

“Schools: Future Labs” – Combining the Teaching of Sciences and Foreign Language

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Abstract

The Erasmus+ project Schools: Future Labs (SFL) was funded under the Key Action 2: Cooperation for innovation and exchange of good practices – Strategic partnerships in the field of education, training and youth of the Erasmus+ program. Its main objective was to increase the employability of young people, by getting them interested in STEM (Science, Technology, Engineering, and Mathematics) subjects and in the habit of using a foreign language. To reach its objective, Schools: Future Labs developed and tested a teaching methodology based on action research, involving task-based exploration of STEM subjects in combination with Content and Language Integrated Learning (CLIL). This methodology was student-led, self-directed and included project planning and implementation skills. The purpose of this project was to spread the methodology, at least, in the participating countries. The efficacy of this methodology is evaluated, both in quantitative and qualitative terms. The evaluation results were very positive, as 89% of the students wanted to continue learning with the SFL methodology. The work adds to previous studies exploring the ways of improving the learning process by motivating students and raising their interest both in science and foreign language (FL).

1. Introduction

During the last decades it became evident, on a worldwide scale, that it is imperative to modify curricula, starting from primary school, in order to ensure that graduating high school students possess the skills and competencies needed to make a successful transition to employment. These skills and competencies include the ability to communicate effectively in several languages, specializations in STEM subjects, learning how to learn, and showing initiative.

With respect to STEM subjects, the traditional approach usually leads to theoretical lessons that fail to engage students or motivate them to pursue these subjects in the future.

Likewise, the current approach to foreign language teaching, combined with large classroom sizes, makes it impossible for students to actually learn the language, and to engage with the foreign language in an active way or appreciate the practical use of it.

These difficulties lead to students' disengagement and must be taken seriously into consideration and be addressed, since the ability to communicate in a foreign language (FL), as well as the interest they show in STEM subjects are vital to students' future employment prospects and to the European economies.

“Schools: Future Labs” (SFL) was a trans-national project attempting to address these issues. It was funded under the Key Action 2: Cooperation for innovation and exchange of good practices – Strategic partnerships in the field of education, training and youth of the Erasmus+ program. The project developed a teaching methodology based on task-based learning, content and language integrated learning and STEM approaches.

“Schools: Future Labs” proposes a cost-effective methodology that will transform the teaching and learning of languages and STEM subjects so that students become active, self-directed, exploratory participants during their learning process [10]. With the appropriate support and guidance, as well as access to basic tools of scientific exploration, students discover that STEM subjects and foreign languages are interesting, useful, and open doors to their future.

The proposed methodology is student-centered and includes implementation skills geared to the developmental level of the learners. SFL proposes an innovative, bottom-up approach that is motivating both for teachers and their students, stimulates students' curiosity and creativity and encourages cooperative and communicative teaching and learning.

2. The Innovative Aspects of the Project

Schools: Future Labs proposes an experimental, self-directed learning approach in order to put

students' interest, curiosity and initiative at the centre of the teaching process [10].

Further innovative aspects of "Schools: Future Labs" include:

- Teaching STEM subjects in tandem with language study for an integrative approach to learning.

- Use of an "Action Research" teaching approach, which focuses on student-led, task-based learning;

- Use of an exploratory methodology in the classroom (between teachers and their students) and also as a method for teacher training (between the project trainers and the teachers);

- Strengthening the teachers' profile through the development and the accreditation of the Teacher Training Course (TTC) based on this methodology;

- Partnership and cooperation among different types of institutions all aiming to improve teaching practices: schools (teachers), teacher training institutes, Universities specialized in teacher trainings, two National Education Ministries in Spain and Romania, and two cultural institutes (Goethe-Institut, Instituto Cervantes);

- Implementing the methodology in primary schools, thereby nurturing an early interest in STEM subjects and reaching students before they reach an age when they are too embarrassed to try to speak in a foreign language, they are not proficient in;

- Measuring and analyzing the project's outcomes and results in qualitative and quantitative terms, by supporting its implementation on a broader scale;

3. The Partners

The SFL project has 13 partners in Greece, Romania, Bulgaria and Poland, and promotes cooperation between different types of institutions with teaching practices: schools, teacher training institutes, universities, Education Ministries and Cultural Institutes.

More specifically the SFL partners are:

- Goethe-Institut Athen, Greece
- Instituto Cervantes Athens, Greece
- National and Kapodistrian University of Athens, Greece
- University of Shumen, Department for Information, Qualification and Lifelong Learning, Bulgaria
- Mazowieckie Samorządowe Centrum Doskonalenia Nauczycieli – MSCDN, Poland
- Ministerio de Educacion, Cultura y Deporte, Spain
- Ministerul Educației și Cercetării Științifice, Romania
- Uwekind International School, Bulgaria
- 49th Primary School "Benito Juarez", Bulgaria
- Colegiul National Ion Măiorescu, Romania
- Liceul Teoretic Bilingv Miguel de Cervantes, Romania
- Społeczna Szkoła Podstawowa nr 4 STO, Poland

- Ellinogermaniki Agogi S.A., Greece

4. The Aims

"Schools: Future Labs" project aimed to help students become captivated by these often-dismissed subjects and encourage their engagement. In other words, it attempted to trigger students' interest in STEM subjects and in using a foreign language. It was expected that through this project students will acquire or enhance transversal skills adaptive to any employment situation. Moreover, it aimed to revive the motivation and the enthusiasm not only for the students but also for the teachers.

The long-term goal of SFL extends beyond simply implementing and documenting this new methodology: SFL project aims to promote a collaborative way of learning and change classroom practice inspiring progress in global educational institutions.

5. The Expected Results

The efficacy and effectiveness of the Schools: Future Labs methodology is evaluated, both in quantitative and qualitative terms.

With respect to the students, we anticipated that they: will be more interested in STEM and FL subjects; will achieve a deeper level of knowledge in STEM; will develop better fluency in the chosen foreign language; will acquire useful skills.

With respect to the teachers, we anticipated that they: will strengthen their professional skills; will find their classes more fulfilling, interesting and enjoyable; will derive great personal and professional satisfaction from being able to improve their students' learning outcomes.

Based on these results, we would be able to promote the adoption of the Schools: Future Labs methodology by public education authorities in the participating countries and its implementation in more schools, including secondary schools.

6. The Project Planning and Outputs

This project's duration lasted three years, from 1/9/2014 until 31/8/2017.

Year 1: Training of trainers, training of teachers, selection of mobile labs, project partnership meeting and joint training in which the partners presented the draft project outputs.

Year 2: Constant testing of methodology and finalization of all formal teaching materials (lesson plans, teacher training course, toolbox), and evaluation of the implementation.

Year 3: Schools continued using the mobile labs. Partners focused on dissemination and exploitation

by showcasing the results and organizing the Closing Conference.

The three foreseen outputs of this project were:

a) A **teacher training course** to train the teachers on the Schools: Future Labs methodology; [11] This course is composed of 5 modules / components to be taught and 3 annexes containing material for teachers to use as required. The course is designed to fit into a 5-day program comprising 7-8 hours each day, thus fitting itself into a one-week training period.

Each module can be taught as a stand-alone element and this flexibility allows trainers to set preferences and accommodate the program to a pre-defined timeframe and other local constraints. However, to ensure optimal learning results, trainers should follow the module sequence suggested. The five modules comprise the following methodologies and areas of implementation:

- Task-based learning: method and application
- Content and Language Integrated Learning: method and application
- STEM through CLIL and with “mobile labs”: guidelines, method and application
- Lesson planning and execution: guidelines, checklists, templates
- Observing and assessing teaching.

b) Accompanying **lesson plans** that teachers can use to implement the methodology in tandem STEM/FL classes; [11] The lesson plans can be used as teaching and learning tools accessible to teachers and teacher trainers who would like to make their lessons more attractive for their students.

The lesson plans offer “reassurance” to teachers by providing clear guidelines on how to engage students in self-directed learning.

By adopting the Schools: Future Labs methodology, language and subject teachers can provide their students with much needed hands-on experience, and build on their natural curiosity and desire to discover, learn and communicate.

This is one of the ways to manage a class in which students are all pursuing different interests and to stimulate subject learning and multilingualism in Europe.

c) A **virtual student-learning portfolio**,

An on-line application accessible to teachers and students as a tool for them to present and share their work, which can also document each student’s learning outcomes. [11], [12].

These outputs are available in English, German, Spanish, Bulgarian, Greek, Polish and Romanian and can be uploaded at the official webpage of the SFL project [11].

All of these outputs were made possible through the piloting of the methodology within primary schools in the four participating countries, offering two foreign languages (Spanish and German) within a variety of STEM subjects (Biology, Chemistry, Physics)

In order to implement the SFL methodology, teachers were supported by a two year training.

7. The Implementation

The project was carried out for three years in Greece, Romania, Bulgaria and Poland. It was implemented and tested in (1 or 2) primary schools in each of the aforementioned countries, enabling the participation of schools that teach Spanish and German as a foreign language in combination with physics, chemistry or biology as STEM subject. The specific schools as well as the subjects taught are listed in the table below.

Table 1: Participating schools in each country

School	Country	STEM subject	FL
Ion Mairescu	Romania	physics	German
Miguel de Cervantes	Romania	physics	Spanish
Uwekind	Bulgaria	chemistry	German
Benito Juarez	Bulgaria	chemistry	Spanish
STO Krakow	Poland	biology	Spanish
Ellino-germaniki Agogi	Greece	physics	German

After the initial training of teachers the SFL project was implemented during the second semester of 2014/2015 school year (in the 5th Grade) and during the entire 2015/2016 school year (both in the 5th and 6th Grades). The implementation continued during the 2016/2017 school year (in the 5th and 6th Grades as well as in the 7th grade in one country). The numbers of students and teachers involved in the project each school year are listed below.

Table 2: Participating students and teachers

	2014-15	2015-16	2016-17
5 th gr. students	171	119	120
6 th gr. students	-	146	97
7 th gr. students	-	-	65
STEM teachers	11	9	9
FL teachers	6	6	6

During the pilot phase, teachers developed lesson plans, according to a relevant template based on the SFL methodology. Supporting local as well as joint teachers trainings and production seminars were

offered to the teachers, by enhancing the implementation in the classrooms.

8. The Evaluation

The evaluation played a crucial role in the project and the strategy was planned according to the project's needs and target groups. It was based on research questions regarding students, teachers and the project in general.

With respect to the students, the research questions were:

- Do students achieve a higher and deeper level of knowledge in STEM subjects than those not involved in this project?
- Do students develop better fluency in their chosen foreign language than those not involved in this project?
- Are students more interested in STEM subjects and in FL learning than those not involved in this project?

With respect to the teachers our research questions were:

- Do teachers find their SFL classes more interesting, fulfilling and motivating?
- Are teachers' profiles strengthened by the acquisition of additional teaching skills?

With respect to the project in general, our research questions were:

- Is the project's methodology feasible and implementable?
- Is this methodology useful and successful?
- Is it feasible to promote this methodology in more schools, including secondary schools and extend it to more countries?
- Are the project's outputs adequate to enable other schools to adopt it?

In order to find answers to all these questions, the University of Athens designed an evaluation strategy, both quantitative and qualitative, aiming to evaluate students' skills acquisition, learning outcomes, changes in level of interest in STEM and FL, students' and teachers' perceptions of, and satisfaction with, the methodology.

8.1. The Tools, the Questionnaires

The tools used for the evaluation (qualitative and quantitative) were questionnaires, observations and interviews during the on-site visits to the partner schools.

The team of Athens University used attitudes / motivation / perceptions questionnaires for students and teachers before and after the implementation of the SFL and satisfaction with the methodology questionnaires after the implementation. Moreover, they also included self-assessment questions.

They also compared participating students' attitudes and performance with non-participating students before and after the implementation. Finally, they took into consideration the lesson plans and received feedback from the teachers.

More specifically, in order to evaluate students' learning outcomes and skills obtained they compared school tests performance before and after the implementation of the SFL project and collected data on teacher assessment, as well as student self-assessment.

In order to evaluate students' and teachers' attitudes / motivation / interest regarding STEM and FL as well as their satisfaction with the methodology, the team compiled questionnaires, after studying the relevant international literature and studies (on science learning, foreign language learning, STEM and CLIL programs).

Based on this research (study of research methods, tools and questionnaires used, data analysis, statistical analysis, conclusions reached), their experience and the questions and goals of this project, the team selected to focus on seven factors for students and six factors for teachers (FL/STEM).

More specifically, the factors for students were:

- interest / enjoyment,
- perceived competence,
- tension / pressure,
- value / usefulness,
- science learning,
- foreign language learning,
- cooperative learning.

The factors for teachers were:

- interest / enjoyment,
- perceived competence,
- tension / pressure,
- value / usefulness,
- science teaching / foreign language teaching.

For each one of these factors they selected and adapted several questions from the ones commonly used in similar surveys (Intrinsic Motivation Inventory), and added some to meet the research's goals [1], [2], [3], [4], [5], [6], [7], [8], [9], [14]. In order to ensure the questionnaires reliability, some reverse questions were added (e.g. "learning a foreign language is fun" and "learning a foreign language is boring"). To control the questionnaires content validity they asked a group of experts to consider each item of the questionnaires as "necessary," "useful, but not necessary" or "unnecessary" and calculated the ratio content validity for each item of the questionnaire. Finally, they calculated and internal consistency reliability of each questionnaire by the coefficient Cronbach's alpha, which proved good ($r=0.83$). Following the validity and reliability controls of the questionnaires, some questions were removed or modified. This resulted in the three final questionnaires for the pre-tests: fifty-five questions for students, nineteen

questions for STEM teachers, and nineteen questions for FL teachers.

The University of Athens team followed the same procedure for the post questionnaires. In total, there were seventy-two questions for students, forty-four questions for STEM teachers and forty-one questions for foreign language (FL) teachers. The additional questions of the post questionnaires measured and evaluated how satisfied were the participants with the methodology.

All participants completed the questionnaires before and after the implementation of the SFL project and their answers were compared.

The same questionnaires (without the additional questions about the methodology) were also sent to non-participating students, in order to compare participants' answers with non-participants'.

The University's team collected all qualitative data needed by in situ observations in all participating schools in the four partner countries. They observed the lessons and talked to all the participating teachers, receiving feedback from them about the methodology implemented.

8.2. The Scoring

The data from the questionnaires were coded and registered in a database. With regard to students' questionnaires, each one of the first four factors (interest / enjoyment, perceived competence, tension / pressure, value / usefulness) included separate questions for STEM and for FL. Students were asked to answer using a 5-points scale: 1 = strongly disagree, 2 = disagree, 3 = not sure, 4 = agree, 5 = strongly agree. The scoring of students' answers followed this scale from 1 to 5 and for the reverse questions the scoring was also reversed.

For each of these four factors it was calculated for each student his/her STEM score and his/her FL score separately, based on their answers to the relevant questions.

The total score was also calculated for each of these factors as well as for the other three factors (science learning, foreign language learning, cooperative learning) by adding all the scores of the questions of each factor (e.g., for the factor cooperative learning that consisted of 4 questions the maximum total score for a student would be 5 x 4 questions = 20 points).

Since the number of the questions was not the same for all factors, in order to have a common scale and make comparisons and statistical analyses, the scores were converted into percentages.

9. The Results

9.1. First Year

After the data processing and the statistical analysis the descriptive results were summarized and analyzed by each factor (separately for STEM and FL as well as totally), separately for each school / country and overall.

The comparisons of the data obtained from the different schools didn't show significant differences between them, despite the different number of the participating students in each school. Therefore it was decided to group all data together and conduct the analysis overall across all participating schools. The results of the analysis were very positive and encouraging since it was found:

- statistically significant improvement of participants attitudes / motivation in almost all factors both in STEM and FL
- satisfaction of participants with the methodology

Regarding students' attitudes the independent samples T-Tests performed showed statistically significant differences in all factors except "tension", with the participating students attaining higher total scores in comparison to the non-participating (interest: $t=2,945$, $p=0,004$; perceived competence: $t=3,159$, $p=0,002$; tension: $t=-1,399$, ns; value: $t=4,577$, $p<0,001$; science learning: $t=3,272$, $p=0,001$; FL learning: $t=2,813$, $p=0,005$). This was not the case before the implementation, where both groups' scores were similar and statistically there were no significant differences in any of the factors (interest: $t=1,231$, ns; perceived competence: $t=0,808$, ns; tension: $t=-1,281$, ns; value: $t=1,033$, ns; science learning: $t=0,707$, ns; FL learning: $t=0,667$, ns).

They also compared participants' answers before and after the implementation and the paired samples T-tests showed statistically significant improvement in all factors after the implementation.

The evaluation of the learning outcomes / students' performance (based on students' self-assessment and their assessment by the teachers) was also very satisfactory. Participants' performance was improved in both STEM and FL.

Some noteworthy results based on participating students' answers were that 72% of them consider the SFL lesson more interesting and 69% found the combination of FL and STEM more fun. However, the most important result was that 78% of the participating students would like to participate again in the SFL project.

As for the teachers, all of them answered that this way of teaching raised students' interest and improved their cooperation. Also, most of them (75%) noticed that students were more involved in the lessons than before and that students were able to respond adequately as the lesson was more fun

(88%). All of the teachers would recommend this methodology to their colleagues and almost all of them (88%) would like to participate again.

9.2. Second Year

Similar statistical analyses were performed at the end of the second year of the implementation. Concerning the attitude / motivation questionnaires, there were statistically significant differences in all factors between participating and non-participating students across schools after the implementation of SFL (interest: $t=9,146$, $p<0,001$; perceived competence: $t=8,776$, $p<0,001$; tension: $t=-2,245$, $p=0,02$; value: $t=9,875$, $p<0,001$; science learning: $t=5,406$, $p<0,001$; FL learning: $t=9,031$, $p<0,001$; cooperative learning: $t=1,742$, $p=0,05$). Participating students achieved higher scores, as shown in Figure 1.

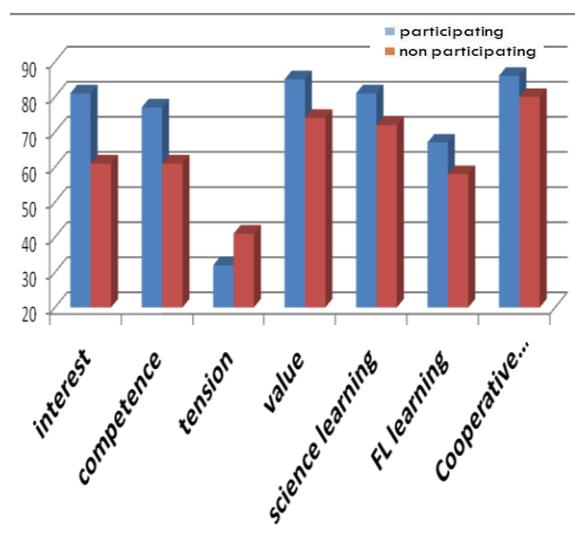


Figure 1. Comparison of participants' - non-participants' scores after the implementation (%)

It is worth mentioning that there were statistically significant differences between the two groups also before the implementation in some factors. This meant that the two groups did not start from the same point.

The team claimed that this was due to the 6th graders because the majority of them participated also in the SFL the previous year. For this reason, they examined the students of the 5th and 6th grade separately.

With regard to the 5th graders there were no significant differences between participating and non-participating students before the implementation, but after the implementation the participating students attained statistically significant higher performance.

However, regarding the 6th graders they already had a raised level of interest in STEM, a raised level

of interest in FL, a higher perceived competence level in STEM, and a lower level of tension in FL.

These results confirmed that the implementation of the project last year had a positive effect on students, and it remained evident also the following year.

Moreover, after the second year of the implementation the participants' performance was higher in almost all factors.

In order to evaluate the participants' satisfaction with the methodology and their assessment of the project, the University of Athens examined their answers to the additional questions of the post-questionnaires. Some indicative results were that the majority of the students:

- considered the lessons more interesting (62%),
- had no difficulty understanding the concepts of STEM in the foreign language (61%),
- perceived lessons combining STEM with the FL as much more fun (62%),
- found it easier to cooperate with their teams (67%)
- did not feel stressed by the presence of two teachers in the classroom (70%).

However, the most important result was that 82% of participating students answer that they would like to participate again in the SFL Project.

Regarding participants' performance and skills in STEM and foreign language there was statistically significant improvement after the implementation in all areas measured such as: fluency in speaking the FL, vocabulary development in FL, accuracy of writing in FL, accuracy of speaking the FL, experimental skills, hypothesizing / predicting, problem solving, critical thinking, ability to observe, taking initiative, autonomy, cooperating with other students, as shown at the tables below.

Table 3. Comparison of participating students' performance in the Foreign Language before and after the implementation of SFL project

Foreign Language	before	after
Competence	46%	72%
fluency in speaking	44%	69%
vocabulary	46%	73%
accurateness in writing	42%	69%
accurateness in speaking	42%	68%

The paired samples T-Test revealed statistically significant improvement in participants' performance in all cases: competence: $t=-8,842$, $p<0,001$; fluency in speaking: $t=-8,884$, $p<0,001$; vocabulary: $t=-9,440$, $p<0,001$; accurateness in writing: $t=-9,657$, $p<0,001$, accurateness in speaking: $t=-9,553$, $p<0,001$.

Table 4. Comparison of participating students' performance in the Science before and after the implementation of SFL project

Science	before	after
experimental skills	61%	82%
Hypothesizing	53%	76%
problem solving	59%	78%
critical thinking	59%	76%
ability to observe	63%	83%

The paired samples T-Test revealed statistical significant improvement in participants' performance in all cases: experimental skills: $t=-10,310$, $p<0,001$; hypothesizing: $t=-9,842$, $p<0,001$; problem solving: $t=-9,819$, $p<0,001$; critical thinking: $t=-8,962$, $p<0,001$; observing: $t=-9,782$, $p<0,001$.

Table 5. Comparison of participating students' performance in the Other Skills before and after the implementation of SFL project

Other Skills	before	after
taking initiative	58%	78%
Autonomy	61%	78%
Responsibility	62%	79%
Cooperating	66%	85%

The paired samples T-Test revealed statistical significant improvement in participants' performance in all cases: taking initiative: $t=-9,509$, $p<0,001$; autonomy: $t=-8,001$, $p<0,001$; responsibility: $t=-8,709$, $p<0,001$; cooperation: $t=-8,240$, $p<0,001$.

As for the teachers, the majority was satisfied with the methodology, found the lessons more fun and fulfilling and would recommend this methodology to other colleagues. They also reported that they would like to participate in the SFL project again. Moreover, almost all of them said that this way of teaching raised students' interest and improved their cooperation and students were able to respond adequately.

9.3. Third Year

The third and final year of the project the implementation was evaluated in general. Therefore, the University team used only post-questionnaires for the participating students and teachers, since it was not necessary to make any more comparisons between participating and non-participating students and teachers.

The questionnaires were mostly focused on: self-assessment, evaluation of the program, difficulties

encountered, students' assessment by teachers, assessment by the teachers of the training and the support provided. The questionnaires consisted of forty one questions for the students, forty nine questions for the STEM Teachers and forty seven questions for the FL Teachers. The results were very positive and encouraging, since participants were satisfied with the methodology and their performance in both STEM and FL had progressed. There was also a great improvement in their skills.

With regard to the interest / enjoyment of participating students and their assessment of the project:

- 77% of them considered the SFL lesson more interesting
- 69% of them considered the science lesson more interesting
- 71% of them did not find tiring the lessons combining FL and STEM
- 72% of them enjoyed the presence of two teachers in the classroom
- 97% of them enjoyed working with their classmates
- 99% of them enjoyed conducting experiments
- 74% of them enjoyed reading the instructions in FL
- 71% of them found lessons much more fun

However, the most important result is that 89% of participating students answered that they would like to participate again in the SFL project.

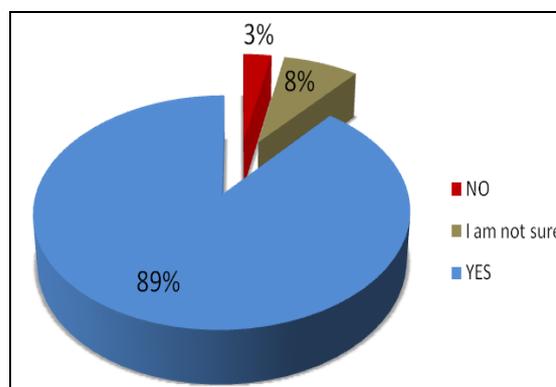


Figure 2. Percentage of participating students' answers to the question "I want to participate again in this program"

Concerning students' difficulties during the implementation of the project only 22% said that they had difficulty in understanding the concepts of science when using the FL. Only 7% said that they felt stressed by the presence of two teachers in the classroom at the same time. Only 6% of them said that they had difficulty in communicating with the members of their team. Concerning the students' self-assessment:

- 74% believed that after participating in the program they were doing better in FL

- 79% believed that after participating in the program they could express themselves and understand texts in the FL better than before
- 79% were satisfied with their performance in FL
- 71% believed that after participating in the program they were doing better in science
- 78% believed that after participating in the program they could carry out experiments better than before
- 76% were satisfied with their performance in science
- 75% believed that after participating in the program their teamwork spirit was enhanced.

The teachers confirmed the students' estimations concerning their performance and they stressed that students' performance had indeed improved in both STEM and FL subjects.

The teachers were also asked to assess each student's performance in FL and STEM as well as their skills indicating whether there was no improvement, slight improvement, significant improvement or great improvement after participating in the program. The results are shown in the graphs below.

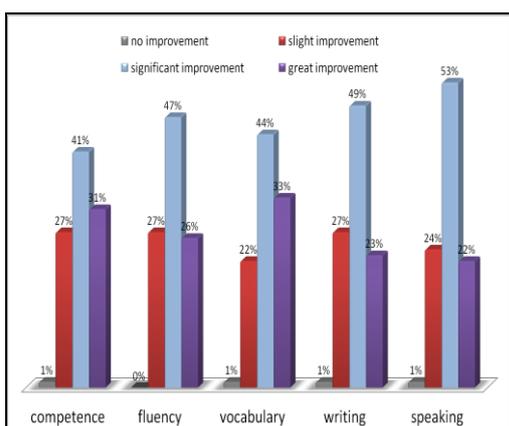


Figure 3. Percentage of students' performance Improvement in the foreign language

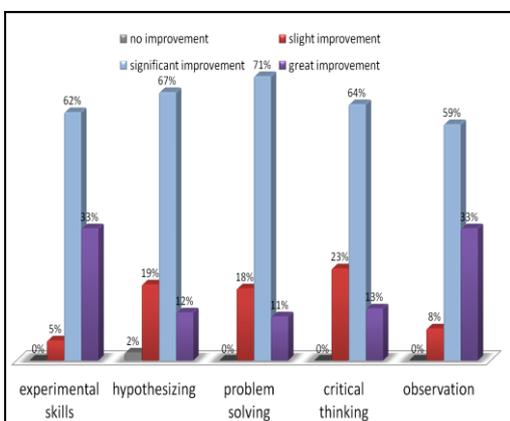


Figure 4. Percentage of Students' Performance Improvement in Science

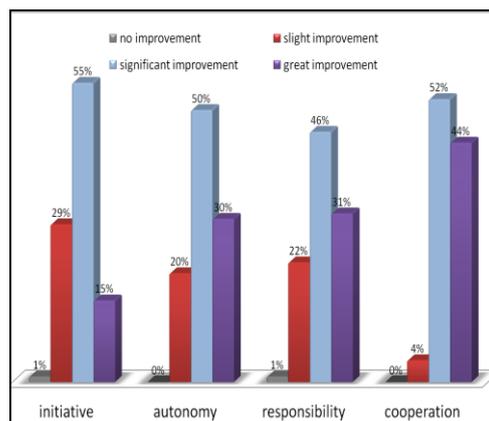


Figure 5. Percentage of Students' Skills Improvement

Almost all of the teachers answered that this way of teaching raised students' interest (90%) and improved their cooperation (92%) and they were able to respond adequately (100%). Most teachers also said that they managed to do the lesson more fun (80%) and all of them said that the methodology improved the teaching process and they would recommend it to their colleagues. Moreover, almost all of them (90%) would like to participate again.

With regard to the difficulties they encountered during the implementation of the program, many of them (60%) said that it took more time to complete a lesson, but 90% of the teachers enjoyed teaching in tandem.

Concerning the training courses most of the teachers answered that they were very useful (80%), the duration was adequate (70%), the material used was useful (80%), while 70% of them said that it would have been better if the training courses were not so focused on theory.

With regard to the lesson plans, most of the teachers (90%) answered that they had adequate support, and considered the lesson plans very useful. However, 50% of them said that they were tiring and 70% found it hard to compose them.

Teachers found it very interesting to cooperate with other colleagues. They enjoyed implementing the methodology and giving the opportunity to the students to think independently and creatively. Some useful comments from the teachers were that they would have liked to have more time in each lesson and a bigger variety of topics. In this way, they could have worked with smaller groups of students and could have carried out more experiments.

9.4. The On-site Visits

Regarding the evaluation of the SFL projects' feasibility, success and usability in general, the University of Athens team made in situ visits in the partner schools and observed how the methodology

was implemented. They visited all participating schools in each country and the general impression was that the SFL project was implemented with great success in all schools. The on-site visits gave them also the opportunity to receive feedback directly from the teachers and students. The basic observations were:

- Students showed interest and participated willingly.
- They showed great enthusiasm and seemed to enjoy the course throughout
- They responded successfully to the activities of the course (comparing, identifying, predicting ...)
- They conducted the suggested experiments with great enthusiasm
- They completed the worksheets successfully.
- They used the German/Spanish language during most of the time of the course. They used known words fluently and had no difficulty making proper sentences and expressing their opinion.
- They seemed to understand the instructions they were given in the German / Spanish language and it was not difficult for them to answer or present their work in front of the rest of the class using the foreign language.
- They cooperated harmoniously (in smaller or larger groups)

With regard to the teachers, despite the meticulous preparation of the course (use of worksheets, necessary vocabulary and appropriate visual material), they also showed considerable enthusiasm for the course and love for their work, which led to the success of the project. The smooth cooperation between the two teachers played a crucial role as the lesson was taught mostly in German and Spanish. The interventions in the mother tongue were few.

9.5. The Dissemination of the SFL Project

The last year of the project was focused on dissemination. More specifically:

- The majority of students answered that they had talked about this program to other students (in total more than 1.000) from their school as well as from other neighbor schools.
- Most of the teachers answered that they had talked about this program to other teachers (in total more than 350) from their school as well as from other neighbor schools.

Moreover, during the science fairs organized by the schools more than 150 teachers and 650 students were informed about the SFL project.

10. Discussion

The evaluation results showed that the SFL program is being implemented with great success in all schools. The methodology used in the project appeared feasible, useful, and successful. The lessons

seemed to be more interesting and fun for students as well as for teachers.

Participating students improved their attitude, their motivation and their performance significantly in almost all factors in both STEM and FL.

It was also observed that the students' skills acquisition was improved. Finally, both participating teachers and students were satisfied with the SFL methodology and felt more confident.

More specifically, with regard to the students the following were observed:

- improvement of participants' attitudes / motivation in almost all factors both in STEM and FL,
- enthusiastic participation,
- raised level of interest for both STEM and FL among participating in comparison to non-participating students,
- improvement in participants' performance in STEM,
- improvement in participants' performance in FL,
- improvement in participants' skills,
- improvement in participants' cooperation,
- satisfaction of participants with the methodology.

With regard to the teachers we found:

- they implemented successfully the SFL project and expressed their satisfaction with the methodology,
- they found their classes more interesting, fulfilling and motivating,
- their profiles seemed to be strengthened by the acquisition of additional skills through the development and adoption of the SFL methodology,
- they derived personal and professional satisfaction from being able to improve their students' learning outcomes and mostly from making the lessons more fun and interesting.

With regard to the project in general we found that:

- the SFL lessons seemed to be more interesting and more fun,
- the SFL methodology can be implemented,
- the students responded successfully and were much more involved in the lessons,
- both students and teachers would suggest to others to participate in a program like that,
- students were satisfied and enthusiastic,
- teachers were satisfied and enthusiastic.

The teacher training courses, according to the teachers:

- were useful,
- were adequate,
- provided useful material,
- would have been better if they were more practical.

The lesson plans, according to the teachers were very useful, however some admitted that they also were tiring and difficult in composing. As for the

support for the lesson plans teachers considered it adequate or great.

With regard to the difficulties they encountered in general, teachers referred mostly to the lack of time and the composing of the lesson plans. On the other hand, most of the students stressed out that they had no difficulties understanding the instructions in the foreign language or cooperating with their classmates.

With regard to the project in general, its methodology is feasible, since it was implemented in all schools successfully. Moreover, this methodology is useful and successful, since it has accomplished positive results in all areas: learning outcomes, motivation/interest, skills acquisition, satisfaction.

The successful implementation of the project was also evident during the science fairs organized last summer in all participating schools during which the results of the students' work were demonstrated. These were organized as mini-competitions ending in the selection of a winning science project which was presented during the Closing Conference of SFL Project.



Figures 6. Students presenting their science projects during the science fairs

The Closing Conference took place at the Instituto Cervantes in Bucharest on 16-17 June 2017. The success of the Conference was evident from the great participation of students, teachers, foreign language and STEM teachers' associations, teacher

training centers, pedagogical institutes and education ministries from all project countries and beyond.

Students from all schools (winners of the science fairs) accompanied by their teachers presented their science projects. Moreover, the results of the project were presented in detail and discussions focused on how the School Future Labs methodology could be taught to more teachers through continuing education, and ultimately incorporated in the practice of a broader number of schools.

11. Conclusions

Our results are quite encouraging urging us to promote the adoption of the Schools: Future Labs methodology by public education authorities in the participating countries and its implementation in more schools.

Our work adds to previous studies exploring the ways of improving the learning process by motivating students and raising their interest both in STEM and FL.

The question that rises is how may this methodology be promoted in more schools and in more countries? An important role toward this direction plays the dissemination of the project by the participating teachers and students, as was done through the science fairs organized by all schools and the closing conference. Serving this aim and for a more effective dissemination and promotion of the project a Schools: Future Labs Promo Video was created and was presented at the conference. The promo video is also available at the official site of the project [11] as well as at YouTube [13].

However, the adoption of the project's methodology and its implementation in more schools and countries cannot be carried out without the help of the official authorities, ministries, universities, institutions of educational policy, teacher training institutes, language institutes etc.

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