energy	(1)	(2)	(3)	(4)	(5)

19. Heat waves will occur more often and last longer.	1	2	3	4	5
20. Extreme events will become less intense and less frequent in many regions.	1	2	3	4	5
21. Climate change will amplify existing risks and create new risks for natural and human systems.	1	2	3	4	5
22. Coastal and low-lying areas are at risk from sea-level rise.	1	2	3	4	5
23. Climate change is projected to undermine food security.	1	2	3	4	5
24. Projected climate change will impact human health	1	2	3	4	5
25. Climate change is projected to decrease displacement of people.	1	2	3	4	5

Appendix 3. Technological Pedagogical STEM Knowledge Survey

The purpose of this survey is to gather data regarding perceptions on Technological Pedagogical STEM Knowledge before the Teacher Training Course on STEM Education held in Albacete, Spain between the dates 16th-20th January 2023. For the success of our project, it is important that you answer each question sincerely. Thank you for your contribution.

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Participant Demographics

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2. Country:
3. What grade level do you teach?
4. What is your teaching subject?
5. How long have you been teaching?
6. How long have you been applying STEM education in your lessons?

Instructions:

For each of the following statements, please indicate the degree to which you agree or disagree. Even though some statements are very similar, please answer each statement. There are no 'right' or 'wrong* answers. The only correct responses are those that are true for you.

Strongly disagree (1) Disagree (2) Neither agree nor disagree (3) Agree (4) Strongly agree (5)

Survey Items	1	2	3	4	5
1. I can engage students in representing connected understanding about the scientific concepts with various forms of technology (e.g. Google site, concept maps).	1	2	3	4	5
2. I am competent in helping my students to critically synthesize information from various web-based resources for science investigation.	1	2	3	4	5
3. I know how to choose appropriate technologies based on the science topics to engage students in authentic research.	1	2	3	4	5
4. I can use technology to facilitate students' ongoing collaboration for science inquiry beyond classroom.	1	2	3	4	5
5. I can support students' formulation of mathematical representations with technology for solving real-world problem.	1	2	3	4	5
6. I am able to guide students in collecting valid measurement data with appropriate technologies (e.g., data loggers, range finders) that they need to solve the real-world challenge they face.	1	2	3	4	5
7. I can engage students in constructing possible mathematical models about the real-world problems with appropriate technologies (e.g., simulation software).	1	2	3	4	5
8. I am competent in prompting students to discuss the mathematical knowledge involved when they are co-constructing the possible products on the computers with team members.	1	2	3	4	5
9. I can guide students in generating a range of reasonable mathematical outcomes (e.g. using Spreadsheet) for a phenomenon to support their decisions.	1	2	3	4	5
10. I can engage students in building knowledge about the engineering design process using various forms of digital technologies (e.g., Power-point presentation, online videos).	1	2	3	4	5
11. I am competent in facilitating students' learning of various software tools that engineers use to develop their ideas (e.g., Computer-assisted design tools).	1	2	3	4	5
12. I can use technologies to scaffold students in solving complex engineering problems.	1	2	3	4	5

13. I can use learning analytics to foster students' online collaboration for the engineering projects that the students undertake.	1	2	3	4	5
14. I can design lessons that appropriately integrate interdisciplinary STEM content and technology for student-centred learning.	1	2	3	4	5
15. I am able to formulate good STEM problems to stimulate students interdisciplinary learning	1	2	3	4	5
16. I can plan different teaching and learning activities for the different subjects involved in a STEM projects.	1	2	3	4	5
17. I can facilitate students' knowledge construction for the STEM projects using different ICT tools.	1	2	3	4	5