RESULTADOS DE LA ENCUESTA A LOS PARTICIPANTES EN LOS PROGRAMAS ESPAÑOLES (Y EN LENGUA ESPAÑOLA) PARA PROFESORES

ISABEL BEJAR ALONSO (CERN)

ABSTRACT

Nowadays there are many initiatives to bring science to students and leverage their interest in STEM Education. Most initiatives consist of visits by scientists to the classrooms, scientific activities carried out by professional associations and visits to laboratories and research centres. These activities bring students into contact with STEM professionals, and their working environment and allow them to experience for a brief lapse of time what it is like to work in a STEM profession. The activities are based on a student–STEM professional interaction, which by design are very punctual and they allow students to visualize only some domains and aspects of the job.

Our work focuses on the benefits of using teachers as a “continuity link” between students and STEM professionals. We have analyzed the case of a research center that has been offering a palette of total immersion programs for secondary school teachers for the last 25 years. The program includes lectures on high-energy physics, engineering and sustainability, infrastructure visits, and hands-on labs that they can replicate in their schools. The program also allows the group of teachers to interact among themselves and create long-lasting bonds so that they can support each other and exchange best practices. To ensure the consistency of the sample, we have considered one of the national teacher programmes. The questions have been focused on how their lessons have evolved, the interactions they have experienced with other teachers and the impact of the immersion program in shaping future engineering careers among their students.

1 INTRODUCTION

The Teachers Program [1] held at CERN [2] is a series of training sessions designed for high school teachers to learn about particle physics, the latest developments in scientific research, and to develop new teaching strategies for their classrooms. The sessions include lectures, hands-on activities, social activities, and visits to CERN's facilities. There are two main categories, the international program and the national program. The national programs are held in one of the national languages of CERN Member States, while the international is held in English.

The National programs [3] are often organized with the support of National research centres or the local or national science or education ministry. In all cases, the goal of these programmes is to encourage teachers to bring cutting-edge science and technology into their classrooms and to inspire the next generation of scientists and engineers.

The program in Spanish language [4] (open also to latin american countries) has been running since 2007. On average 35 teachers participate yearly in the program with values oscillating depending on the external funding to cover travel and accommodation costs.

This paper explores the impact of this program as a booster of STEM student engagement. Findings suggest that immersive collaborations between research managers, teachers and students could promote the students' interest in future STEM careers.

2 STATE OF THE ART

There are several ways to promote STEM (Science, Technology, Engineering, and Mathematics) among students, including:

1. Encouraging early exposure to STEM: It is essential to expose students to STEM subjects early on in their academic journey. This can be done through various means such as school programs, STEM camps, clubs, competitions, hackathons, research projects, and extracurricular activities. These activities can help students develop their skills and network with peers who share their interests. Promoting active learning techniques, such as problem-based learning, inquiry-based learning, and peer instruction, can improve students' critical thinking, problem-solving, and collaboration skills [5]. These techniques have been shown to improve academic performance and retention of STEM students [5][6]. Moreover, these techniques can also enhance students' engagement, motivation, and interest in STEM disciplines [7].
2. Providing hands-on learning experiences: STEM subjects often involve practical applications, and students benefit greatly from hands-on learning experiences. Universities can offer laboratory sessions, internships, and research opportunities to help students develop practical skills. Experiential learning opportunities allow students to apply their knowledge and skills in real-world settings. Engaging STEM students in research opportunities, such

as undergraduate research programs and internships, can provide them with hands-on experience, which can improve their understanding of scientific concepts and research methodologies [8]. Research opportunities can also enhance students' motivation, self-efficacy, and interest in STEM disciplines [9]. These opportunities can help students gain practical experience, build their resumes, and network with potential employers.

3. Creating a supportive environment: It is important to create a supportive environment that encourages students to pursue STEM fields. Universities can do this by providing mentorship programs, peer support groups, and networking opportunities. Then, providing access to mentoring and tutoring programs can help students succeed academically and professionally. Mentoring programs can provide STEM students with guidance, support, and advice, which can improve their academic performance, self-efficacy, and retention rates [10]. Mentoring programs can also help to create a sense of community, which can enhance their motivation and engagement [11]. These programs can also help students connect with experts in their field of study.
4. Offering scholarships, grants and other financial aid: STEM degrees can be expensive. Offering scholarships and financial aid can help alleviate this concern and provide students with the necessary resources to pursue their studies.
5. Partnering with industry: Partnering with industry can help provide students with real-world experience, mentorship, and career opportunities. Universities can collaborate with local companies to offer internships, apprenticeships, and job shadowing opportunities.
6. Diversity and Inclusion: Creating a diverse and inclusive learning environment can promote STEM students' academic success and engagement [12]. A diverse learning environment can expose students to different perspectives, experiences, and ideas, which can enhance their creativity and critical thinking skills. Moreover, an inclusive learning environment can provide students with a sense of belonging, which can improve their motivation, self-efficacy, and retention rates [12].

Overall, promoting STEM students in university studies requires a multi-faceted approach that involves creating a supportive environment, providing hands-on learning opportunities, and offering financial assistance and industry partnerships.

3 CASE STUDY: SPANISH TEACHERS PROGRAMME AT CERN

CERN, the European Organization for Nuclear Research, offers various educational programs aimed at students, teachers, and the general public.

1. **The CERN Teacher Programs.** Provides professional development opportunities for high school teachers, enabling them to learn about particle physics and CERN's research. Thousands of teachers from more than 80 countries have participated in the program since 1998.

2. **The Visits program**. CERN welcomes thousands of visitors every year, including school groups, teachers, and individuals. In 2019, CERN received over 110,000 visitors from all over the world.
3. **The CERN openlab and Summer Student Programme**. It offers undergraduate and graduate students the opportunity to work on cutting-edge research projects alongside experienced researchers. Thousands of students from worldwide have participated in the program [13][14].
4. CERN also offers educational resources, including online courses, for students and teachers [15].

In this study, the authors have focused on one National Program, the Teacher Program in Spanish Language that has been followed mainly by teachers from Spain, Mexico and some other countries in Latin America. The program has been followed by around 500 teachers from 2007 to 2022. Each national program is slightly different from the other for this reason was important to be sure that the persons answering the survey had attended a similar program with the same balance of lessons, visits, social activities and hands-on activities.

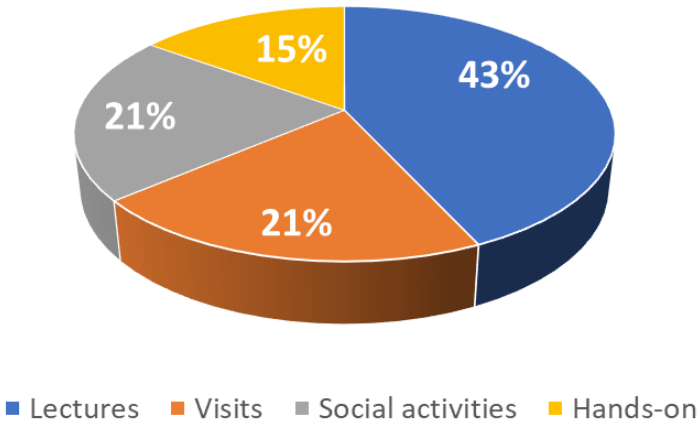

Figure 1 : Distribution of hours during the training for the program in Spanish language

4 METHODOLOGY

The authors prepared a survey to analyze the perception of the teachers after their participation in the program. The survey wanted to capture data on:

- How their way of teaching had been modified (5 q.)
- How their network had evolved (6 q.)
- How their students had been impacted (4 q.)

Lection captured their opinion and feedback on how to improve the program (4 q.).

The original sample contained 467 e-mails distributed as follows:

Year 20XX	07	08	09	10	11	12	13	14	15	16	17	18	19	22	NI
Participants															-
Answers	1	0	2	8	3	13	5	3	14	8	27	33	47	52	2
% answer															-

We had a 47% answer rate. If we compare the sample with those answering the survey there is a stronger answer rate in the last years.

We had 51% of answers from women compared with the initial sample of XX%.

For the age as we asked for their present age and not the age when they participated it is more difficult to compare

5 RESULTS

In this paper, we would like to centre on the 4 questions related to how their students have been impacted by the fact that they had attended the program.

5.1 I have seen increased motivation in my students after incorporating new activities/concepts into my lessons.

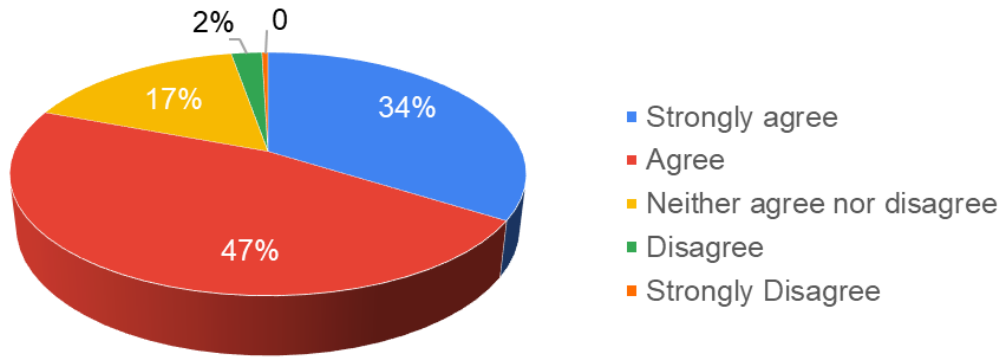

Figure 2 : Results from the full sample

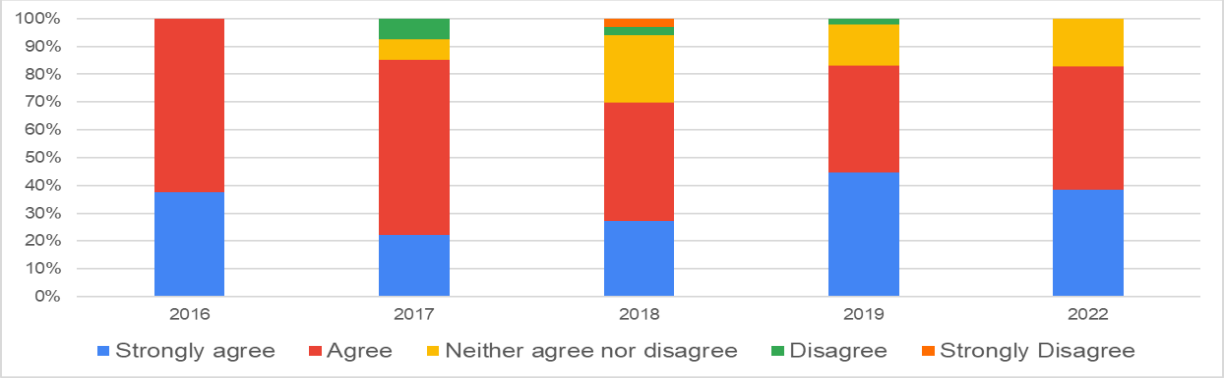

Figure 3: Detail considering the last 5 sessions

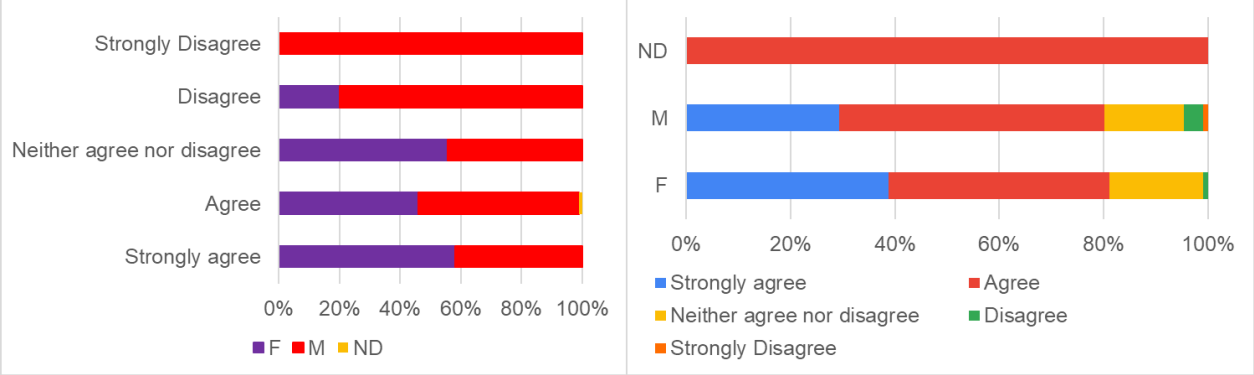

Figure 4: View by the sex of the teacher

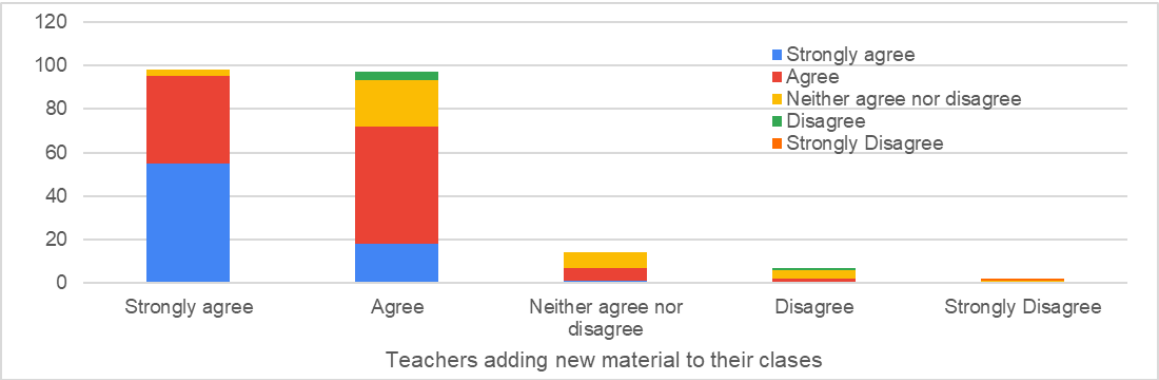

Figure 5: Correlation between teachers including new material in their classes and increased motivation perceived in their students

On average 81% of the teachers perceive an improvement in their pupils' motivation after including new material acquired during the STP lessons or via their acquired networking. As can be seen in Figure 5. There is a correlation between adding more new material and an improvement motivation of the students.

5.2 My students have contacted me more than before to guide them in their higher education studies.

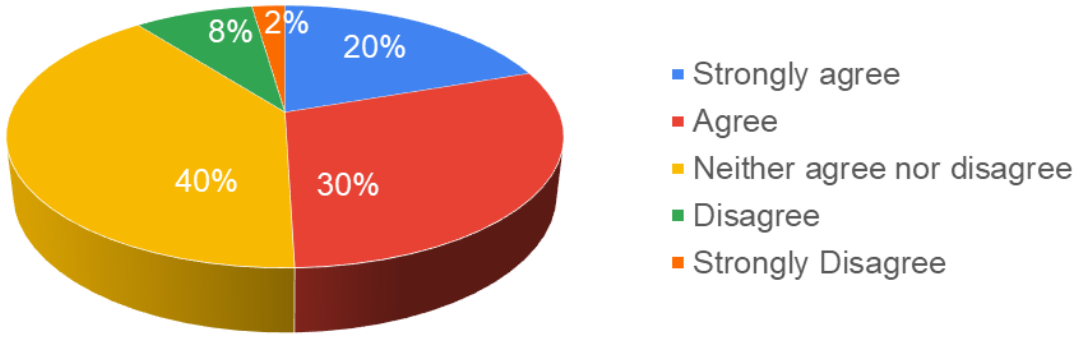

Figure 6: Results from the full sample

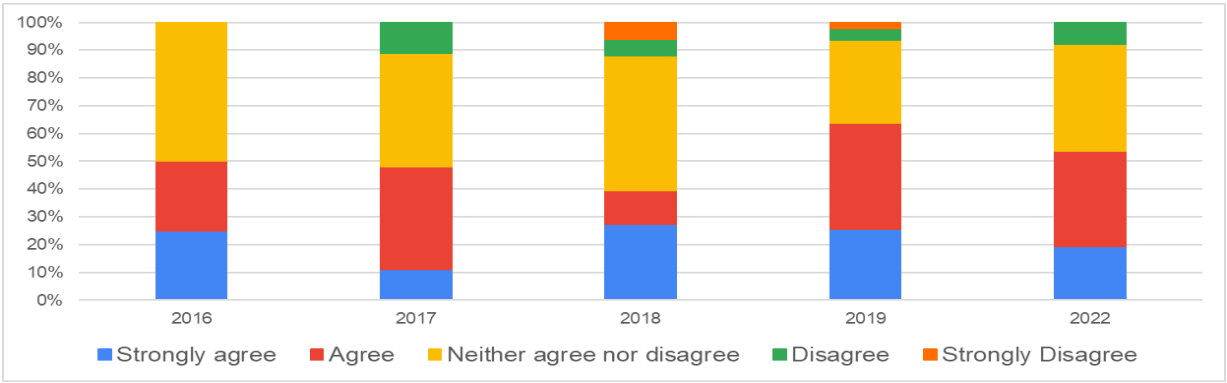

Figure 7: Detail considering the last 5 sessions

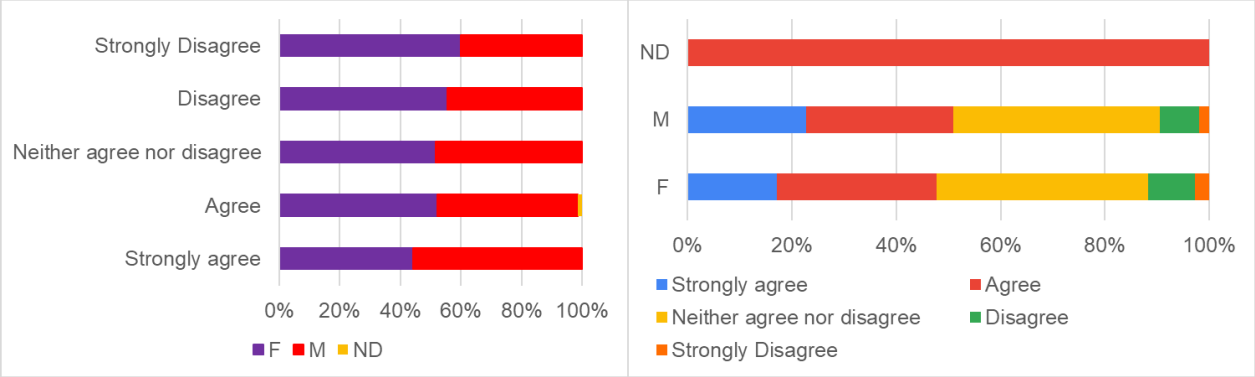

Figure 8: View by the sex of the teacher

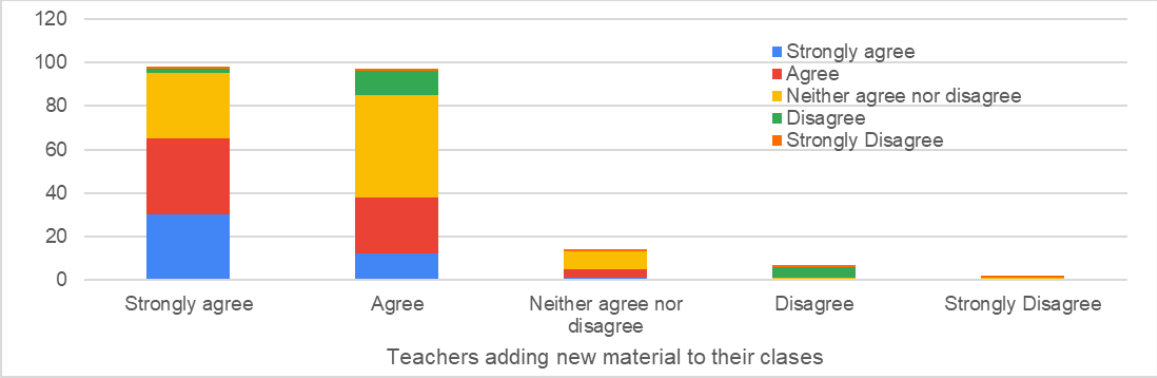

Figure 9: Correlation between teachers including new material to their classes and increased number of students contacting them for guidance

On average 50% of the teachers peceived that they are contacted more often to guide students in their future studies. As can be seen in Figure 9 the teachers that have incorporated more new concepts are the ones that are contacted more than before.

5.3 My students have requested more extracurricular activities in STEM.

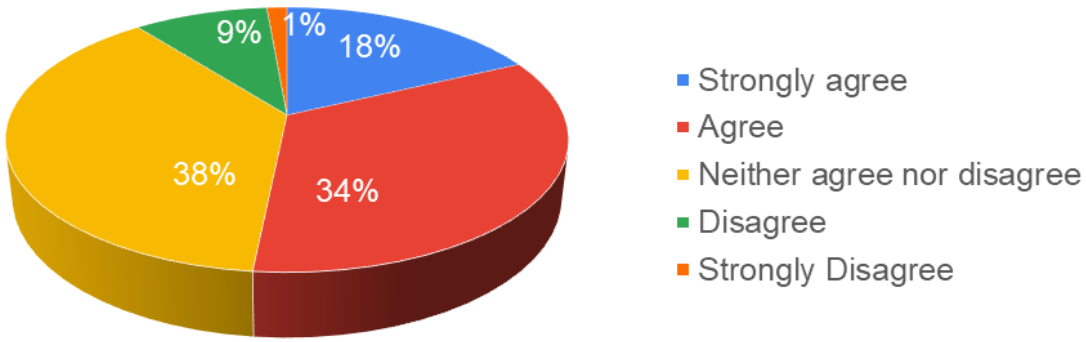

Figure 10: Results from the full sample

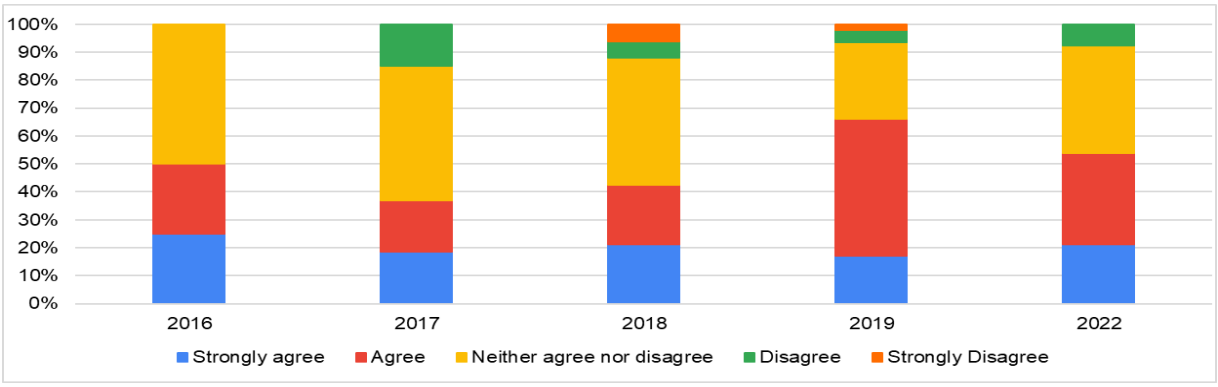

Figure 11: Detail considering the last 5 sessions

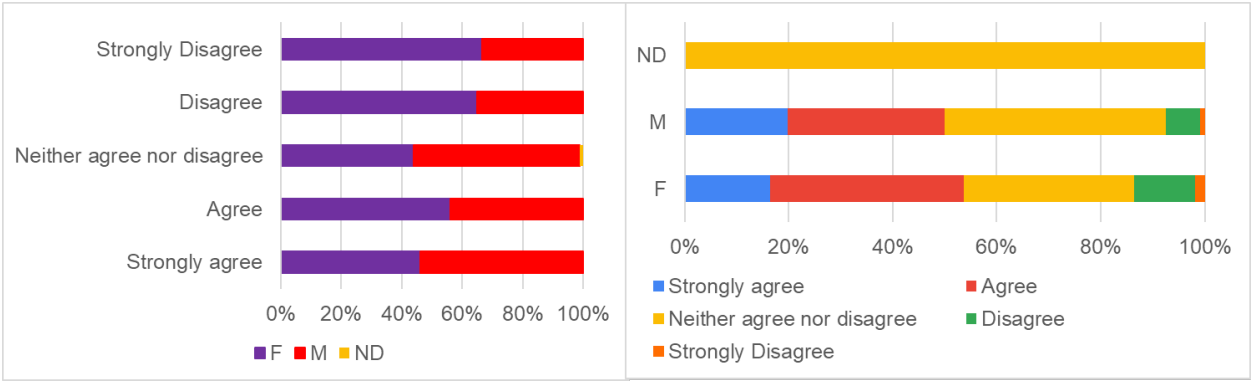

Figure 12: View by the sex of the teacher

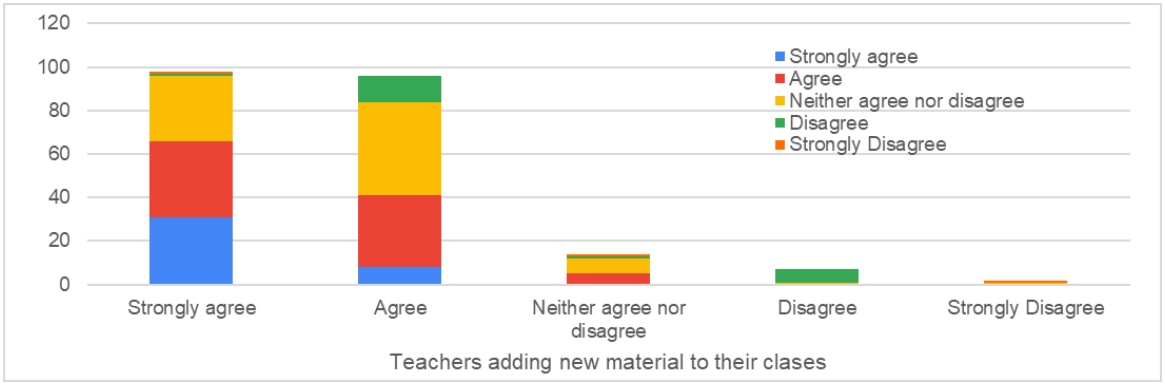

Figure 13: Correlation between teachers including new material and students requesting more extracurricular STEM activities

52% of the teachers consider that their students have requested more STEM activities and once more there is a correlation with those teachers that have incorporated new concepts into the class

5.4 By how much do you estimate that it has increased the number of students choosing a STEM degree?

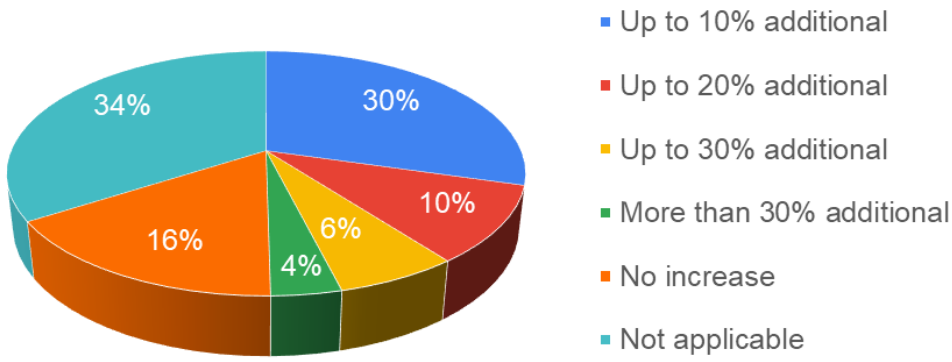

Figure 14: Results from the full

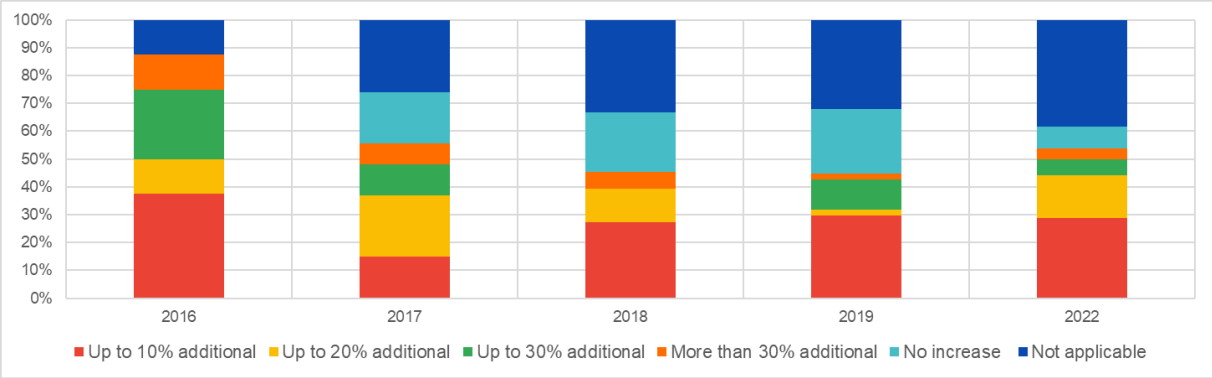

Figure 15: Detail considering the last 5 sessions

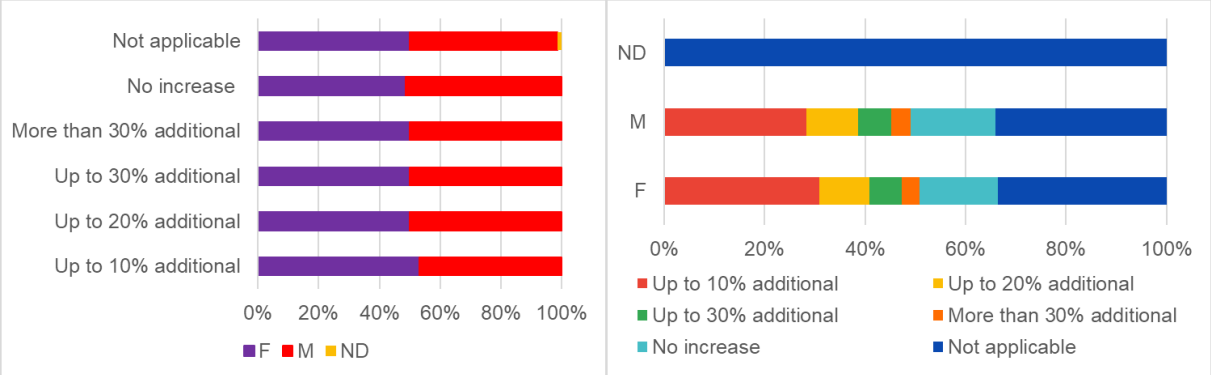

Figure 16: View by the sex of the teacher

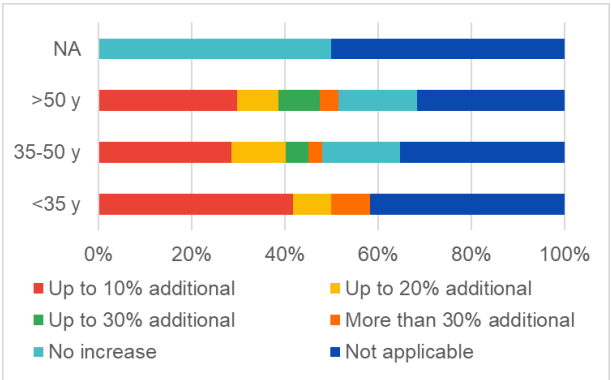

Figure 17: View by present age of the teacher

50% of the teachers consider that there have been an increased number of students going to STEM studies. With the years it looks like there are more teachers considering that there is a positive impact.

6 SUMMARY AND ACKNOWLEDGMENTS

The results of the survey show that teachers attending programs bringing them closer to researchers improve their motivation by incorporating new material into their classes and that this fact has a positive effect on improving students' motivation, their request for new STEM activities, closer contact with the teachers and an improve on the number of future students choosing a STEM career.

The survey will be further analyzed in the other 3 aspects not treated in this paper.

We would like to thank J. Wiener from the CERN teacher program for his collaboration and fruitful discussions.

REFERENCES

[1] CERN Teacher Program website https://teacher-programmes.web.cern.ch/

[2] CERN website: https://home.cern/

[3] CERN National Programmes CERN Spanish Program https://teacher-programmes.web.cern.ch/national-teacher-programmes

[4] https://teacher-programmes.web.cern.ch/spanish-teacher-programme

[5] Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences, 111(23), 8410-8415.

[6] Deslauriers, L., Schelew, E., & Wieman, C. (2011). Improved learning in a large-enrollment physics class. Science, 332(6031), 862-864.

[7] Price, M. (2004). Does Active Learning Work? A Review of the Research. Journal of Engineering Education, 93, 223-231

[8] Lopatto, D. (2004). Survey of Undergraduate Research Experiences (SURE): First Findings. Cell Biol Educ. 2004 Winter; 3(4): 270–277.

[9] Seymour, E. et at. (2004). Establishing the benefits of research experiences for undergraduates in the sciences: First Findings from a three-year Study. Science Education 88(4):493 – 534.

[10] Campbell, P. B., & Jolly, E. (2013). Mentoring programs. In J. S. Halpern, & H. M. Laursen (Eds.), The Changing Face of STEM: Women and Color in Science, Technology, Engineering, and Mathematics (pp. 111–128). Purdue University Press.

[11] Crisp, G., Nora, A., & Taggart, A. (2009). Student characteristics, pre-college, college, and environmental factors as predictors of majoring in and earning a STEM degree: An analysis of students attending a Hispanic serving institution. American Educational Research Journal, 46(4), 924-942.

[12] Chang, M. J., Eagan Jr, M. K., Lin, M. H., & Hurtado, S. (2014). Considering the impact of racial stigmas and science identity: Persistence among biomedical and behavioral science aspirants. Journal of Higher Education, 85(5), 589-615.

[13] CERN summer programs https://careers.cern/summer

[14] CERN openlab website: https://openlab.cern/

[15] Online courses https://teacher-programmes.web.cern.ch/online-teacher-programmes