Analysis of the Master's Degrees of the Department of Physics and Astronomy

Background Studies

Many studies [1–9] have consistently observed that underrepresented minorities and first-generation students generally have lower scores on the physics exam and lower GPAs in first-year physics undergraduate degrees due to a lack of prior preparation. This lack of preparation is also seen in lower high school test (SAT/ACT) grades. Minority students are more likely to take less advanced courses [3], as GPA strongly predicts advanced class-taking.

While not all studies agree, most say that females have a more difficult time due to some stereotyping [1], and women take less advanced in-course majors while they excel in outside-course majors [3].

Students from poorer backgrounds are also repeatedly seen with lower grades in university due to higher levels of stress, lack of nutrition, and lack of adequate healthcare and educational resources [5,10]. The lack of financial resources will also become problematic if the study resources at the university are expensive [4]. While it is not stated that working while studying could potentially lower student performance, a study shows that extracurricular activity takes time, which means less research and lower grades [9].

Factors such as students' self-efficacy and mindset must be considered when discussing complex material such as physics. A positive mindset outperformed a fixed mindset [8,10]. Unfortunately, students from poorer backgrounds and female students have a more fixed mindset [10,11]. Unwelcoming culture (i.e., microaggression and un-inclusive stereotyping) and bad interaction with supervisors (i.e., "this is trivial" and "you should have known this" responses) are the source of low self-efficacy, which in turn lowers students' performance [7].

Studying physics, much like learning any material, would benefit more if there is a conducive interaction between students and teachers [7,8]. A study focusing on the interaction in a physics laboratory shows that being in person is better due to the direct interaction [12]. A study group inside and outside the classroom could help students improve [4,9]. However, an over-reliance on another student could backfire [9]. Additionally, grouping students of the same performance level is essential as it could help all the students more equally [9]. A less prepared student could feel unable to contribute

and feel left behind, and depending on the material, the task might be too difficult or boring [4].

The studies above employed various methods, including comparing the ACT/SAT scores with the physics exam grade, final grades, or GPA. Other studies employed questionnaires about students' perceived experiences with other students and professors and challenges in and outside the classroom. Other studies combined all the aforementioned methods. All these data were then subjected to statistical measurements to test the significance and correlation between one event and another (i.e., whether one event directly causes another or is mediated by another event). A combination of data analysis and survey will be employed for this study.

In general, the goal of the study will be to:

1. How can international students' study experience and performance be improved?
2. Understand the opportunity for internships for international students.

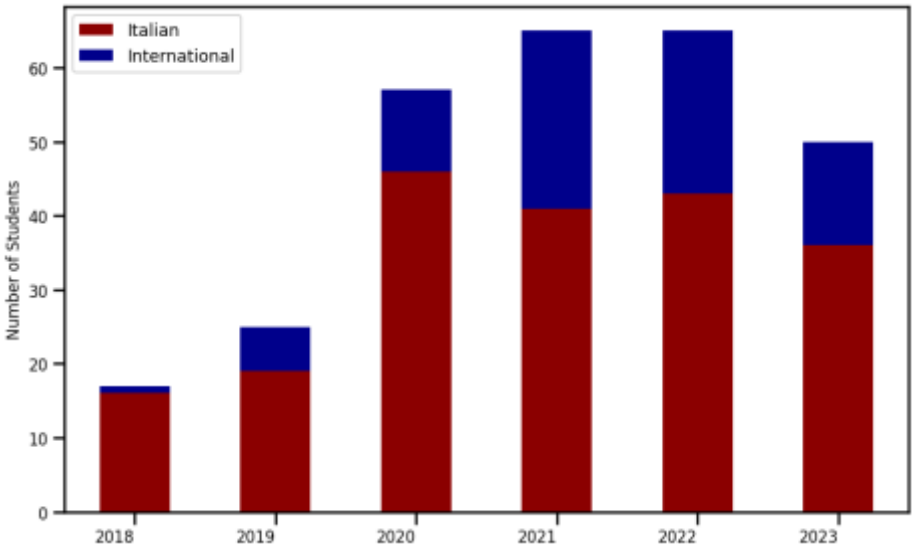
Therefore, it is essential to consider that most of these studies are taken exclusively in the United States of America for physics courses at the bachelor's level. There will be some aspects that will not match the study above. To extend these studies to a Master's in Physics of Data and Physics, international students are portrayed as marginalized students. Associating students from outside the Western countries with students from poorer backgrounds might also help understand the situation. International students also face challenges not mentioned in the study, such as initial culture shock, problems adapting to new environments, and more. Master students might also have different attitudes (mindset and self-efficacy) than bachelor students. The Italian education system is also distinct from the one in the USA since there are at least five chances to take the exam, which could provide more opportunities to improve grades. Furthermore, when analyzing the opportunity for an internship, it might be beneficial to consider the limitations posed by student permits and the general attitude of Italian companies/research centers toward international students (e.g., language barrier and different work culture).

Data Analysis From Student Database (Physics of Data)

The analysis includes only students from cohort 2018/2019 to 2023/2024 whose enrollment status falls under one of the following categories: “immatricolazione”, and “conseguimento titolo”.

1. Student demographic

Fig 1. PoD Student Distribution per Year.



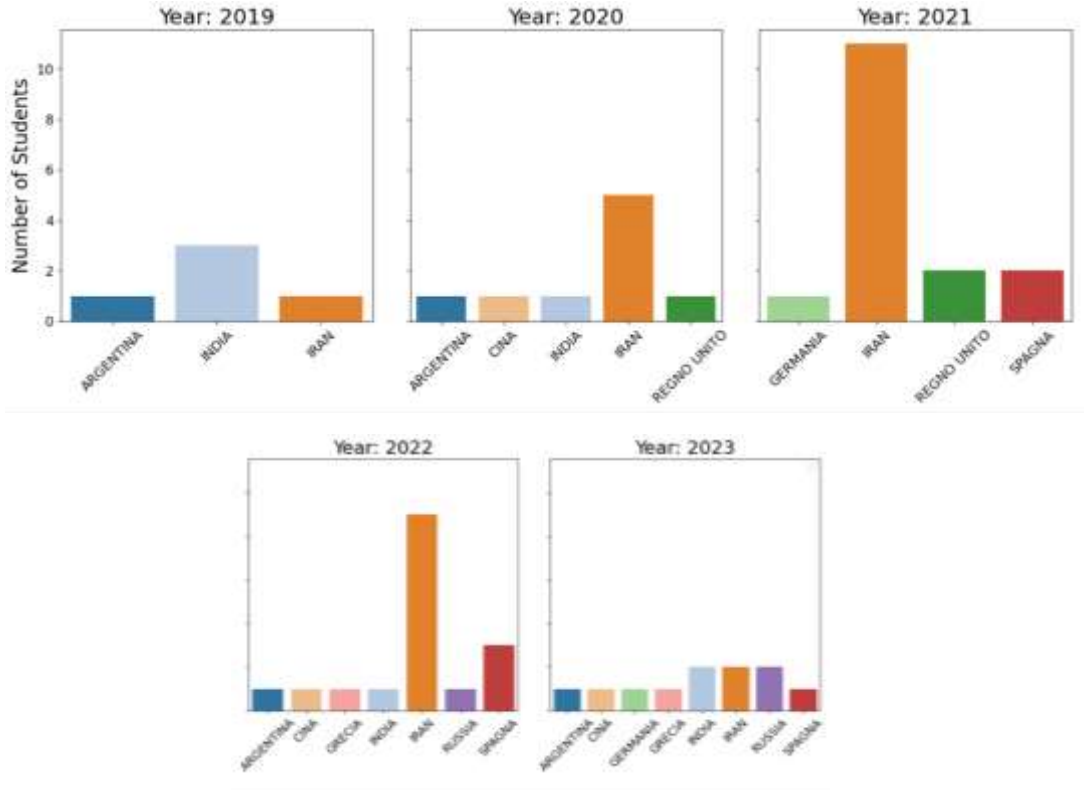
Tab 1. PoD Student Distribution per Year Based on Nationality and Gender.

Anno	Total Students	Italian Students	Inter. Students	Male Italian	Female Italian	Male Inter.	Female Inter.
2018	17	16	1	14	2	0	1
2019	25	19	6	15	4	5	1
2020	57	46	11	34	12	5	6
2021	65	41	24	37	4	11	13
2022	65	43	22	35	8	14	8
2023	50	36	14	29	7	5	9

Based on the student demographics in Figure 1 and Table 1, we can see that the majority of students are Male Italian students. While this is consistent, male Italian students dominate Female Italian Students. However, this is not always the case for International Students; in 2020, 2021, and 2023 Female International Students dominated Male International Students.

The International students of Physics of Data come from many countries, which are: EGITTO, IRAN, INDIA, ARGENTINA, ZIMBABWE (RHODESIA), MESSICO, VIETNAM, CINA, REGNO UNITO, PERÙ, PAKISTAN, BANGLADESH, ARMENIA, GAMBIA, MACEDONIA, ROMANIA, SPAGNA, LIBANO, GERMANIA, INDONESIA, ECUADOR, RUSSIA, GRECIA, SRI LANKA (CEYLON), COLOMBIA, TURCHIA, GEORGIA.

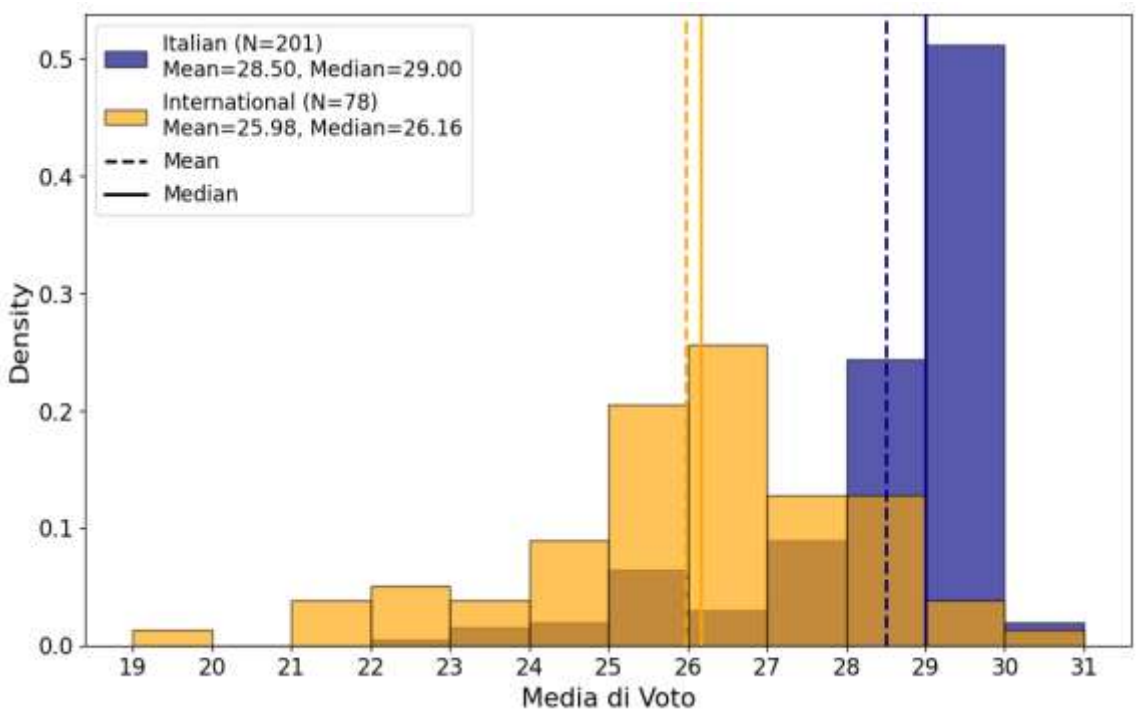
Fig 2. PoD Distribution of International Student's Origin That Appears for 2+ Years



Several countries consistently send students, as seen in Fig.2. PoD students more often come from Iran.

2. Grade Comparison

Fig 3. Grade Distribution Italian Vs. International PoD Students Aggregated Cohort 2018 - 2023

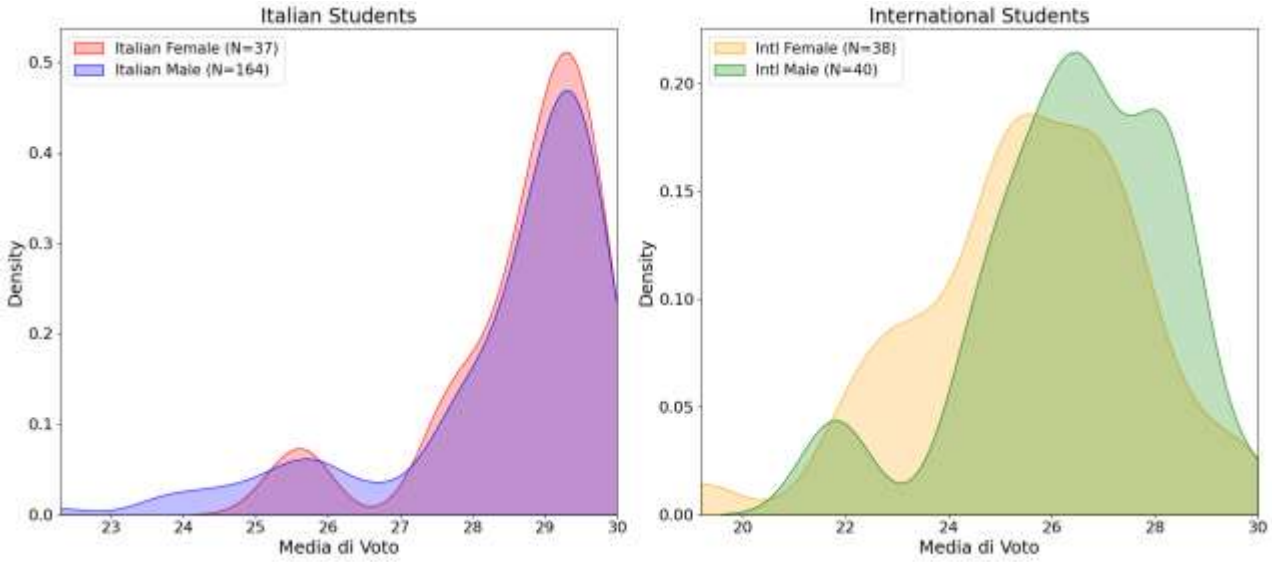


Tab 2. Grade Distribution Italian Vs. International Students Over The Years & Statistical Tests

Cohort	Median Italian	Median Int.	Mean Italian	Mean Int.	Mann-Whitney Significance	KS Test Sig.
2018 - 2023 Aggregated	29.0	26.16	28.5	25.98	****	****

Given the distribution in Fig. 3 and the statistical results given by Tab. 2, there is a firm conclusion that international students have significantly lower grades than Italian students. This agrees with the multiple studies mentioned above regarding minority students performing worse than the majority students, which might be due to a lack of initial preparation, in this case, undergraduate education. However, there may also be other challenges faced by international students that contribute to their lower grades, which we will explore further in the questionnaire results.

Fig 4. Grade Distribution of PoD Students by Gender (Female vs. Male, Aggregated Grades)



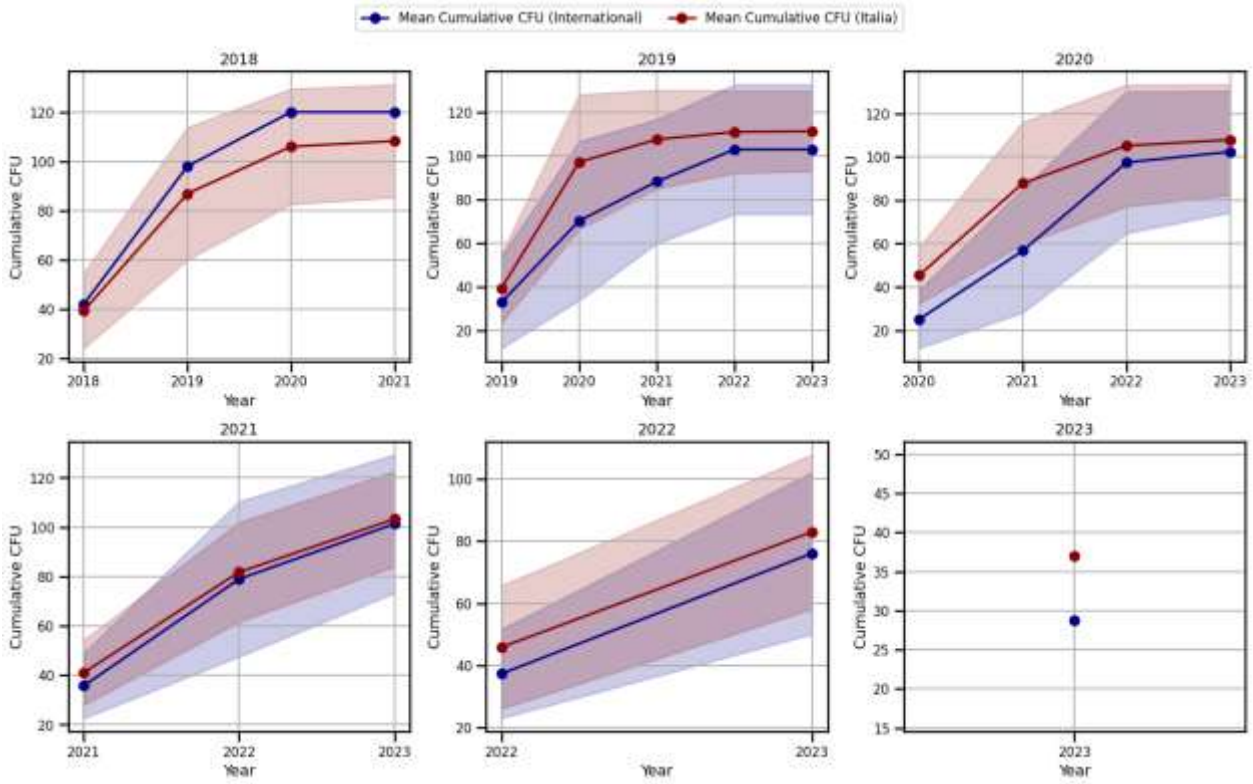
Tab 3. Statistics of PoD Students by Gender (Female vs. Male, Aggregated Grades)

Comparison	Median Female	Median Male	Mean Female	Mean Male	Mann-Whitney	KS Test	T-Test
Italian (F vs M)	29.00	29.00	28.71	28.45	ns	ns	ns
International (F vs M)	25.46	26.64	25.51	26.42	ns	ns	ns

Although no significant differences were found in the grades of female and male students, both internationally and domestically, this does not necessarily indicate a lack of unique challenges female students face. We will explore these potential challenges further later in the questionnaire results to determine if they contribute to any differences in experience.

3. CFU attainment over the years

Fig 5. Cumulative CFU Italian vs. International PoD Students Over The Years



Extending the analysis of student performance not only on the grade but also on their "speed" based on the CFU taken per year, Fig. 5 shows that Italian Students generally complete more courses at the beginning of their studies. It is also important to note that in 2019 and 2020, the COVID-19 pandemic may have disrupted the learning process, which could explain the substantial gap in CFU attainment in the plot above.

Possible Questions, General Topic

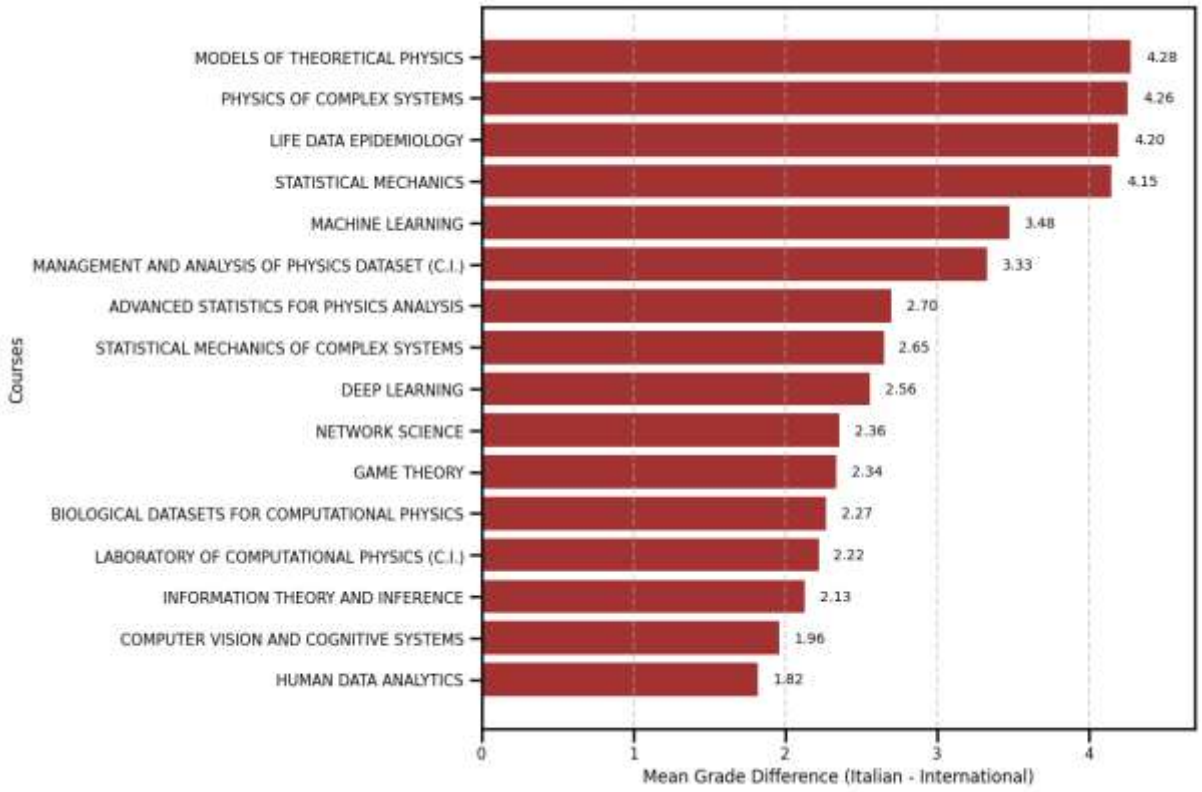
Given the studies mentioned above, the questionnaire by https://forms.office.com/e/ParuqpyiM5, and my own experience, I formulated some general points that would be interesting to ask in the questionnaire.

1. How prepared student feels (confidence in physics, coding, and English ability)
2. How is the interaction with other students and teachers
3. Feelings after the first exam & first homework (to see if the student feels defeated/motivated)

4. Culture shock.
5. Possibility of other stress that might distract from studying (homesickness, financial stress, housing problem)
6. What do the students think about being female/male in physics? Do they feel there is discrimination or stereotyping?

4. Courses With Differences in Grades

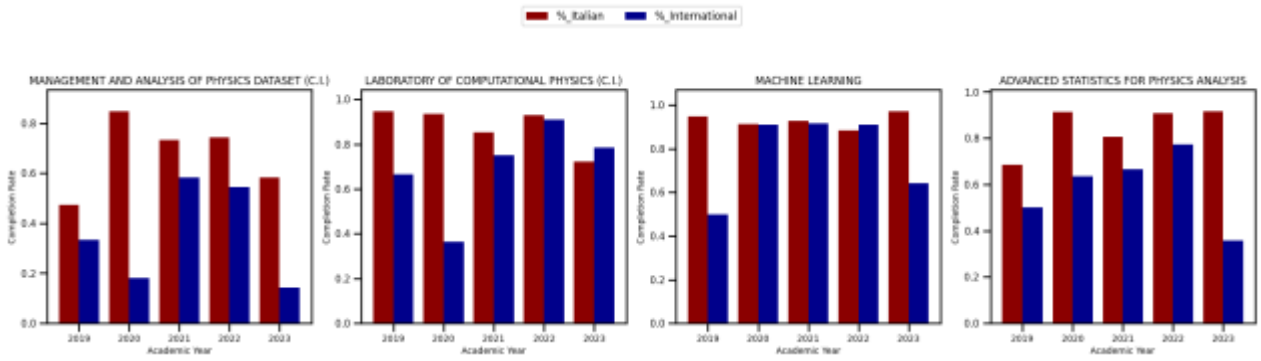
Fig 6. Statistically Significant Grade Disparities in Select Courses with at Least 15 Students Per Group (PoD)



The graph above (Fig. 6) was obtained by aggregating all the cohort data from 2018 to 2023 and filtering the courses taken by at least 15 Italian and 15 international students. The threshold on the number of students is to provide a more reliable significance test and ensure that students consistently take the courses analyzed. The results show that Italian students consistently have significantly higher grades than international students. Cohen's d values are generally above 1, indicating a substantial gap between the two groups. The full results of the statistics are available in the appendix. Looking at the ranking, a larger grade difference is more pronounced in the physics-heavy subjects than in data science/computation subjects.

5. Analysis of Differences in CFU

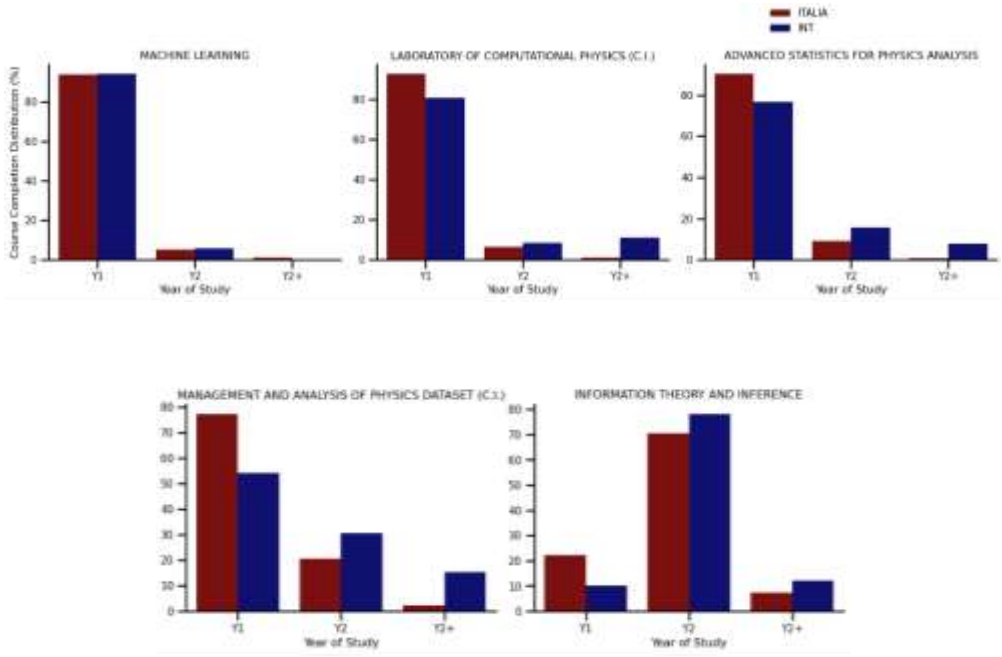
Fig 7. Mandatory Courses Completion Rates of Pod Students During 1st Year of Study



The graph in Fig. 7 highlights mandatory first-year courses, which may contribute to the significant difference in the CFU attained by Italian and international students. Courses such as “Management and Analysis of Physics Datasets” and “Advanced Statistics for Physics Analysis” consistently have higher completion rates among Italians.

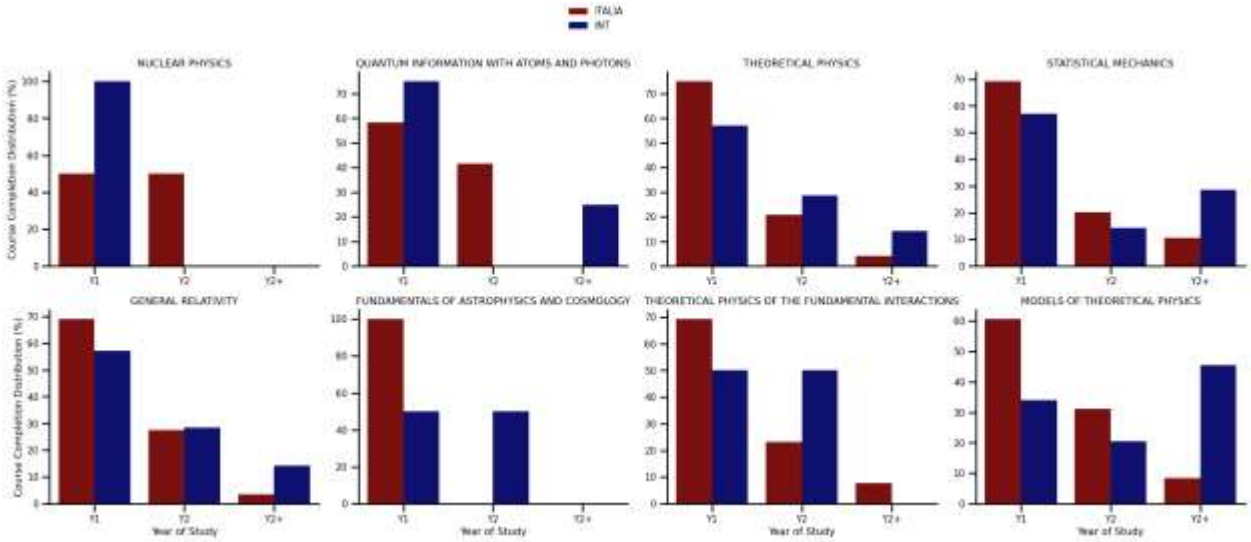
There is no clear, consistent pattern of specific courses for the second year and beyond, causing differences in CFU completion rates between Italian and International students. This is likely due to increased flexibility in course selection, allowing students to pick any classes freely.

Fig 8. Mandatory Courses Completion Distribution Over PoD Students’ Career



The graph above was obtained by aggregating the cohort 2018 - 2023 data. Generally, Italian and international students complete their mandatory courses within the first year of study, except for Information Theory, which is intended for second-year students. Many international students tend to complete their exams during their second year, particularly in the **Management and Analysis of Physics Dataset course.** This trend could indicate specific challenges or difficulties associated with this course. The data does not distinguish between different modules of the course (Mod A or Mod B), which might provide further insight into these differences.

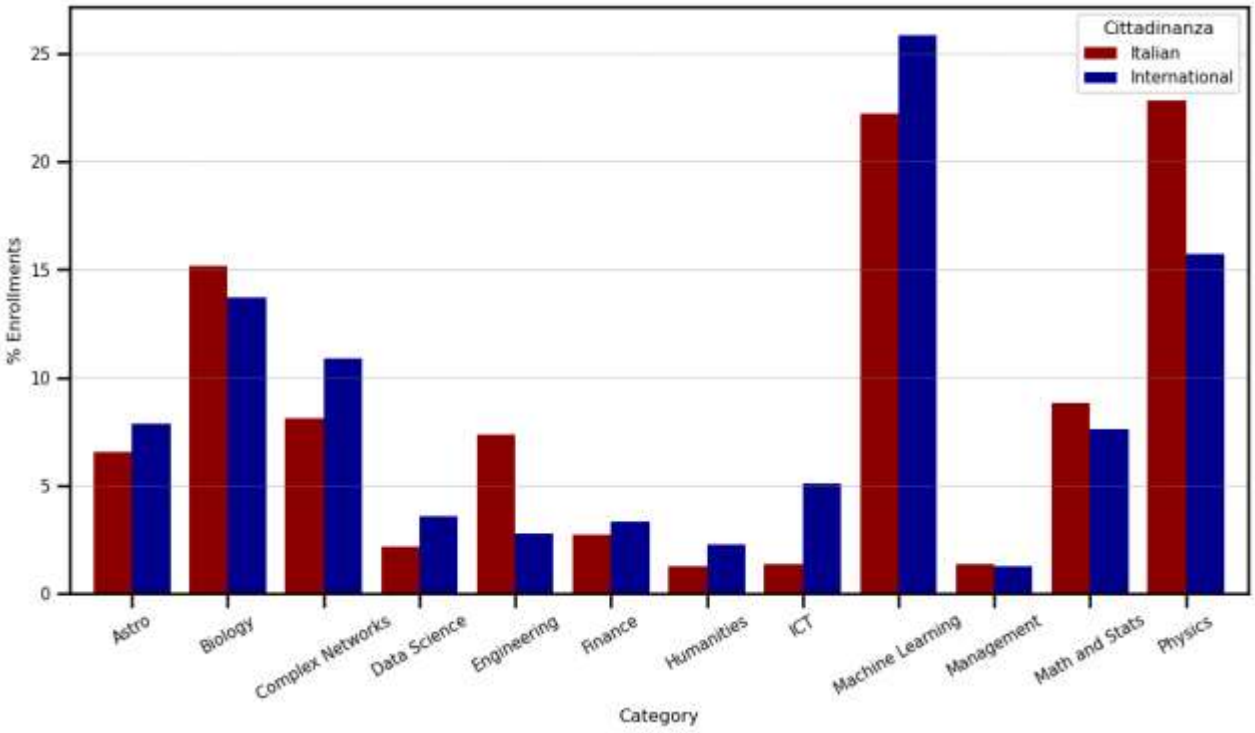
Fig 9. Selective Mandatory Courses Completion Distribution Over The PoD Students' Academic Carrier



Examining the data for selective mandatory physics courses, we observe that Italian students generally complete their exams within the first year of study. In contrast, international students' completion times are more varied, often extending into later years. This trend may suggest that these physics-heavy courses pose more significant challenges for international students, leading to delayed exam completion.

6. Preference Difference

Fig 10. Courses Preferences



Generally, international students prefer Machine Learning, Data Science, Complex Networks, and ICT courses more than their Italian counterparts. Conversely, Italian students are more predominantly enrolled in fields such as physics, mathematics, and biology—with the notable exception of astronomy. A study [3] reveals that undergraduates and minority groups tend to avoid advanced physics courses. In this case, International students might exhibit a similar trend, with other factors at play being worth considering. This trend may stem from a mix of strategic career considerations and a conscious decision to evade the more challenging physics courses.

The full list of the courses and its category is available in the appendix.

Fig 11a. PoD Students' Mandatory Theoretical Physics Subject Preferences

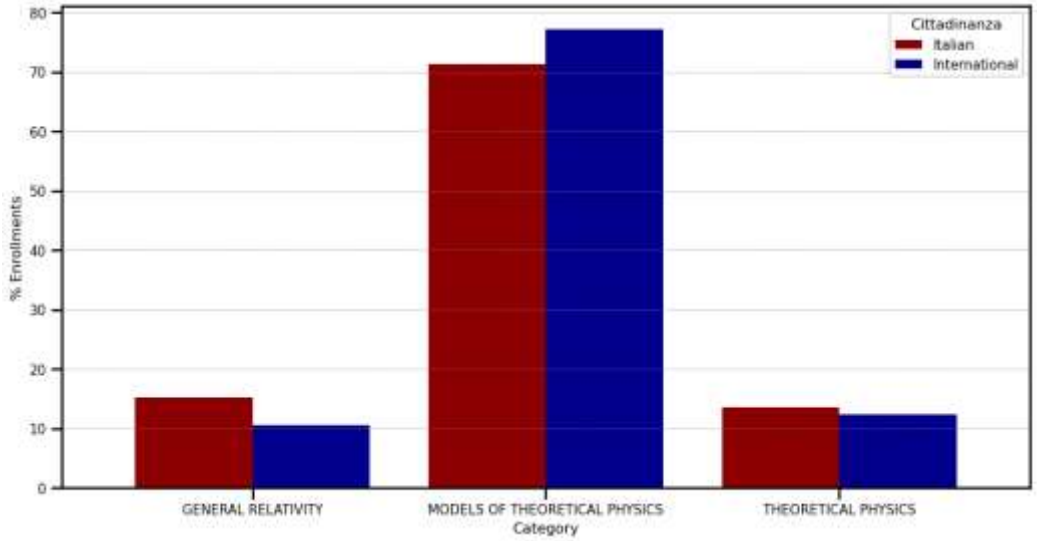


Fig 11b. PoD Students' Mandatory Theoretical Physics Subject Preferences for 1st Year

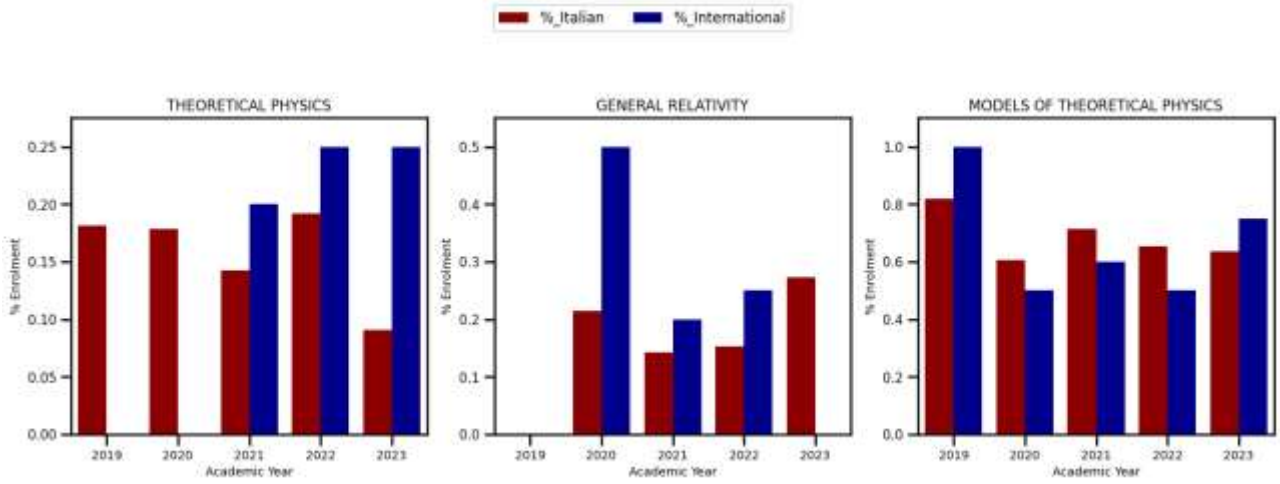
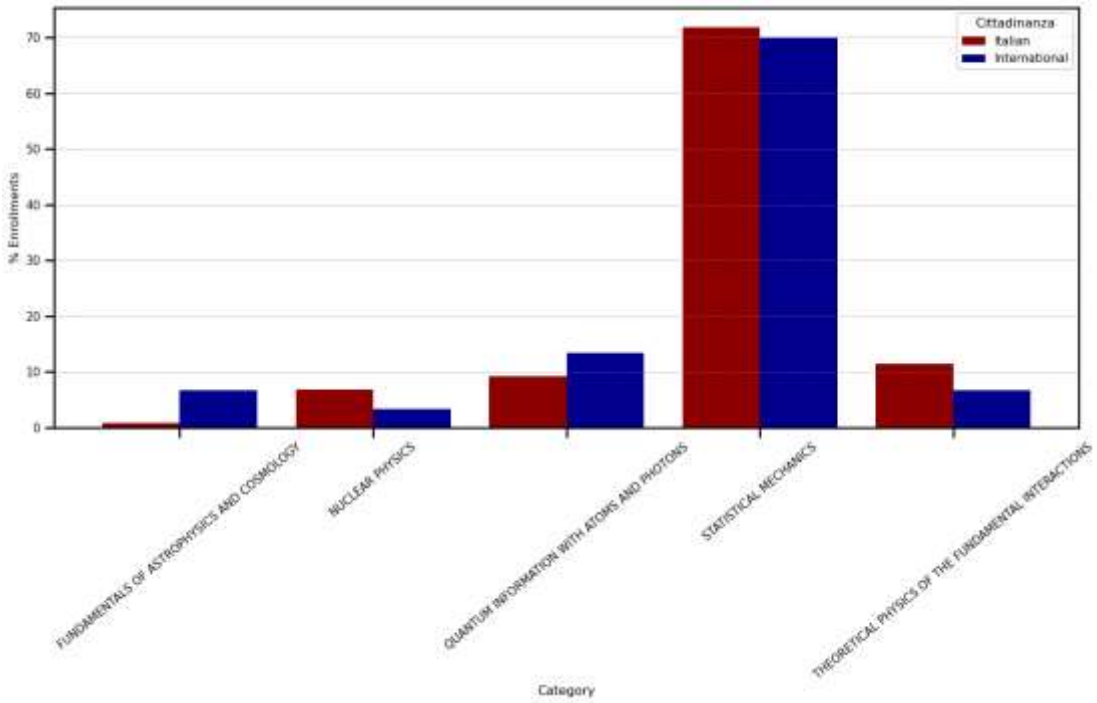


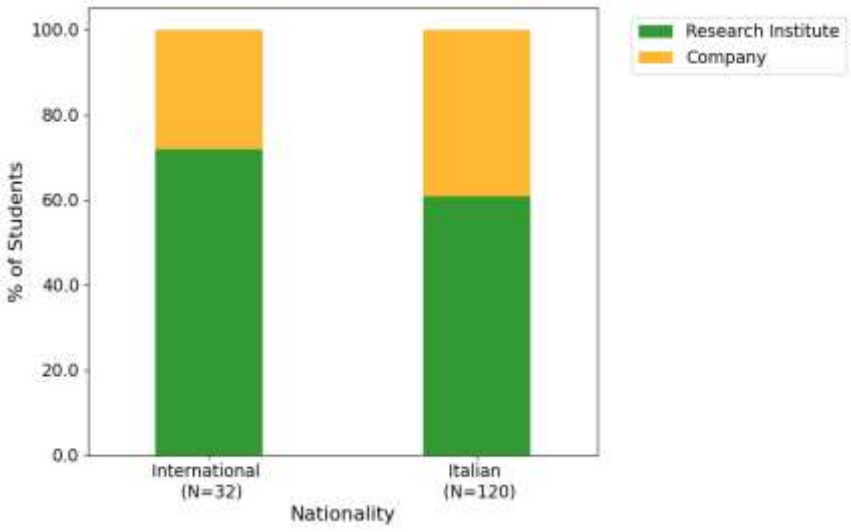
Fig 12. PoD Students' Mandatory Physics Subject Preferences



Generally, both Italian and International Students prefer courses related to statistical physics. Over the years, “Models of Theoretical Physics” courses have been the consistent favorites. Perhaps this is because statistical subjects are closely related to Machine Learning and Data Science.

7. Internship Type

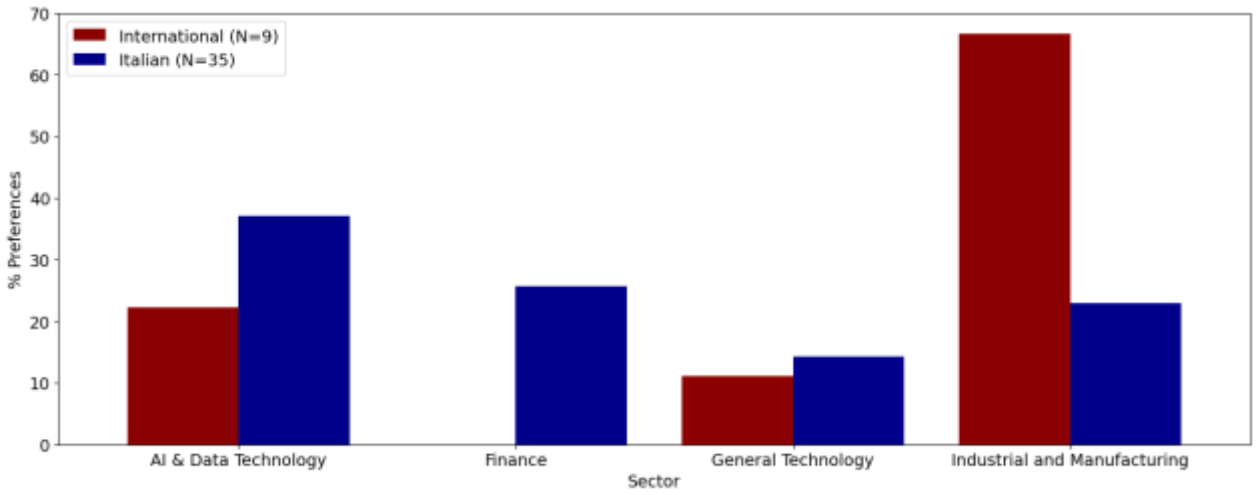
Fig 13. PoD Students’ Internship Type Comparison



Generally, both Italian and international students intern at the Research Institute. However, Italians are +10% more likely to intern in a company than international students. This may be related to the limited working hours of International students due to the rule of having a student permit, paperwork issues, the language barrier, and more. .

8. Company Sectors

Fig 14. PoD Students' Internship Company Sectors

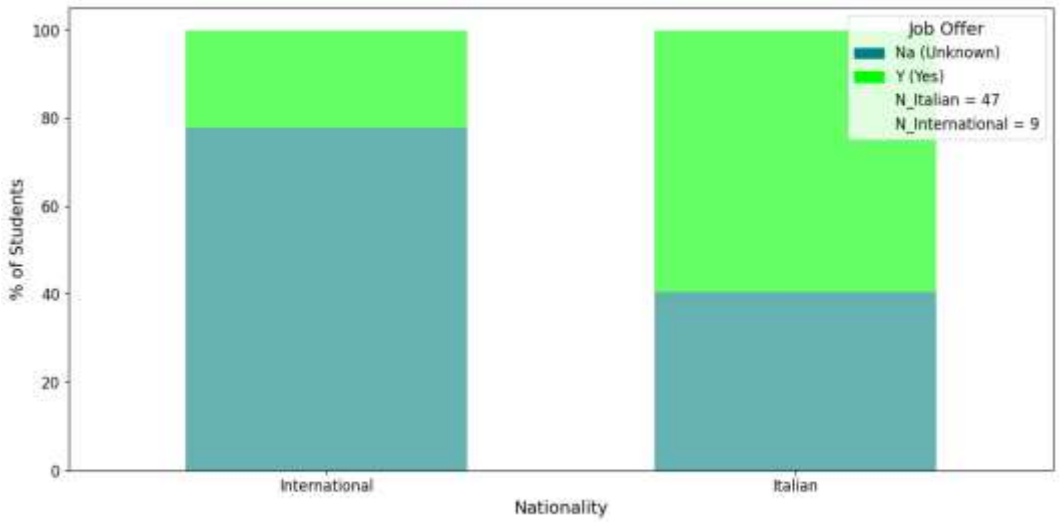


Generally, Italian students are more distributed in several sectors than International students, primarily focusing on the Industrial and Manufacturing sectors. The complete List of the companies in each industry is available in the Appendix.

At first glance, it seems surprising that there are fewer students in the AI and Data Technology sector compared to the Industrial and Manufacturing sector, as seen in International students despite the degree heavily leaning toward data science and AI. This is because AI and Data Technology companies usually consult with clients and might require fluency in the Italian language, making it challenging for international students. Meanwhile, looking closer at the companies where international students intern—**Eneryield, Accenture Argentina, UNOX, Sony, Gunnebo, DuckDuckGoose, Fore, Metalmaker3d, and Volvo Cars—**most of them are global firms. These companies may be more open to communicating in English, even if they are branches of Italian firms, and there could be more opportunities available. It is also possible that there are other factors at play besides language.

9. Job Offers by Internship Company

Fig 15. PoD Job Offer Received from Internship Company



There is a significant amount of missing data regarding job offer responses. Therefore, the comparison shows the number of received job offers and no responses (no “N” or “No” as a response received). These findings may not reflect the actual situation and should not be considered definitive.

10. Pathways After Research Internships

Fig 16. PoD Students Pathways after Research Internship

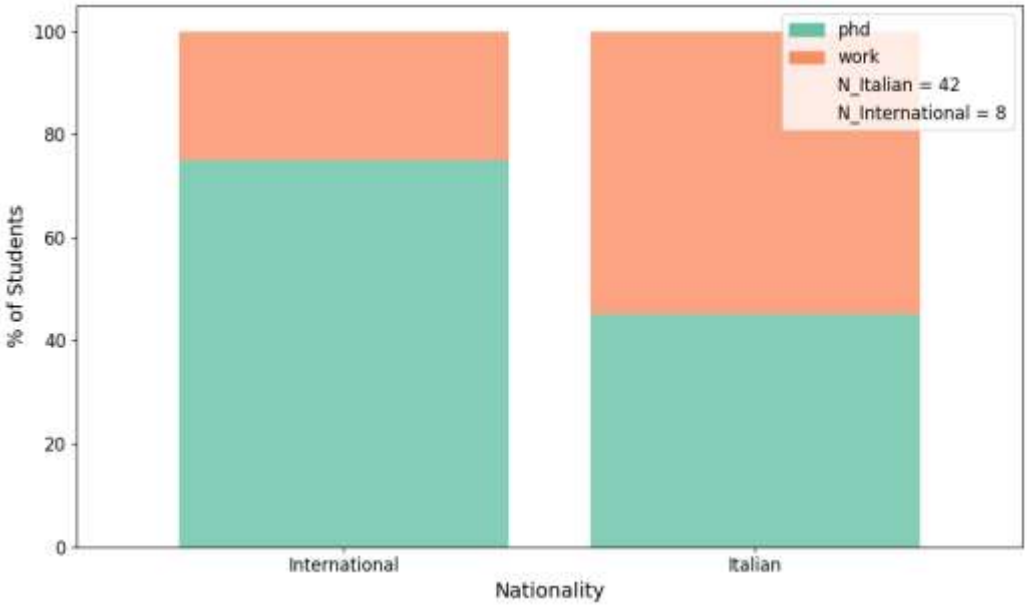
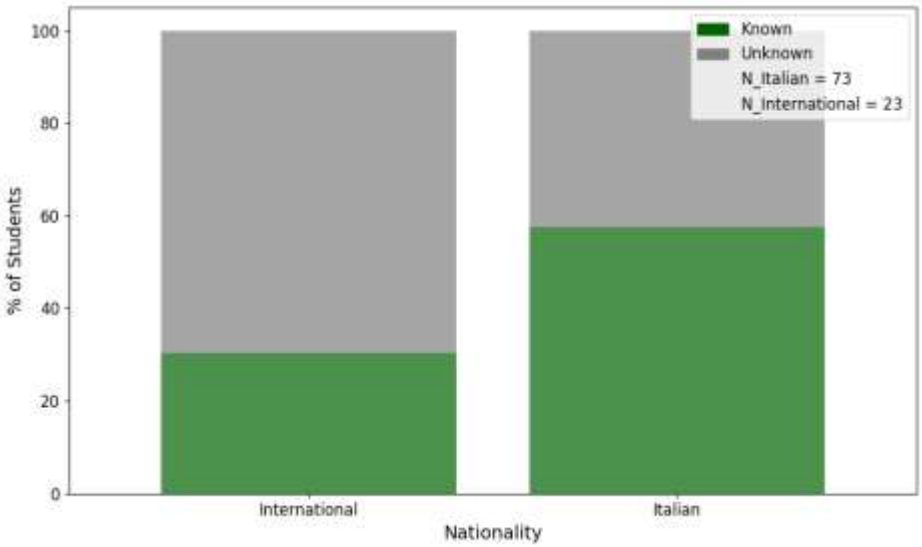


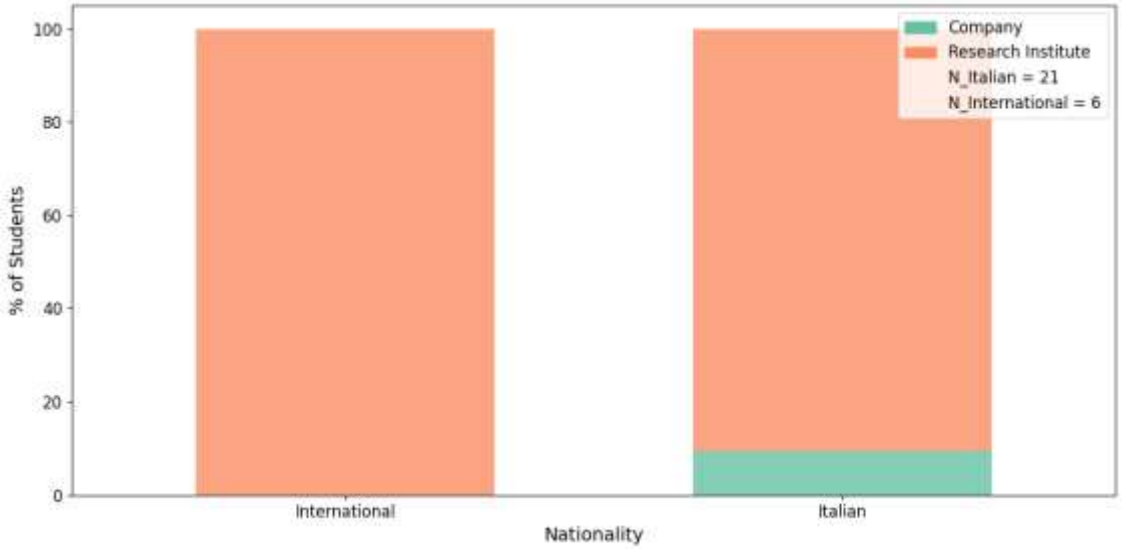
Fig 17. Availability of Data



In general, international students tend to pursue a PhD after a research internship, compared with Italian students, as seen in Fig. 16. However, as shown in Fig. 17, the complete data is limited. Therefore, the results in Fig. 16 might not fully represent the exact scenario.

11. Internship Background of PhD Students: Company vs Research Institute

Fig 18. Internship Background

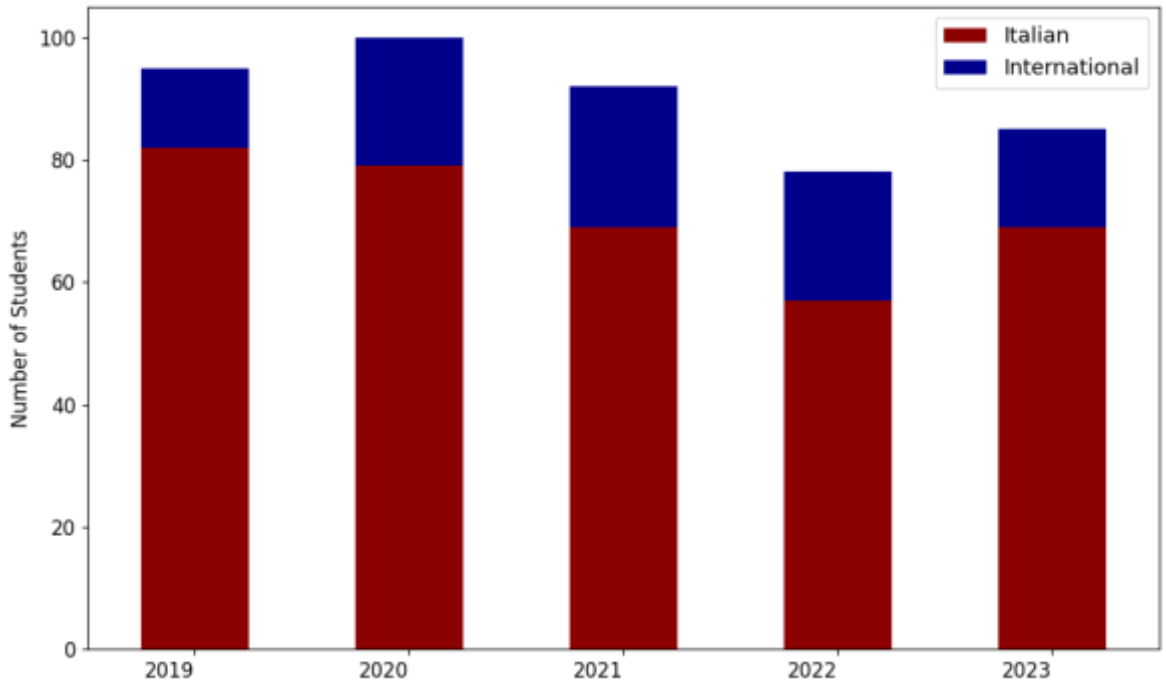


The overwhelming majority of students who continued their studies to PhD did internships in research institutes.

Data Analysis From Student Database (Physics)

The analysis includes only students from cohort 2019/2020 to 2023/2024 whose enrollment status falls under one of the following categories: “immatricolazione”, “conseguimento titolo”, “conseguimento titolo presso altro ateneo”, or “immatricolazione double degree”

Fig 19. Physics Student Distribution per Year.



Tab 4. Physics Student Distribution per Year Based on Nationality and Gender.

Cohort	Total Students	Italian Students	Inter. Students	Male Italian	Female Italian	Male Inter.	Female Inter.
2019	95	82	13	60	22	8	5
2020	100	79	21	63	16	15	6
2021	92	69	23	47	22	15	8

2022	78	57	21	41	16	17	4
2023	85	69	16	51	18	8	8

Based on the student demographics, the majority of respondents are male Italian students, while international students represent a relatively small portion of the overall group.

The International students of Physics come from many countries, which are:

Albania, Bangladesh, Brazil, Canada, China, Colombia, Ecuador, Egypt, Philippines, Georgia, Germany, Greece, Guatemala, Honduras, India, Iran, Ireland, Italy, Jordan, Mexico, Nigeria, Pakistan, Peru, Portugal, Russia, Serbia, Spain, Sudan, Syria, Turkey, Ukraine, United States of America, Venezuela.

Several countries consistently send students, as seen in the figure below. International physics students more often come from Iran.

Fig 20. Distribution of Physics International Students' Countries of Origin

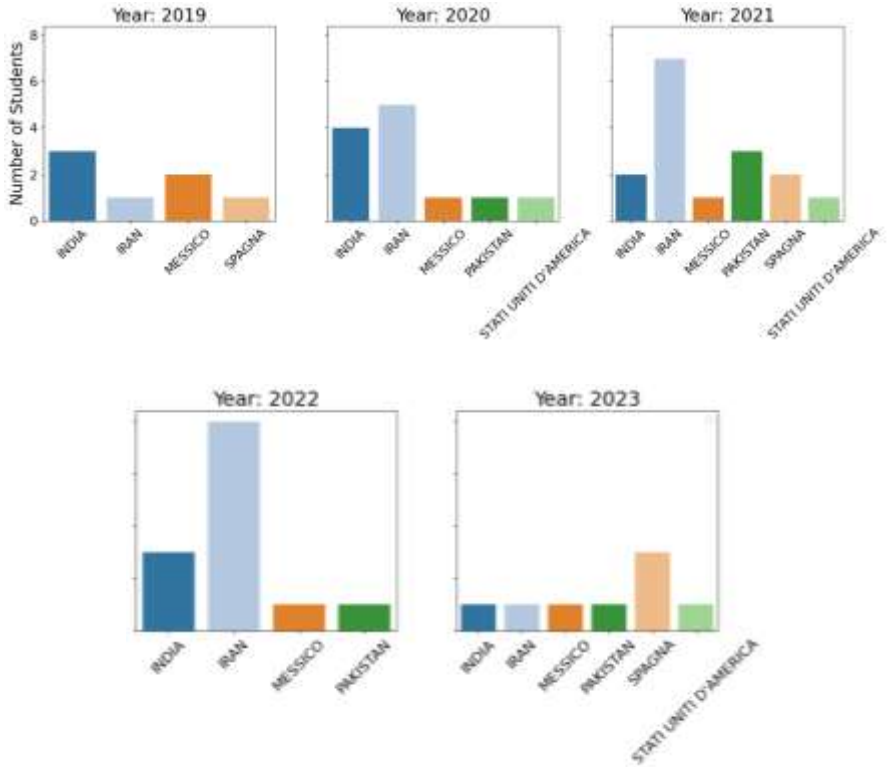
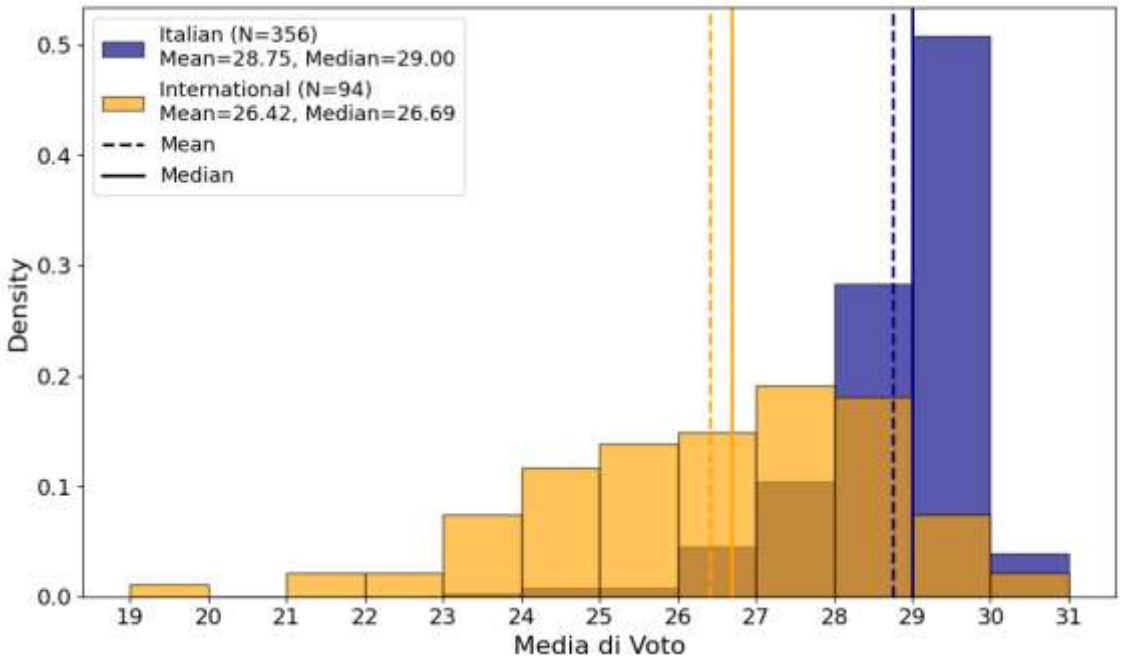


Fig 21. Grade Distribution Italian Vs. International Physics Students Aggregated Cohort 2019 - 2023



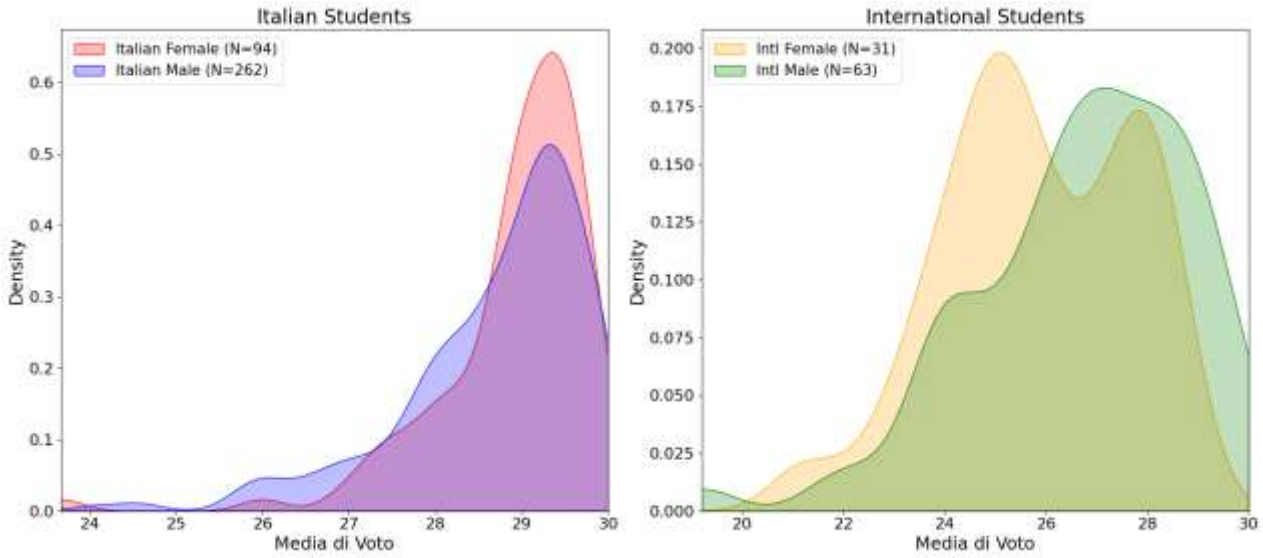
Tab 5. Grade Distribution Italian Vs. International Physics Students Over The Years & Statistical Tests

Cohort	Median Italian	Median Int.	Mean Italian	Mean Int.	Mann-Whitney Sig.	KS Test Sig.
2019 - 2023 Aggregated	29.0	26.69	28.75	26.42	****	****

Given the grade distribution and the statistics description above, there is a firm conclusion that international students have significantly lower grades than Italian students. Much like the one seen in the Physics of Data case. This agrees with the studies mentioned above regarding minority students performing worse than the majority students, which might be due to a lack of initial preparation, in this case, undergraduate education. However, there

may be additional challenges that international students face, which could contribute to their lower grades. We will examine these further in the questionnaire results.

Fig 22. Grade Distribution of Physics Students by Gender (Female vs. Male, Aggregated Grades)

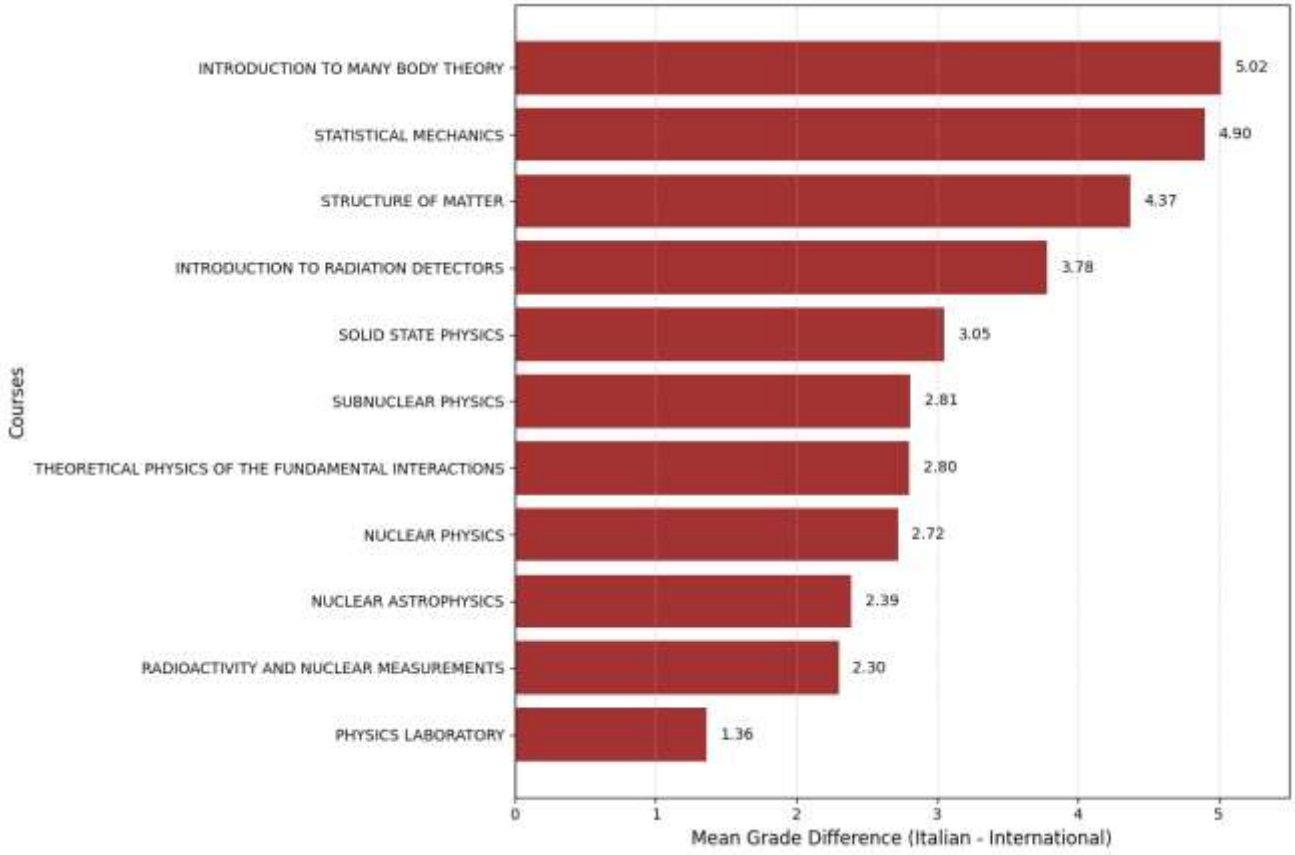


Tab 6. Statistics of Physics Students by Gender (Female vs. Male, Aggregated Grades)

Comparison	Median Female	Median Male	Mean Female	Mean Male	Mann-Whitney	KS Test
Italian (F vs M)	29.15	29.00	28.91	28.70	ns	ns
International (F vs M)	25.60	27.00	25.84	26.7	*	ns

Among Italian students, grade differences between females and males were almost non significant with slight variation which results in slight siginificance given by Mann-Whitney test on International students.

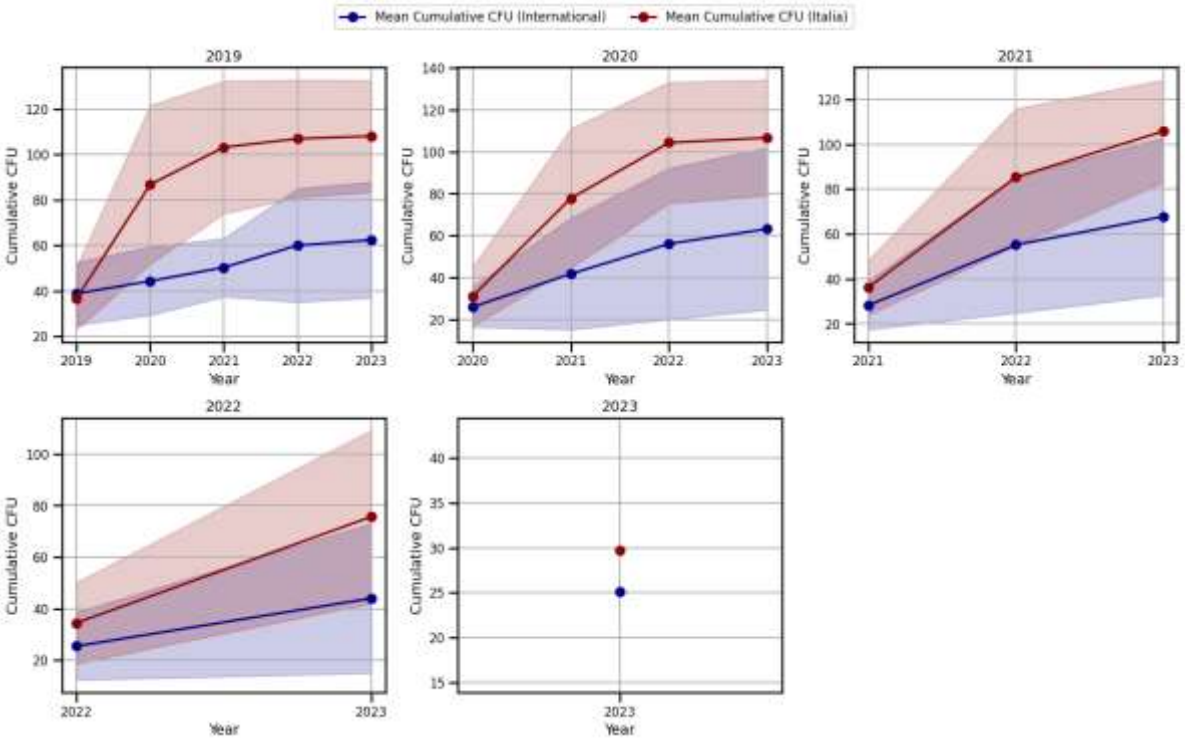
Fig 23. Statistically Significant Grade Disparities in Select Courses with at Least 15 Students Per Group (Physics)



The graph above was obtained by aggregating all the cohort data from 2019/2020 to 2023/2024 and considering only the courses taken by at least 15 Italian and 15 international students and where significant grade differences were observed. The threshold on the number of students is to provide a more reliable significance test and ensure that students consistently take the courses analyzed. The results show that Italian students consistently have significantly higher grades than international students on all of these courses. The full results of the statistics are available in the appendix.

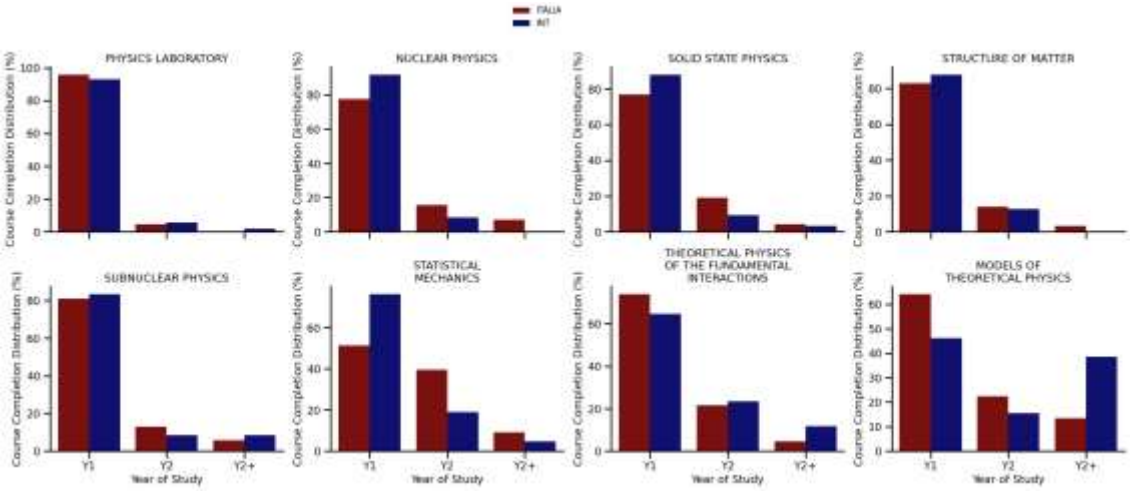
The course “Models of Theoretical Physics” is not included in the analysis, as it had a relatively low total enrollment across all cohorts from 2019/2020 to 2023/2024 with only 89 Italian and 13 international students.

Fig 24. Cumulative CFU Italian vs. International of Physics Students



Extending the analysis of student performance not only on the grade but also on their "speed" based on the CFU taken per year, figure above shows that Italian Students generally finished more exams than International Students. While both groups make steady academic progress, international students may face early and persistent barriers that delay their exam completion and credit accumulation.

Fig 25. Distribution of Elective Mandatory Course Completion Across Years of Study in the Physics Program

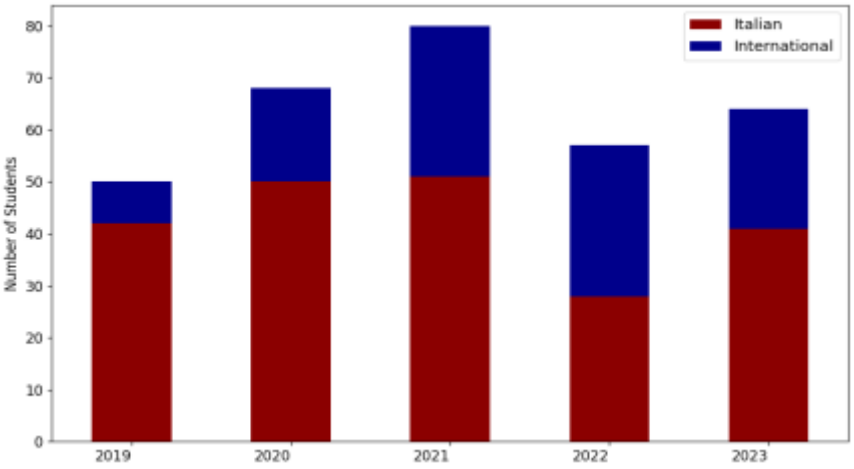


This figure above focuses specifically on mandatory first-year courses that were not universally completed within the first year. The results show that more theoretical physics courses tend to be completed later in students' careers. A notable course is “Models of Theoretical Physics”, where a substantial proportion of international students complete it during their second year or later.

Data Analysis From Student Database (Astrophysics & Cosmology)

The analysis includes only students from cohort 2019/2020 to 2023/2024 whose enrollment status falls under one of the following categories: “immatricolazione”, and “conseguimento titolo”.

Fig 26. Astrophysics Student Distribution per Year.



Tab 7. Astrophysics Student Distribution per Year Based on Nationality and Gender.

Cohort	Total Students	Italian Students	Inter. Students	Male Italian	Female Italian	Male Inter.	Female Inter.
2019	50	42	8	27	15	6	2
2020	68	50	18	34	16	12	6
2021	80	51	29	24	27	15	14

2022	57	28	29	14	14	18	11
2023	64	41	23	29	12	12	11

Based on the student demographics, the majority of respondents are male Italian students, while international students represent a small portion of the overall group.

The International students of Atro&Cosmo come from many countries: **Filippine, Bolivia, India, Russia, Brasile, Stati Uniti d'America, Egitto, Nepal, Kosovo, Algeria, Grecia, Iran, Sri Lanka (Ceylon), Iraq, Canada, Germania, Colombia, Turchia, Irlanda, Kazakistan, Polonia, Francia, Libano, Spagna, Croazia, Portogallo, Paesi Bassi, Thailandia, Messico, Panama, Georgia, Serbia, Ecuador, Oman, Australia, Macedonia, Bangladesh, Malta, Belgio, Bosnia-Erzegovina.**

Several countries consistently send students, as seen in the figure below. International physics students more often come from India.

Fig 27. Distribution of Astrophysics International Students' Countries of Origin

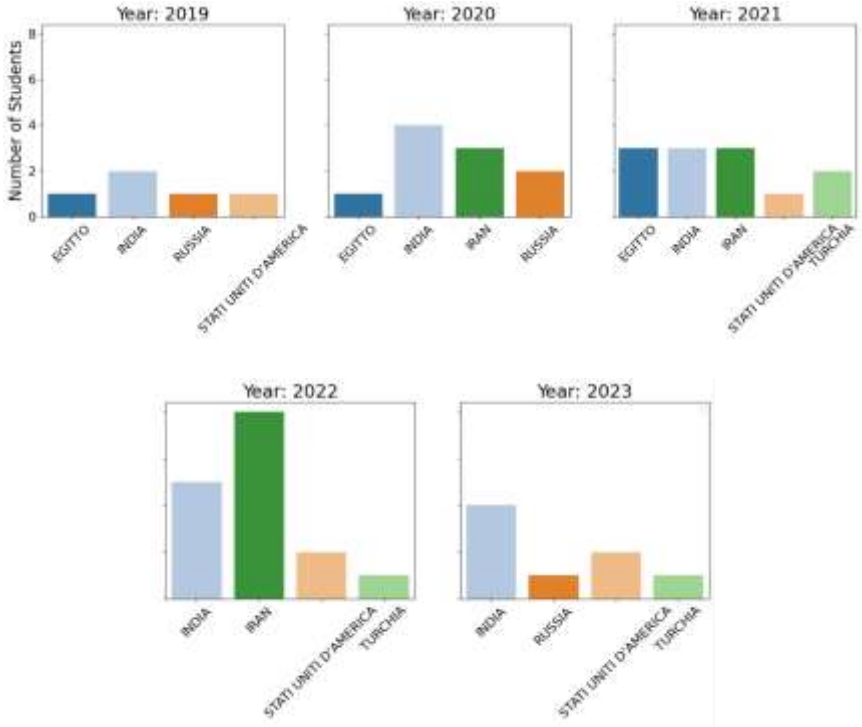
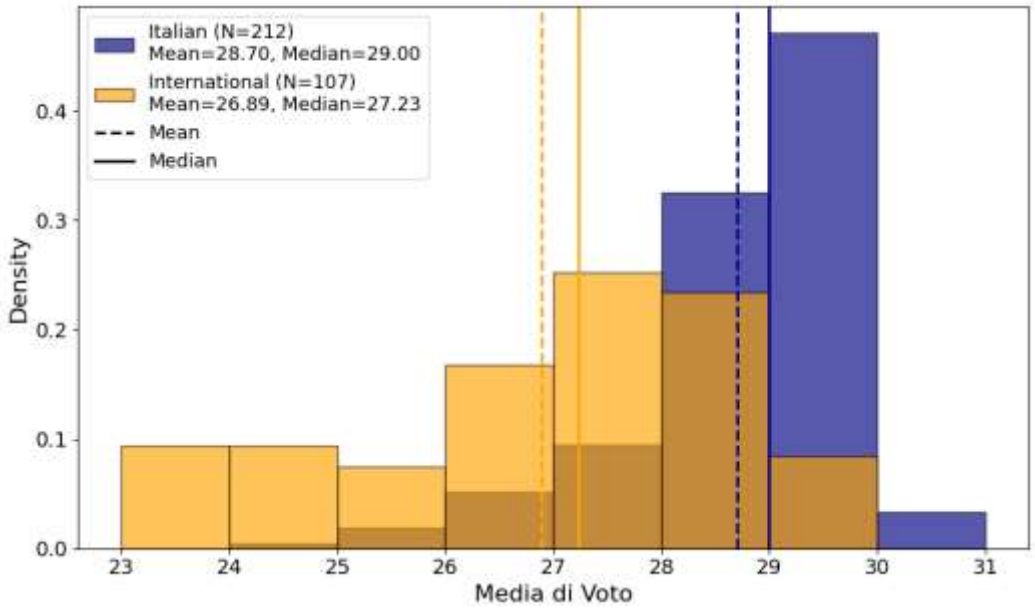


Fig 28. Grade Distribution Italian Vs. International Astrophysics Students Aggregated Cohort 2019 - 2023

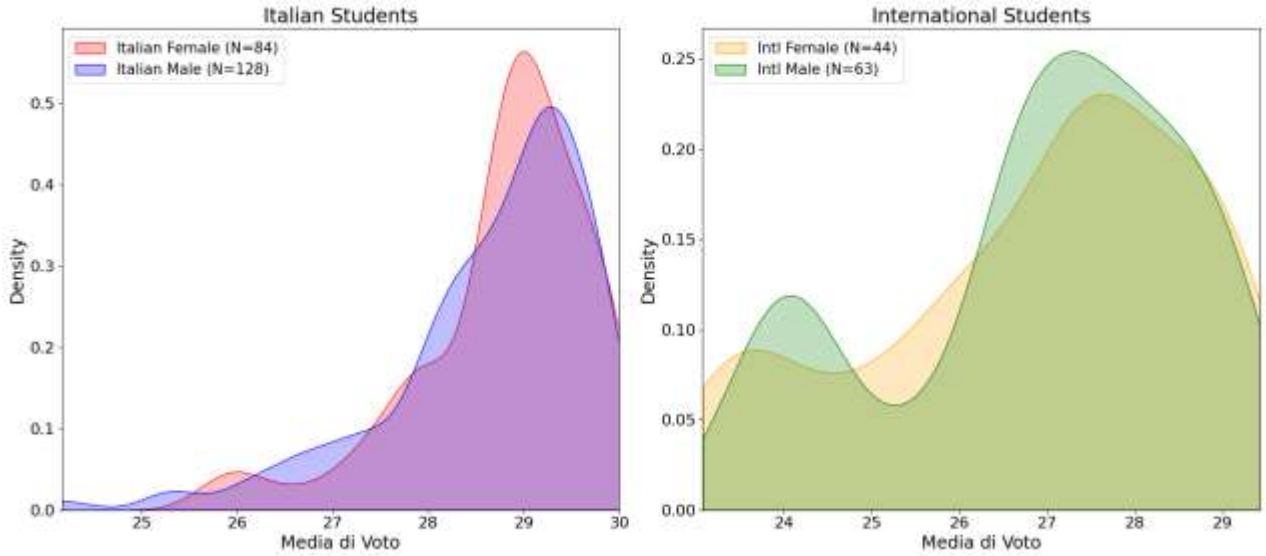


Tab 8. Grade Distribution Italian Vs. International Astrophysics Students Over The Years & Statistical Tests

Cohort	Median Italian	Median Int.	Mean Italian	Mean Int.	Mann-Whitney Sig.	KS Test Sig.
2019 - 2023 Aggregated	29.0	27.23	28.7	26.89	****	****

Given the grade distribution and the statistics description above, there is a firm conclusion that international students have significantly lower grades than Italian students. Much like the one seen in the Physics of Data case. This agrees with the multiple studies mentioned above regarding minority students performing worse than the majority students, which might be due to a lack of initial preparation, in this case, undergraduate education.

Fig 29. Grade Distribution of Astrohysics Students by Gender (Female vs. Male, Aggregated Grades)

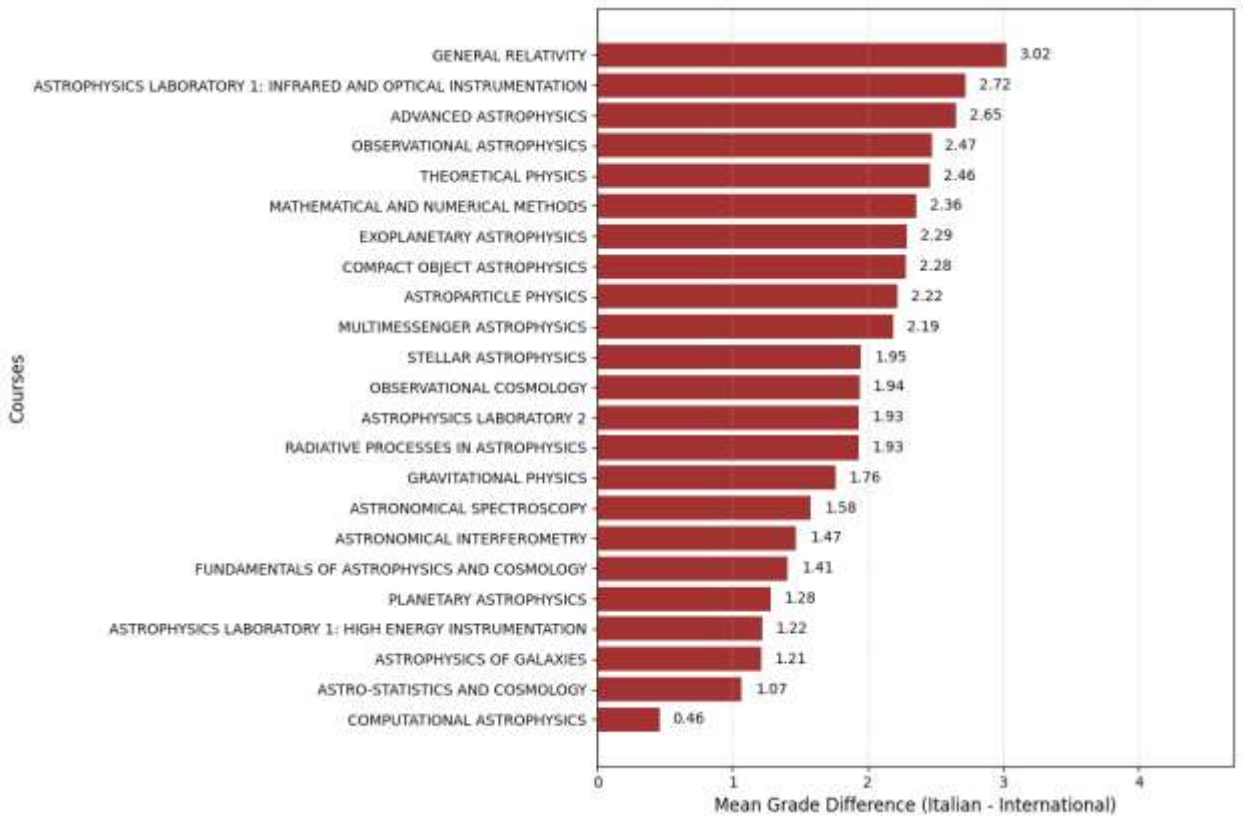


Tab 6. Statistics of Physics Students by Gender (Female vs. Male, Aggregated Grades)

Comparison	Median Female	Median Male	Mean Female	Mean Male	Mann-Whitney	KS Test
Italian (F vs M)	29.00	28.95	28.78	28.65	ns	ns
International (F vs M)	27.23	27.25	26.86	26.92	ns	ns

For both Italian and international student groups, there were no significant differences in grades between female and male students, suggesting a generally gender-fair academic environment.

Fig 30. Statistically Significant Grade Disparities in Select Courses with at Least 15 Students Per Group (Astrophysics)



The graph above was obtained by aggregating all the cohort data from 2019 to 2023 and considering only the courses taken by at least 15 Italian and 15 international students. The threshold on the number of students is to provide a more reliable significance test and ensure that students consistently take the courses analyzed. The results show that Italian students consistently have significantly higher grades than international students on all of these courses. Additionally, this result also supported by Cohen's d values that are generally above 0.6, indicating a substantial gap between the two groups. The full results of the statistics are available in the appendix.

Fig 31. Cumulative CFU Italian vs. International of Astrophysics Students Over The Years

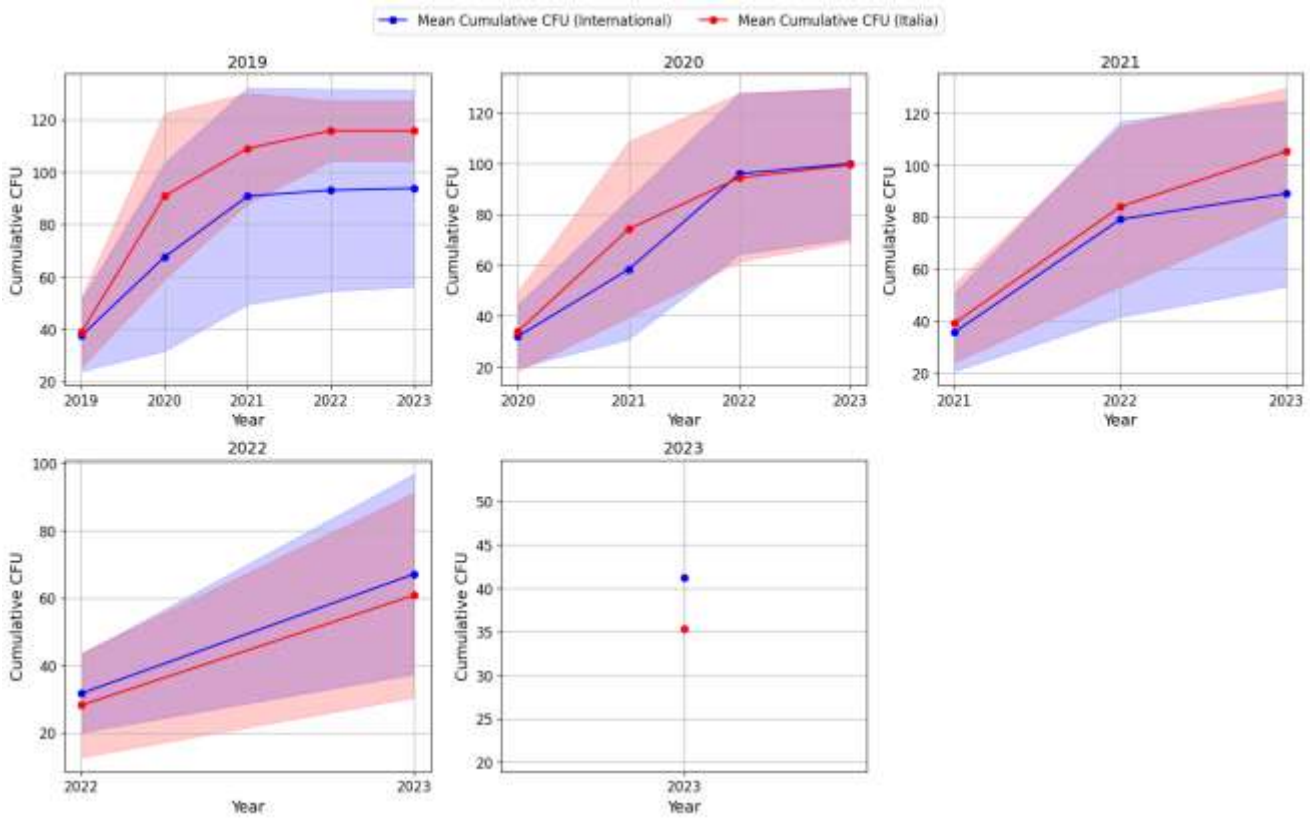
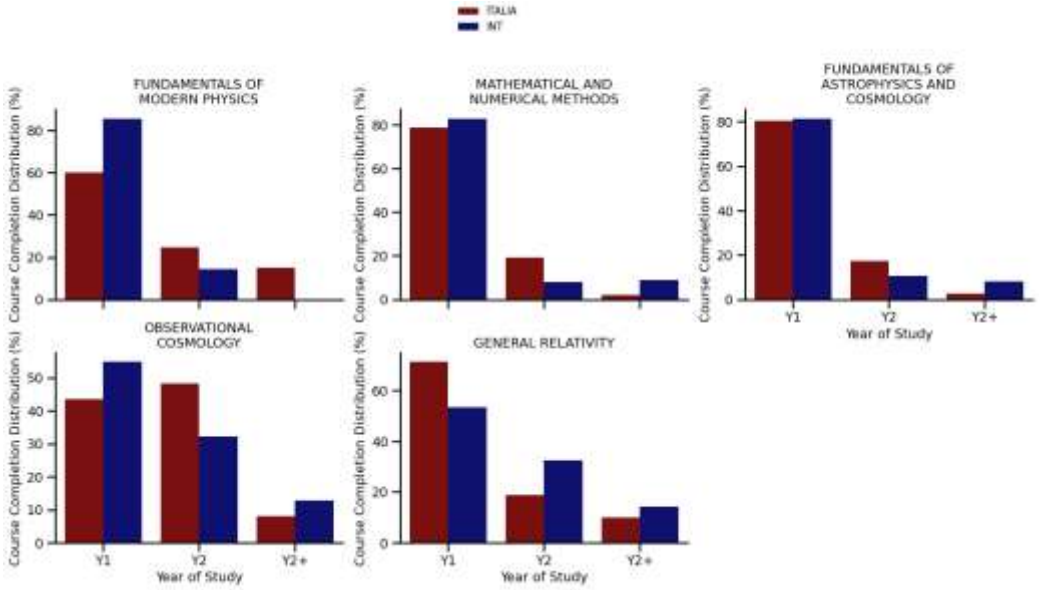


Fig 32. Distribution of Mandatory Course Completion Across Years of Study in the Astrophysics Program



This figure above focuses specifically on mandatory first-year courses that were not universally completed within the first year. The results show that generally most international students finish quite early on or the same as Italian students except on “Observational Cosmology“.

General Overview of the Student and Alumni Questionnaire Responses

This section presents the findings from both current student and alumni responses to the questionnaire. Given the limited number of responses, data from active students and alumni from all the programs in DFA have been combined where appropriate to allow for a more meaningful analysis. The internal consistency of the psychometric constructs was assessed using Cronbach's alpha. Additionally, to assess differences between groups, statistical tests such as the Chi-square test (for multiple-choice responses) and the Mann–Whitney U test (for scaled, sentence-based items) were applied to evaluate the significance and reliability of the observed patterns.

While international and Italian students shared many similar experiences in the MSc program, key differences emerged. International students showed stronger career-oriented motivations, placed more value on practical experience, and reported more challenges—especially related to bureaucracy, adaptation, and networking. They also expressed a greater need for support and scored higher in growth mindset and English communication skills. In contrast, Italian students more often reported logistical or financial difficulties but were also more likely to report no major challenges, although they do ask for some support in academic and career guidance.

Both groups shared neutral to positive levels of growth mindset, self-efficacy, social interactions (both among students and with teachers), physics identity, and programme affordance. However, there was a lack of natural collaboration between Italian and international students, which could hinder overall integration. In terms of professional identity, international PoD students slightly leaned more toward data science, while Italian PoD students slightly identified more as physicists.

1. **General Student Background**

Tab 7. Distribution of Survey Respondents by Program and Status

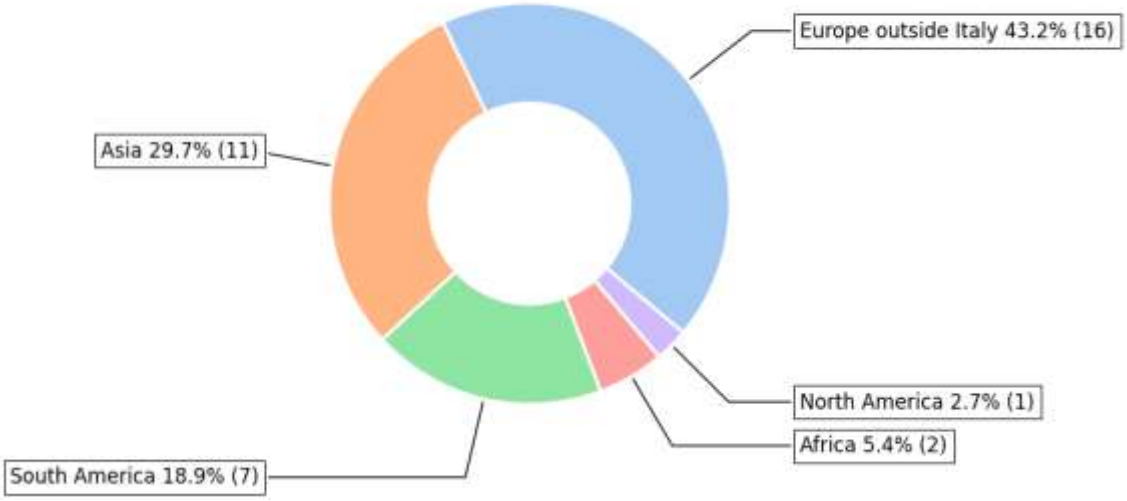
Program	Status	Italian Students Count	International Students Count	Total Students Count
Astrophysics and Cosmology	student	27	8	35
Physics	student	25	5	30
Physics of Data	student	47	13	60
Physics of Data	alumni	42	11	53

The number of responses is relatively low, particularly among active students in Astrophysics and Physics. For PoD alumni, 53 responses out of 78 registered email addresses is a decent response rate. However, as of 15th October 2024, there are a total of 140 PoD alumni, with 109 Italians and 31 internationals.

Tab 8. Distribution of Survey Respondents' Gender

Gender	Count
Man	120
Non-binary/non-conforming	3
Prefer not to respond	3
Woman	52

Fig 33. International Student's Bachelor Origin



Tab 9. Total Number of Students (Active and Alumni) and Percent of Students With Credit Requirements

Student Category	Total Number of Students	With Credit Requirements
International	**37**	**24 (65.71%)**
Italian	**141**	**16 (11.43%)**

International students are generally more likely to have credit requirements. This might be due to them relying on scholarships to fund their studies.

2. Career Motivation and Expectations

Fig 34. Median Importance Ratings for Factors Influencing Enrollment Decisions. In red we highlight the ones significant differences[1] between Italian and international students

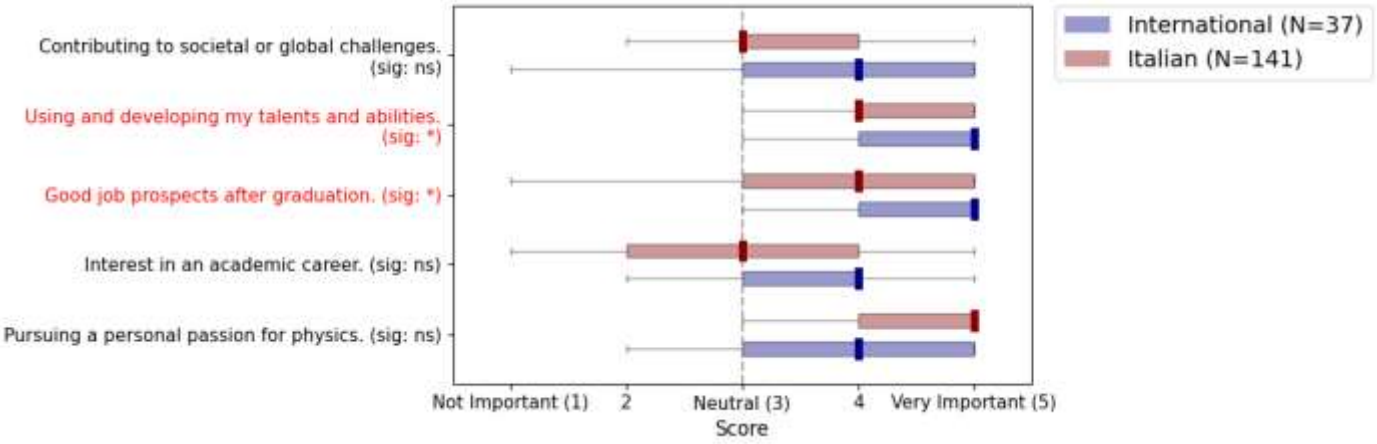
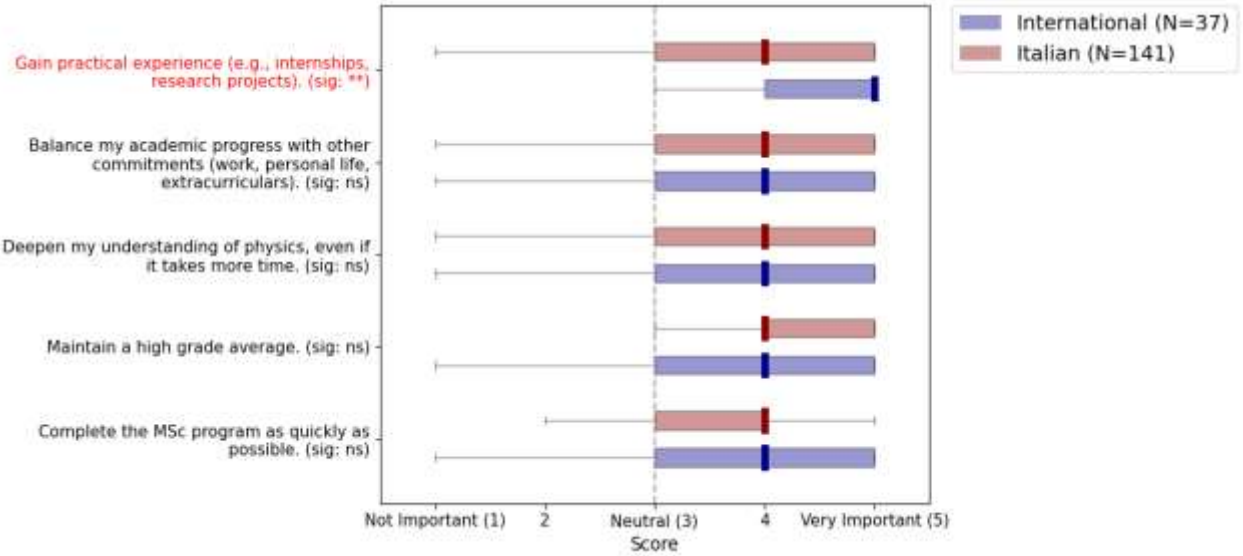


Fig 35. Median Importance Ratings for Academic Priorities and Goals

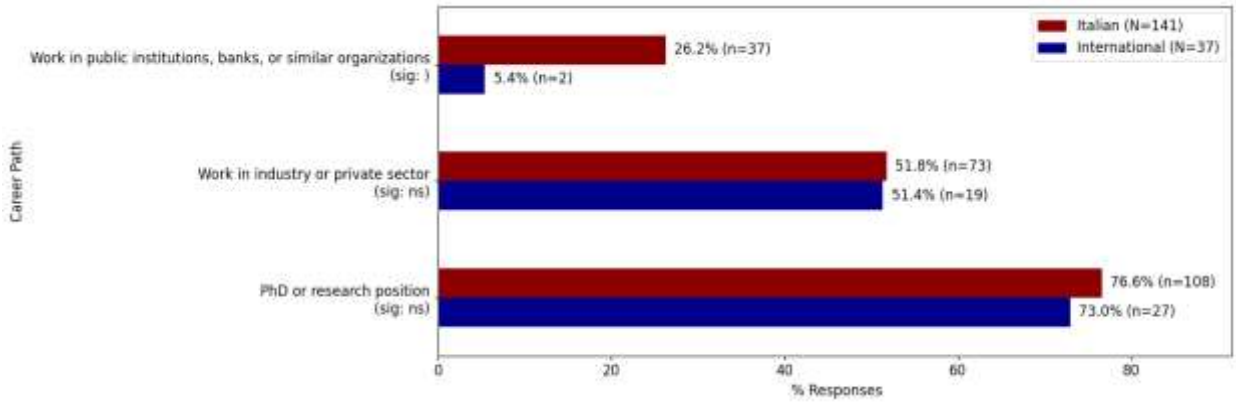


The figures above show that International students placed significantly more importance on developing their talents, and securing good job prospects, suggesting a stronger career-oriented motivation compared to Italian students. They also valued gaining practical experience more highly during the MSc program. In contrast, Italian students

[1] We use Mann-Whitney U statistical test

shared similar views with internationals on passion for physics, interest in academic careers, and maintaining a balanced academic progress (grade and speed).

Fig 36. Students' Career Paths After Graduation - Top 3 (Multiple Choices Allowed).



The figure above suggests that both groups share similar preferences, with pursuing a PhD or a research position being the most favored path rather than careers in industry or public institutions.

3. Student Outcome (Alumni Responses)

Fig 37. Job Offer From Internship Company/Institution

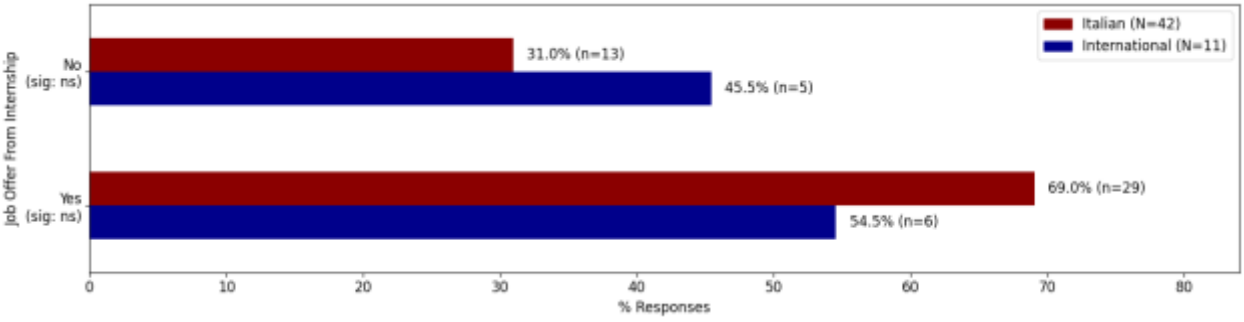


Fig 38. Time Taken To Secure a Job After Graduation

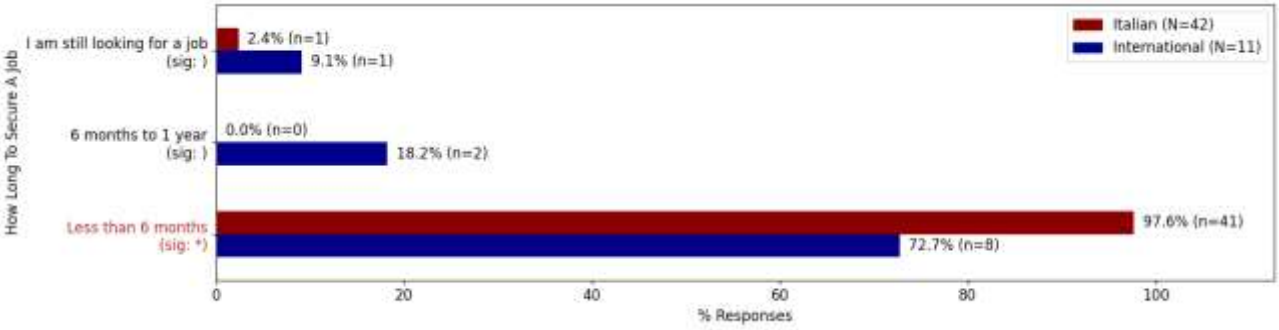
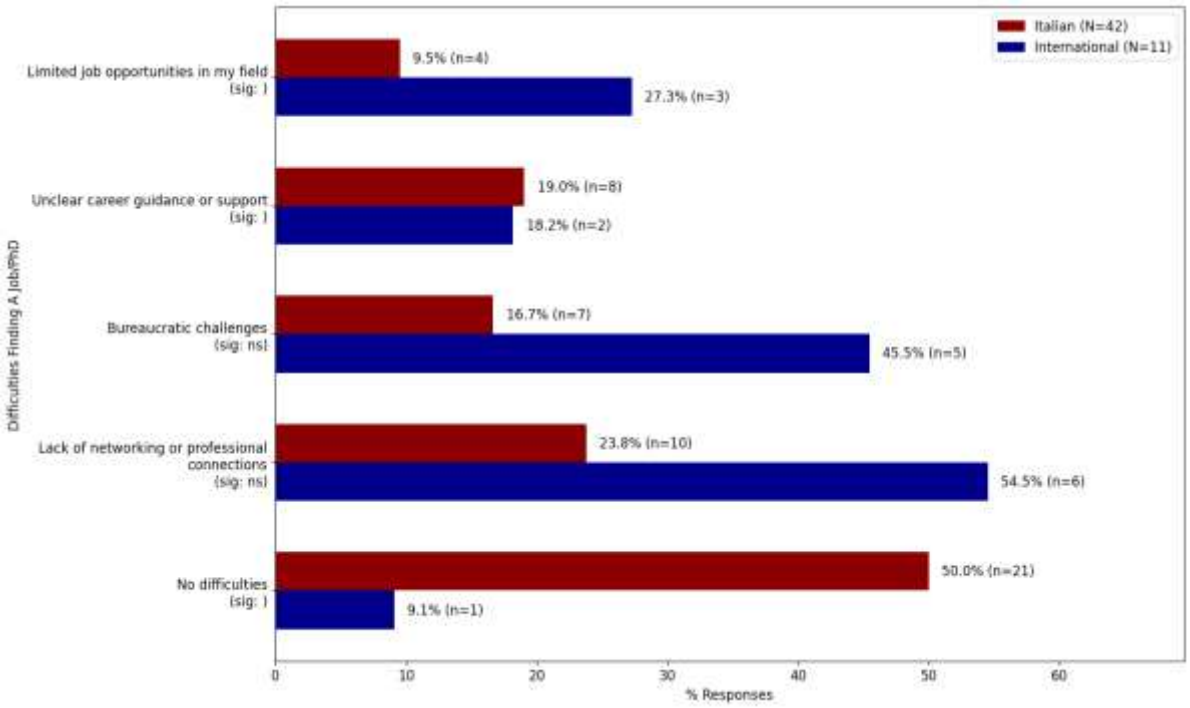


Fig 39. Top 5 Difficulties in Landing a Job/PhD (Multiple Choices Allowed)



The figures indicate that a majority of both international and Italian students received job offers from their internship institutions, with slightly higher rates among Italians. Most respondents from both groups secured a job within six months after graduation, although a small portion of international students needed more time or were still job-seeking. When it comes to challenges, international students reported more difficulties overall. For instance, a higher proportion of Italian students reported no difficulties, whereas international students more frequently cited issues such as a lack of networking or professional connections and bureaucratic challenges It should be noted that the number of responses from international students was small, which may affect the reliability of comparisons.

4. Academic and Personal Resources

Fig 40. Median Student Ratings on Perceived Personal Resources

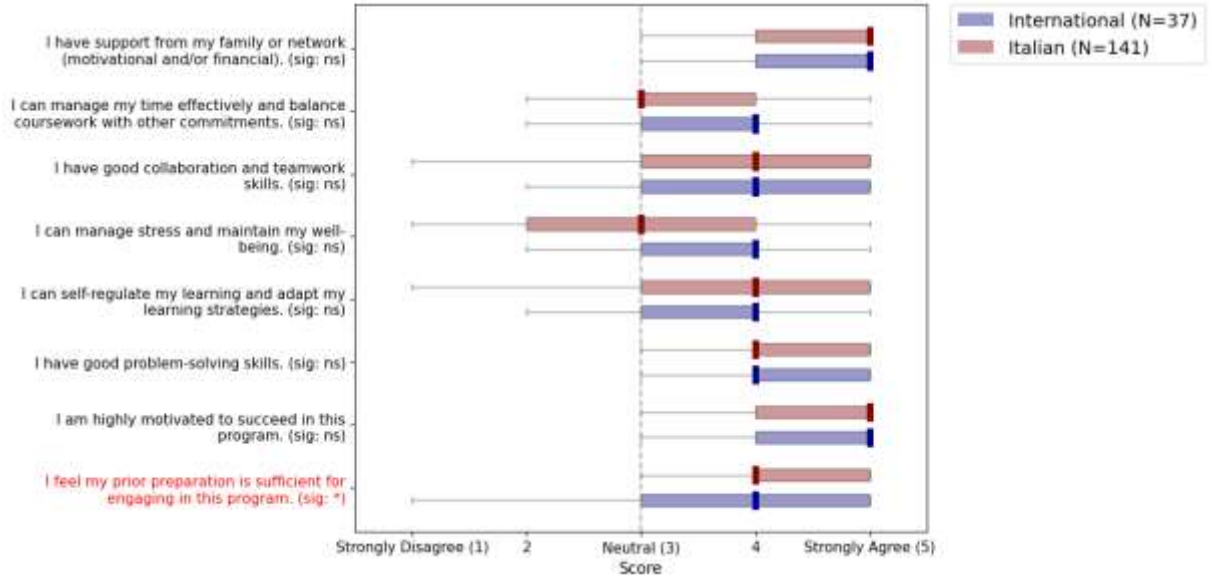
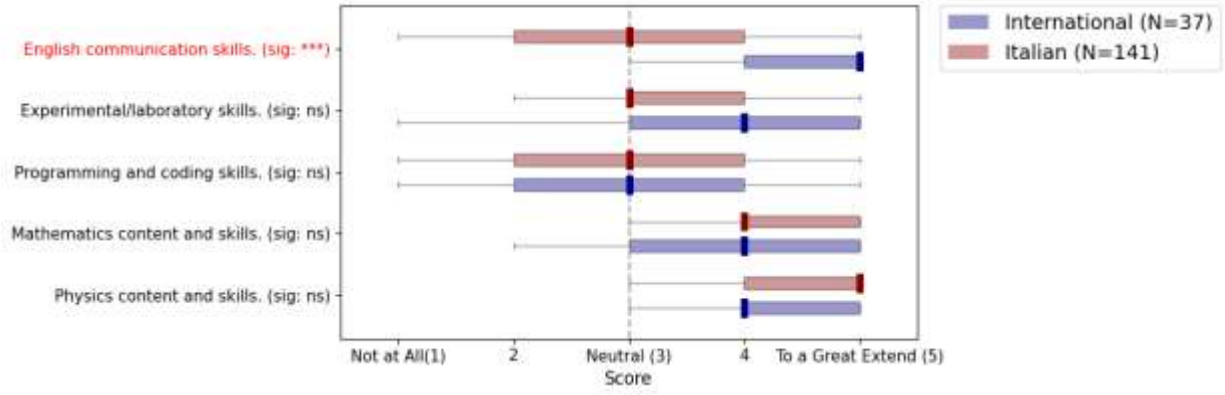


Fig 41. Median Student Ratings on Prior Preparation



From the figures above, both international and Italian students rated themselves similarly across most perceived personal resources, including motivation, problem-solving, collaboration, and time management, with no significant differences observed. However, a significant difference emerged when asked about prior preparations (Fig. 40). While the median ratings for both groups were similar, international students displayed longer tails towards having not enough sufficient preparation. Interestingly, when explored further (Fig. 41), international students rated their English communication skills significantly higher than Italian students. For other areas such as programming, mathematics, physics, and laboratory skills, both groups felt more well prepared, although programming was generally rated lower than mathematics and physics, with no significant difference between the groups.

5. Student Challenges and Needs

Fig 42. Top 6 Challenges Faced by Students (Multiple Choices Allowed). In red we highlight the ones significant differences[2] between italian and international students

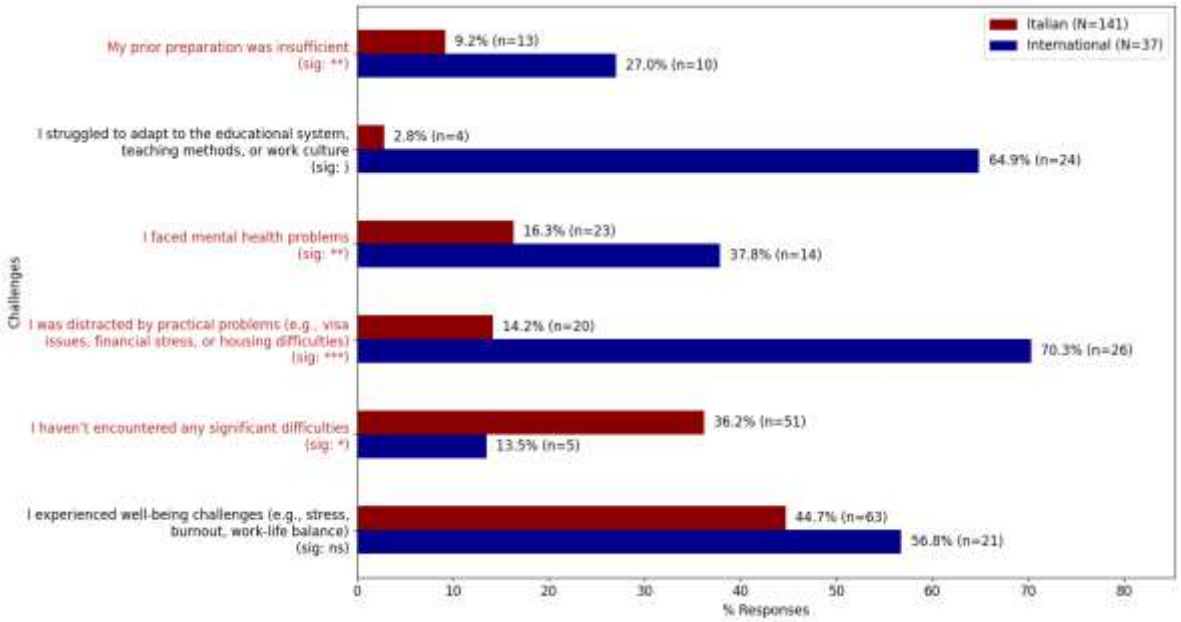
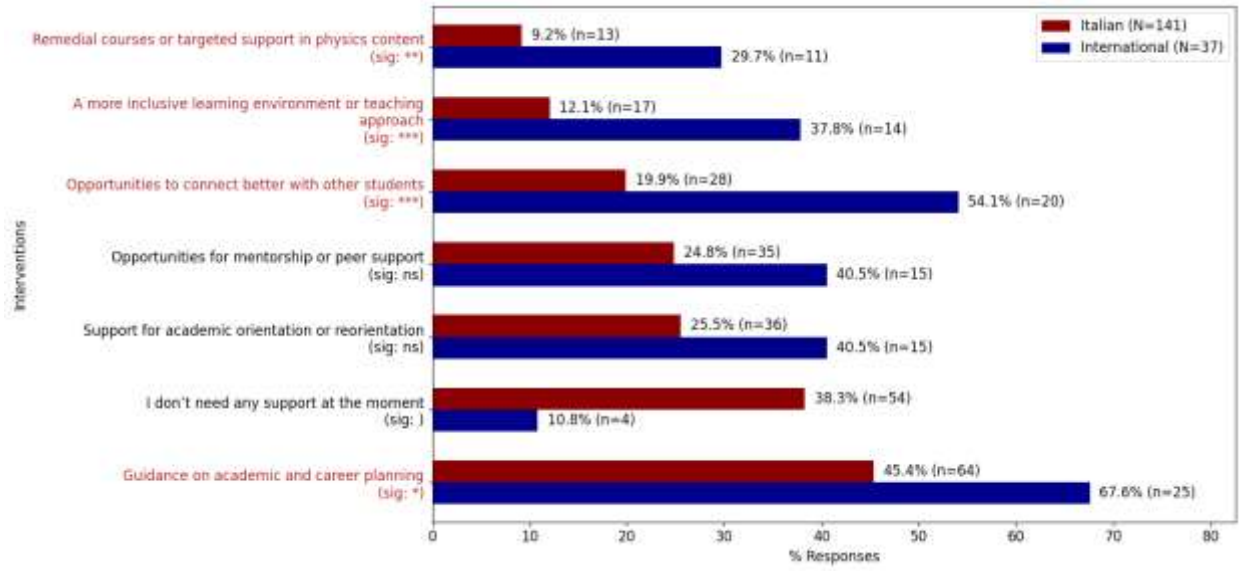


Fig 43. Preferred Interventions According to The Students (Multiple Choices Allowed)



The figures above show that international students faced more challenges than Italians, particularly in adapting to the educational system, handling practical issues (e.g., visa, housing), mental health problems and feeling underprepared. While many Italian students

[2] We use Chi-Square statistical test

reported no major difficulties. International students also expressed a stronger need for support, especially in creating a more inclusive learning environment, building connections with peers and physics support. In contrast, Italians were more likely to feel no support was needed compared to International students. Despite these differences, both groups valued mentorship, career guidance, and academic orientation similarly. Additional open responses revealed nuanced differences in the challenges faced by Italian and international students. Italian students mainly reported issues related to course load, unclear workload expectations, and lack of academic guidance. In contrast, international students highlighted challenges in adapting to the exam format, navigating the unfamiliar academic system, and experiencing limited social and institutional support. Across several open-ended questions, students consistently emphasized the importance of hard work, effective study strategies, and being part of a supportive community, such as studying with friends or collaborating in teams, as key factors in their academic journey. While both Italian and international students shared these themes, international students more often highlighted challenges related to adapting to the academic system, managing bureaucracy, and navigating oral exams, whereas Italian students tended to focus more on course structure and workload. A smaller group of students from both backgrounds mentioned feeling overwhelmed by the study and exam load. Despite these challenges, many students also expressed positive feelings about the program materials and support from colleagues and professors. The complete plot and data of all the responses are included in the appendix.

6. Equity Issues

Fig 44. Equity Issues Faced by Students Part 1 (Multiple Choices Allowed)

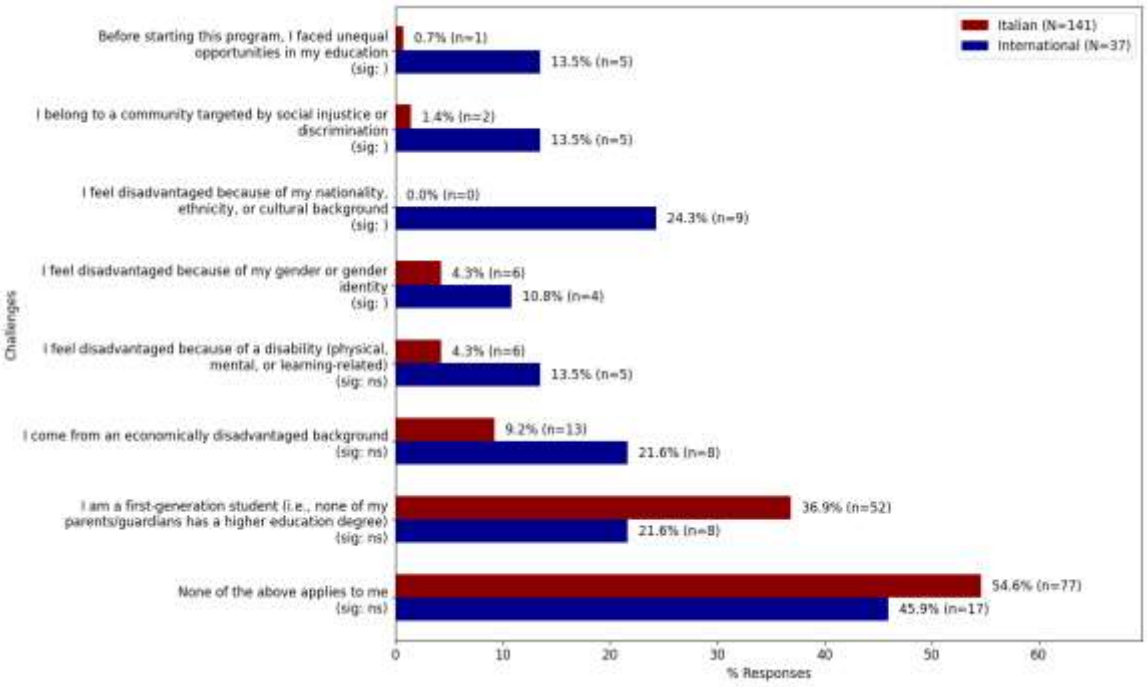
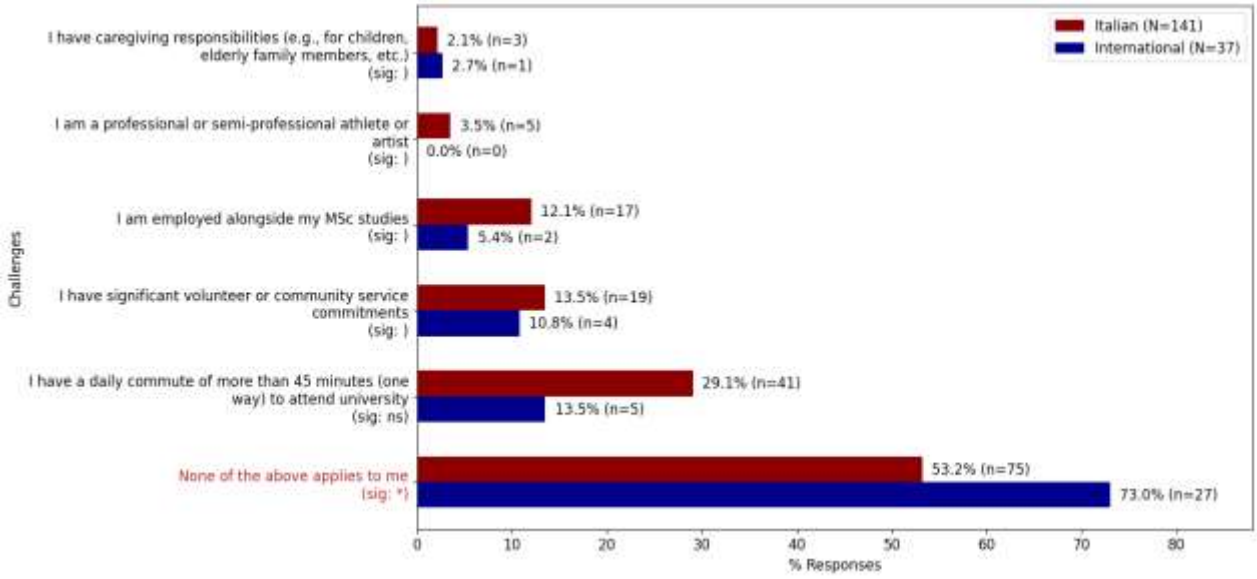


Fig 45. Equity Issues Faced by Students Part 2 (Multiple Choices Allowed)



The figures above highlight various equity-related challenges faced by students. International students were more likely to report feeling disadvantaged due to nationality, ethnicity, or cultural background, while Italian students more often cited issues related to unequal educational opportunities and economic hardship. However, these differences were not statistically significant. It is worth noting that some of these results may be influenced by the fact that one group reported a certain challenge while the other did not, which could limit the ability to detect significant differences. Additionally, Italians were more likely to report having additional responsibilities outside the classroom and long commutes to campus, though again, no significant differences were observed. Overall, while many students did not report specific equity challenges, international students appeared more exposed to structural and cultural disadvantages, while Italians primarily faced logistical constraints.

Tab. 10. Summary Regarding The Problems and Solutions

Main Challenges	Reported By	Suggested Interventions
Adapting to the academic system and work culture	Primarily international students	Orientation sessions, mentoring, bridge courses, clearer guidance
Lack of social integration / peer connection	Primarily international students	More social activities, peer support, randomized group work, welcome events
Unclear academic guidance (thesis, PhD, course expectations)	Both groups, especially internationals	Mentorship, guidance on thesis/PhD, accessible TAs, professor support, earlier meeting/seminar explaining thesis
Workload and unrealistic CFU expectations	Primarily Italian students	Better CFU alignment, simplify exams, workload adjustments
Limited research and internship opportunities	Both groups	Earlier info on research/internships
Mental health issues / emotional stress	Both groups	Spaces to discuss struggles, professor awareness, better planning
Feeling underprepared/insufficient prior knowledge	Primarily international students	Remedial support, bridge courses, mentoring, accessible TAs

General Results on Psychometric

Tab 11. Student Ratings on Several Psychometric Factors (Scale: 1 = Bad, 5 = Good)

Factor	Group	N	Mean	Median	SD	Cronbach Alpha	Mann Whitney U P-val Sign.	Effect Size
Student-Student Interactions	International	37	3.36	3.33	1.11	0.89	ns	0.134
	Italian	141	3.75	3.89	0.79			
Student-Teacher Interactions	International	37	3.73	3.86	0.84	0.81	ns	0.042
	Italian	141	3.85	3.86	0.68			
Programme Affordance	International	37	3.68	3.67	0.81	0.73	ns	0.027
	Italian	141	3.63	3.5	0.67			
Sense of Belonging	International	37	3.61	3.75	1.05	0.81	ns	0.053
	Italian	141	3.77	4.00	0.88			

General Academic and Self-Efficacy	International	37	3.28	3.33	0.81	0.82	ns	0.105
	Italian	141	3.5	3.44	0.71			
Physics Self-Efficacy	International	37	3.63	3.67	0.87	0.91	ns	0.020
	Italian	141	3.67	3.78	0.77			
Study Growth Mindset (Viewing One-Self)	**International**	**37**	**4.38**	**4.50**	**0.72**	**0.85**	*	**0.193**
	Italian	**141**	**4.08**	**4.17**	**0.74**			
Study Growth Mindset (Viewing Others)	**International**	**37**	**3.94**	**4.00**	**0.68**	**0.74**	**	**0.204**
	Italian	**141**	**3.58**	**3.67**	**0.69**			
Physics Identity	International	37	3.97	3.9	0.61	0.86	ns	0.027
	Italian	141	3.90	3.9	0.66			

The high internal consistency (Cronbach's alpha ranging from 0.73 to 0.91) across all constructs confirms that the scales used are reliable. Reverse-worded items were reversed back so that higher values consistently reflected more positive outcomes. From these psychometric results, overall, Italian and International students reported similar perceptions and experiences across most psychometric constructs related to their academic and social life in the program. While no significant differences were observed in areas like student interactions, self-efficacy, or belonging, notable differences emerged in growth mindset. To be specific, International students scored significantly higher in both study growth mindset (viewing oneself) and study growth mindset (viewing others), suggesting they may hold stronger beliefs in the ability to improve in physics through effort. These differences were statistically significant and supported by small-to-moderate effect sizes (0.18–0.20). While the differences in mindset are meaningful, other areas of the academic experience appear to be largely shared across both groups, indicating an overall neutral to slightly positive experience.

Tab 12. Student Ratings of Motivation, Confidence, and Engagement Following Initial Academic Experiences (Scale: 1 = Good, 7 = Poor)

Factor	Group	N	Mean	Median	SD	Wilcox P-val Sign.	Effect Size
Motivation, Confidence, Engagement after First Homework, Exam, Semester	Intern.	37	3.47	3.00	1.88	ns	0.125
	Italian	141	2.92	2.67	1.65		

Tab 13. Student Ratings on Professional Identity Only For PoD Students (Scale: 1 = Physicst, 7 = Data Scientist)

Factor	Group	N	Mean	Median	SD	Wilcox P-val Sign.	Effect Size
I see myself more as…	Intern.	24	4.54	5.00	1.41	*	0.227
	Italian	89	3.64	4.00	1.65		

In general, both groups of students reported neutral levels of motivation, confidence, and engagement, with international students scoring slightly lower on average. However, this difference was not statistically significant. Meanwhile, a significant difference was observed in professional identity, where international students tended to identify more strongly as data scientists, whereas Italian students leaned more toward identifying as physicists. Overall, student responses suggest a midpoint perspective in professional identity, indicating that many still see themselves as balancing both roles.

Detailed Results on Psychometric

7. Motivation, Confidence, and Engagement After First Homework/Exam/Semester

Fig 46. Motivation After First Homework/Exam/Semester

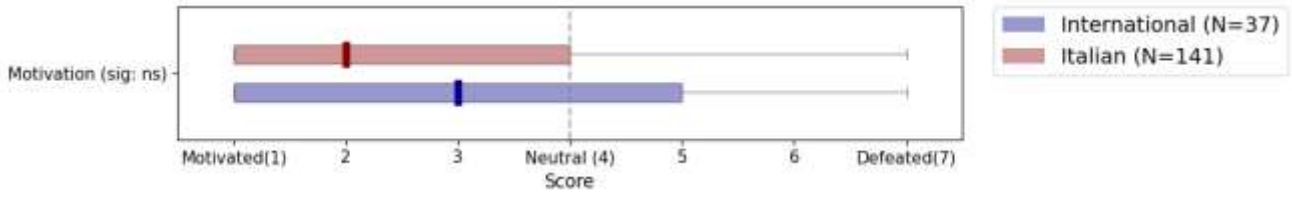


Fig 47. Confidence After First Homework/Exam/Semester

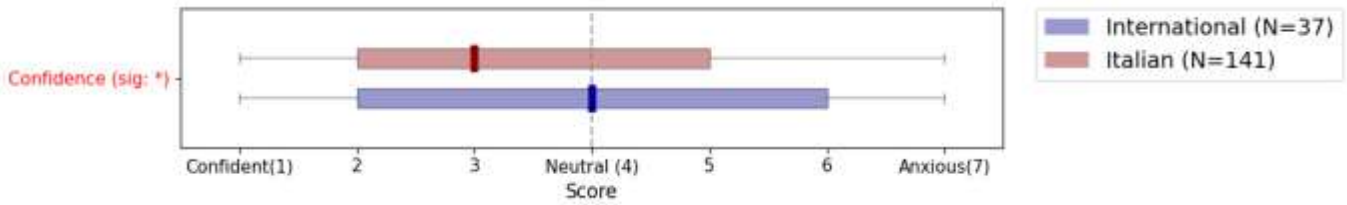
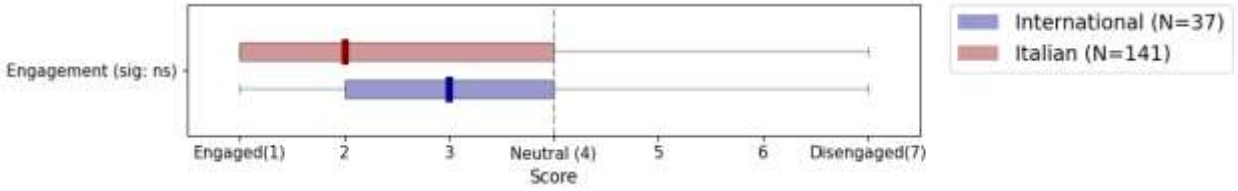


Fig 48. Engagement After First Homework/Exam/Semester



8. Interaction and Connectedness

Fig 49. Median Student Ratings on Student-Student Interactions

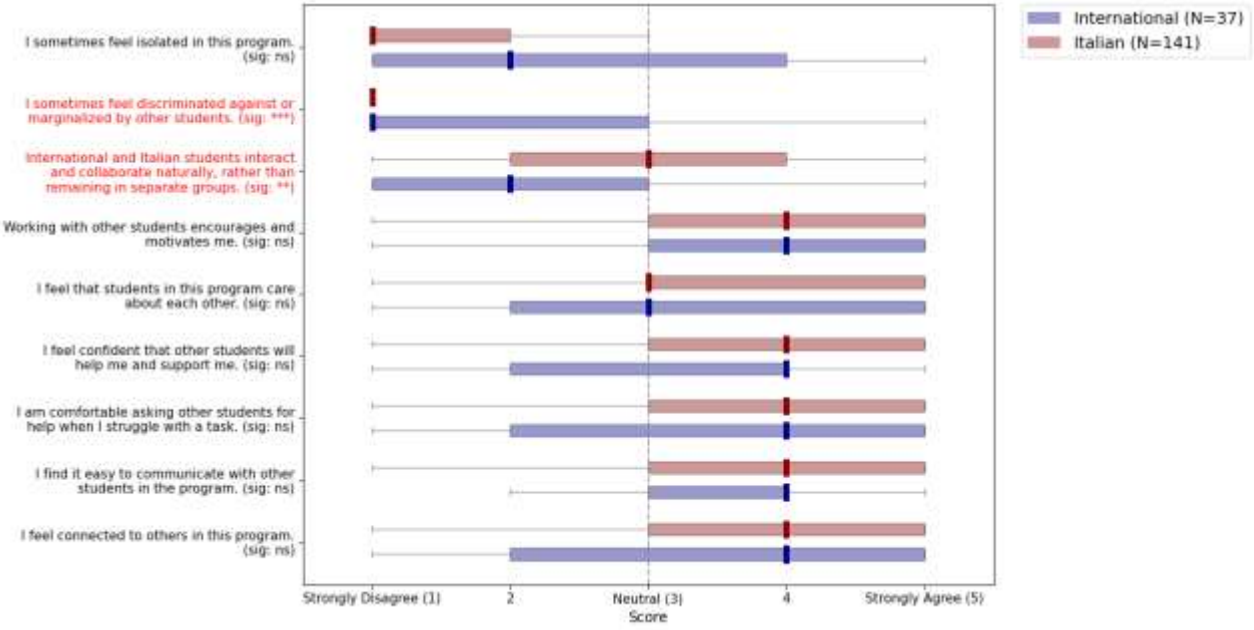


Fig 50. Median Student Ratings on Student-Teacher Interactions

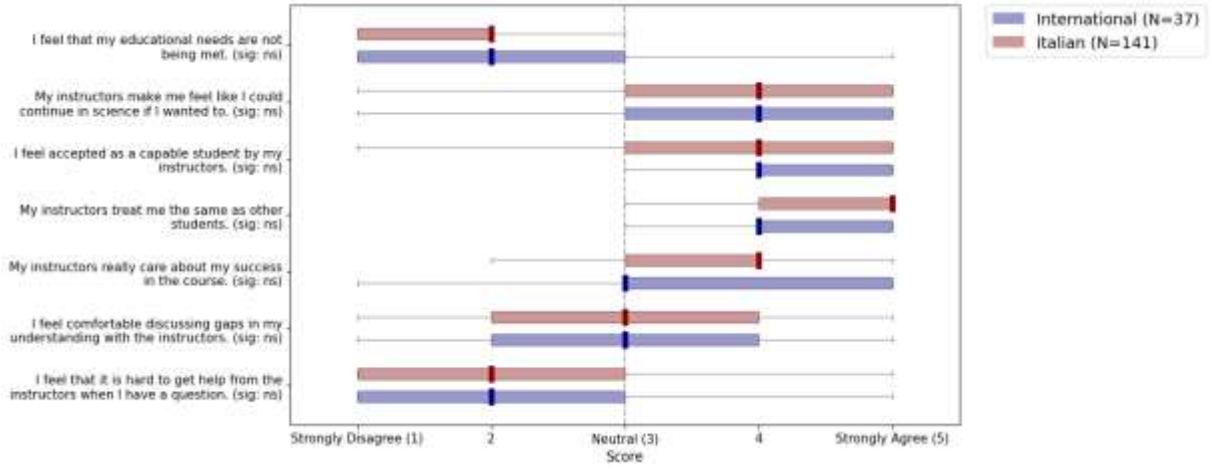


Fig 51. Median Student Ratings on Program Affordance and Learning Opportunities

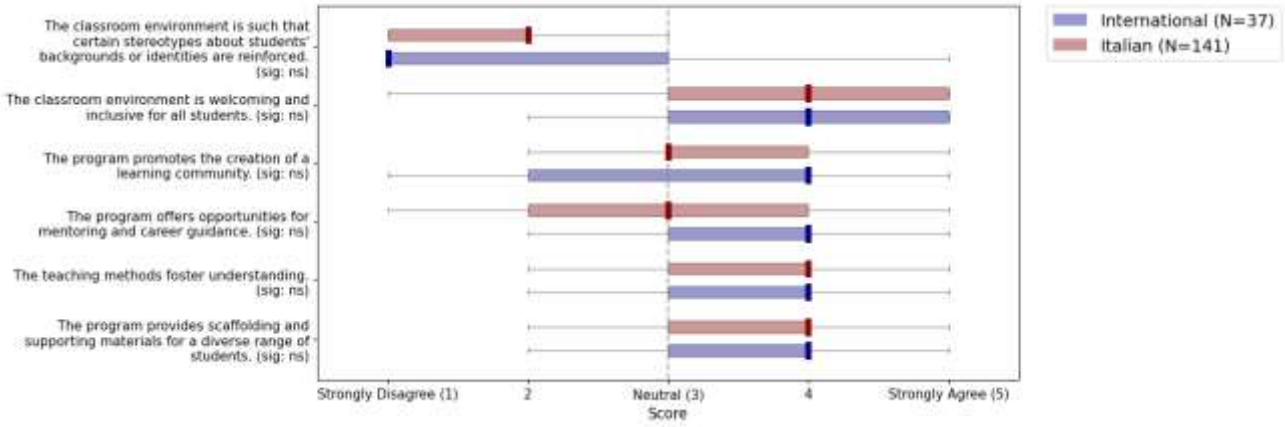
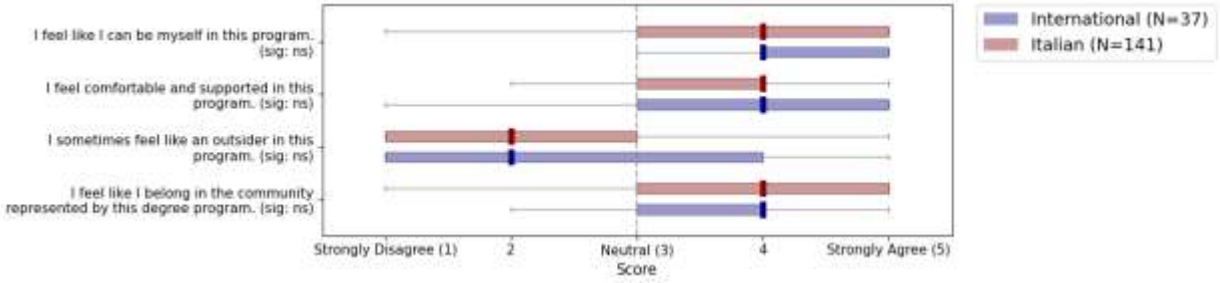


Fig 52. Median Student Ratings on Sense of Belongings



9. Motivational Factors

Fig 53. Median Student Ratings on General Academic and Self-Efficacy

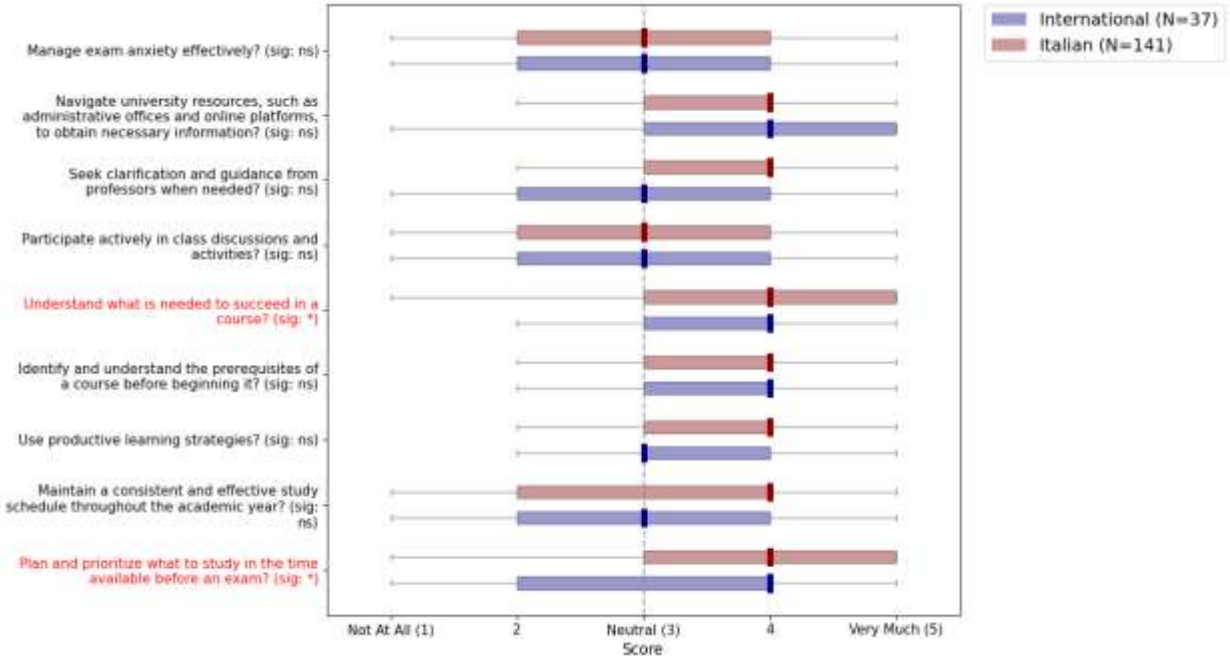


Fig 54. Median Student Ratings on Physics Self-Efficacy

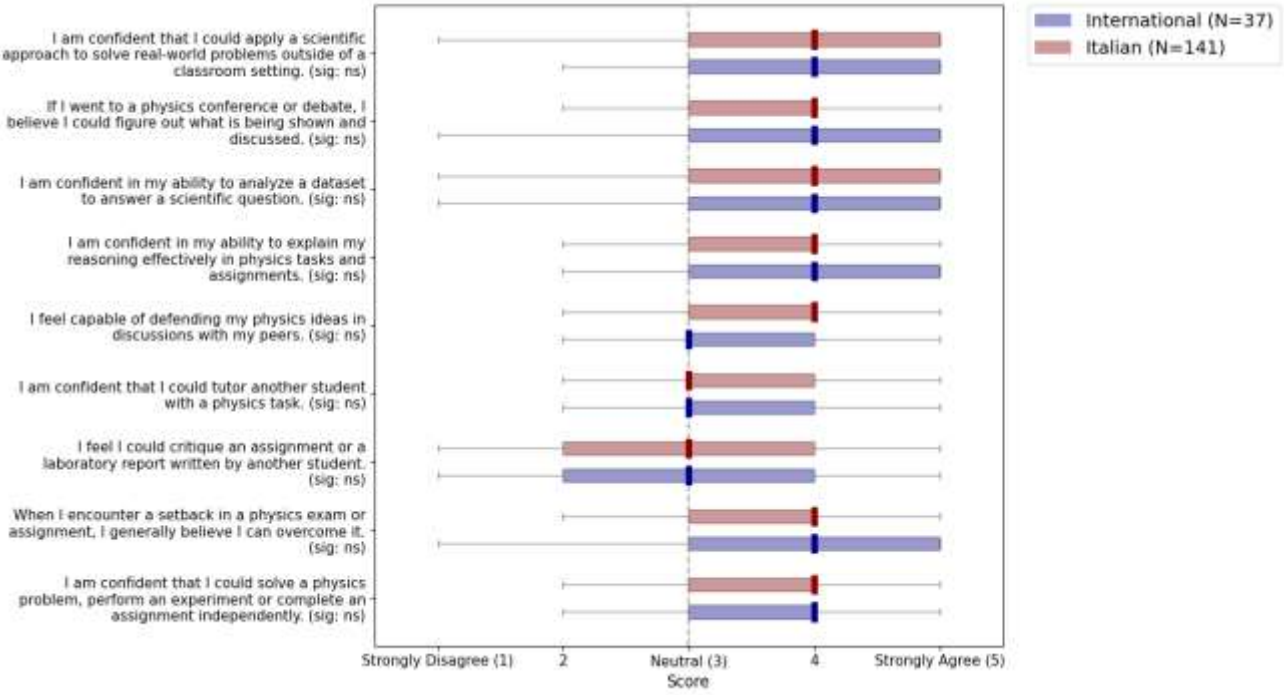


Fig 55. Median Student Ratings on Growth Mindset on One-Self

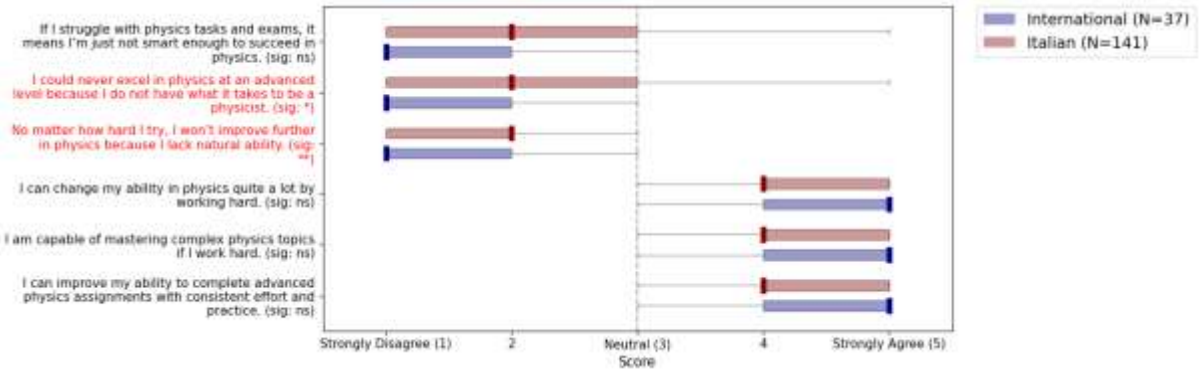


Fig 56. Median Student Ratings on Growth Mindset on Others

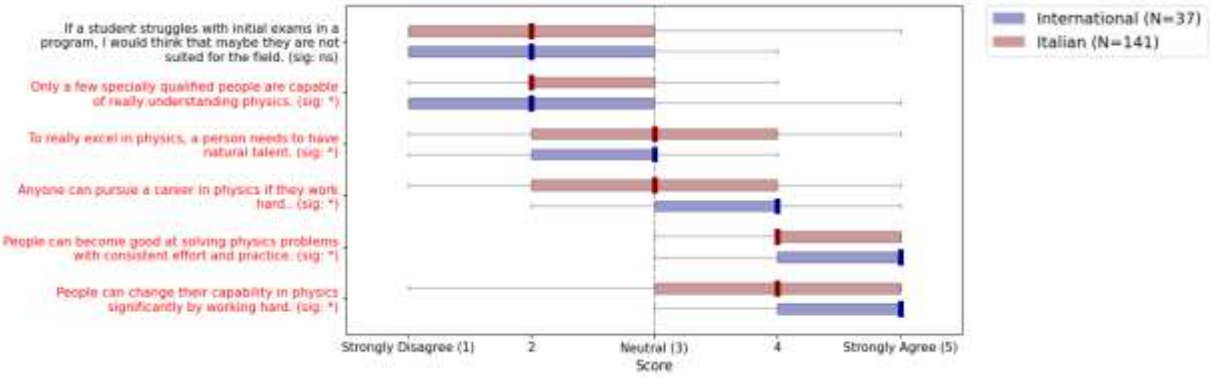
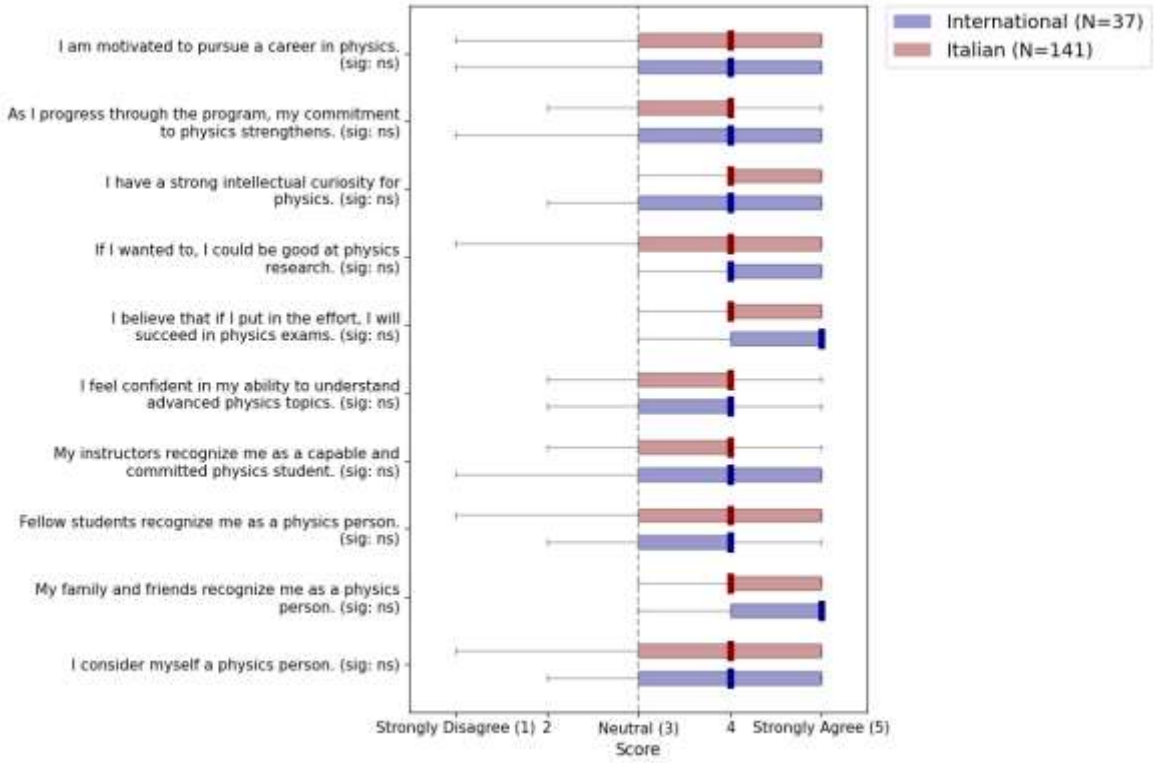
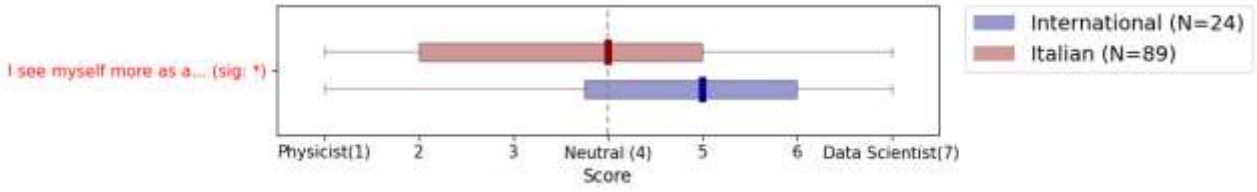


Fig 57. Median Student Ratings on Physics Identity



10. Professional Identity of PoD Students

Fig 58. Student Ratings on Professional Identity (Only on Physics of Data Students)



References:

[1] J. Stewart, G. L. Cochran, R. Henderson, C. Zabriskie, S. DeVore, P. Miller, G. Stewart, and L. Michaluk, “Mediational effect of prior preparation on performance differences of students underrepresented in physics,” Physical Review Physics Education Research, vol. 17, no. 010107, 2021.

[2] S. Salehi, A. C. Berk, S. Brunelli, A. G. Creech, A. G. Drake, S. H. Fagbodun, S. Hall, J. A. Hewlett, M. O. James, M. I. Shuster, et al., “Context matters: Social psychological factors that underlie academic performance across seven institutions,” CBE—Life Sciences Education, vol. 20, no. 4, 2021.

[3] C. Zhang, N. R. Kuncel, and P. R. Sackett, “The implications of stem college graduates’ course-taking patterns for the graduate school pipeline,” Research in Science Education, vol. 53, pp. 3–17, 2023.

[4] J. E. Nardo, N. C. Chapman, E. Y. Shi, C. Wieman, and S. Salehi, “Perspectives on active learning: Challenges for equitable active learning implementation,” Journal of Chemical Education, vol. 99, pp. 1691–1699, 2022.

[5] G. Cooper and A. Berry, “Demographic predictors of senior secondary participation in biology, physics, chemistry and earth/space sciences: students’ access to cultural, social and science capital,” International Journal of Science Education, vol. 42, no. 1, pp. 151–166, 2020.

[6] R. A. Costello, S. Salehi, C. J. Ballen, and E. Burkholder, “Pathways of opportunity in stem: Comparative investigation of degree attainment across different demographic groups at a large research institution,” International Journal of STEM Education, vol. 10, no. 46, 2023.

[7] A. Maries and C. Singh, “Towards meaningful diversity, equity, and inclusion in physics learning environments,” Nature Physics, March 2024.

[8] S. Salehi, S. Cotner, and C. J. Ballen, “Variation in incoming academic preparation: Consequences for minority and first-generation students,” Frontiers in Education, vol. 5, 2020.

[9] E. Burkholder, L. Blackmon, and C. Wieman, “What factors impact student performance in introductory physics,” PLOS ONE, vol. 15, no. 12, p. e0244146, 2020.

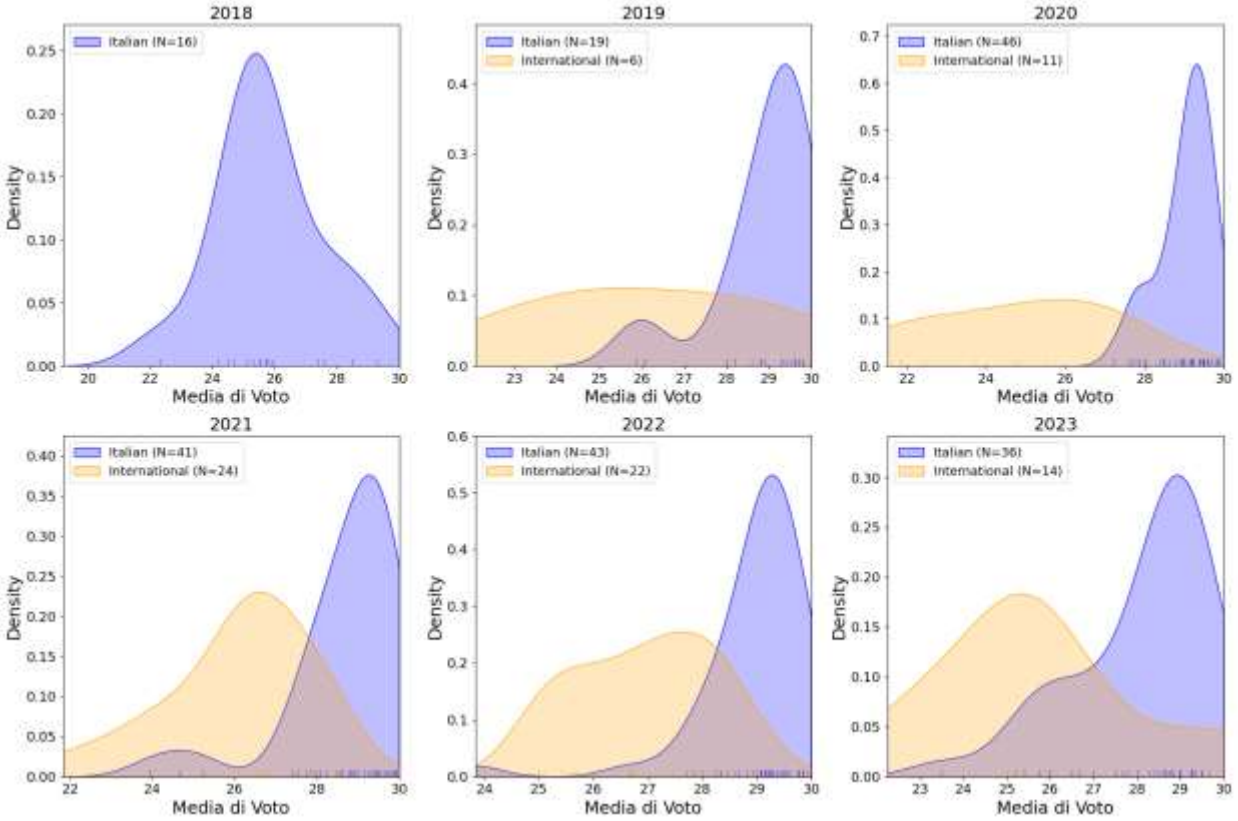
[10] S. Claro, D. Paunesku, and C. S. Dweck, “Growth mindset tempers the effects of poverty on academic achievement,” Proceedings of the National Academy of Sciences, vol. 113, no. 31, pp. 8664–8668, 2016.

[11] Z. Y. Kalender, E. Marshman, C. D. Schunn, T. J. Nokes-Malach, and C. Singh, “Framework for unpacking students’ mindsets in physics by gender,” Physical Review Physics Education Research, vol. 18, no. 010116, 2022.

[12] D. J. Rosen and A. M. Kelly, “Working together or alone, near, or far: Social connections and communities of practice in in-person and remote physics laboratories,” Physical Review Physics Education Research, vol. 18, no. 010105, 2022

Appendix:

Fig 1. Grade Distribution by Cohorts for PoD



Tab 1. Statistics of Grades With at Least 15 Students Per Group and Significant Differences

Course	Italian Mean Grade	Intern. Mean Grade	Italian Median Grade	Intern. Median Grade	Mean Difference	Median Difference	T-test	Mann-Whitney	Cohens d	Num Italian	Num Intern.
MODELS OF THEORETICAL PHYSICS	28.80	24.52	30.0	25.0	4.28	5.0	****	****	1.76	132	44
PHYSICS OF COMPLEX SYSTEMS	29.73	25.47	30.0	26.0	4.26	4.0	***	****	1.94	26	17
LIFE DATA EPIDEMIOLOGY	29.63	25.44	30.0	25.5	4.20	4.5	**	****	1.74	41	16
STATISTICAL MECHANICS	28.01	23.86	28.0	24.0	4.15	4.0	****	****	2.15	94	21
MACHINE LEARNING	29.14	25.65	30.0	26.0	3.48	4.0	****	****	1.31	198	69

MANAGEMENT AND ANALYSIS OF PHYSICS DATASET (C.I.)	29.11	25.78	30.0	26.0	3.33	4.0	****	****	1.90	175	59
ADVANCED STATISTICS FOR PHYSICS ANALYSIS	28.40	25.70	29.0	26.0	2.70	3.0	****	****	1.64	194	64
STATISTICAL MECHANICS OF COMPLEX SYSTEMS	28.85	26.20	30.0	27.0	2.65	3.0	**	****	1.12	81	25
DEEP LEARNING	29.40	26.84	30.0	27.0	2.56	3.0	****	****	1.45	96	37
NETWORK SCIENCE	29.54	27.19	30.0	28.0	2.36	2.0	**	***	1.01	37	27
GAME THEORY	27.46	25.12	28.0	25.0	2.34	3.0	*	*	0.69	57	26

BIOLOGICAL DATASETS FOR COMPUTATIONAL PHYSICS	29.20	26.93	30.0	27.0	2.27	3.0	**	**	1.10	15	15
LABORATORY OF COMPUTATIONAL PHYSICS (C.I.)	29.88	27.67	30.0	28.0	2.22	2.0	****	****	1.43	186	72
INFORMATION THEORY AND INFERENCE	29.37	27.24	30.0	27.0	2.13	3.0	****	****	1.27	108	50
COMPUTER VISION AND COGNITIVE SYSTEMS	28.61	26.64	29.0	27.0	1.96	2.0	****	****	1.07	71	28
HUMAN DATA ANALYTICS	29.07	27.25	30.0	28.0	1.82	2.0	**	***	0.90	27	24

Tab 2. Statistics of Physics Students Grades With at Least 15 Students Per Group and Significant Differences

Course	Italian Mean Grade	Intern. Mean Grade	Italian Median Grade	Intern. Median Grade	Mean Difference	Median Difference	T-test	Mann-Whitney	Cohens d	Num Italian	Num Intern.
INTRODUCTION TO MANY BODY THEORY	29.18	24.17	30.0	26.5	5.02	3.5	****	****	2.81	103	18
STATISTICAL MECHANICS	28.52	23.62	29.0	24.0	4.90	5.0	****	****	2.98	165	21
STRUCTURE OF MATTER	29.43	25.06	30.0	25.5	4.37	4.5	****	****	3.41	123	16
INTRODUCTION TO RADIATION DETECTORS	28.28	24.50	29.0	25.0	3.78	4.0	***	****	1.36	53	22

SOLID STATE PHYSICS	28.63	25.58	30.0	26.0	3.05	4.0	****	****	1.37	100	33
SUBNUCLEAR PHYSICS	29.35	26.54	30.0	28.0	2.81	2.0	****	****	1.55	138	48
THEORETICAL PHYSICS OF THE FUNDAMENTAL INTERACTION	26.92	24.12	27.0	24.0	2.80	3.0	**	**	1.01	154	17
NUCLEAR PHYSICS	29.00	26.28	29.0	27.0	2.72	2.0	****	****	1.43	116	36
NUCLEAR ASTROPHYSICS	29.50	27.11	30.0	28.0	2.39	2.0	***	***	0.83	30	35
RADIOACTIVITY AND NUCLEAR	29.42	27.13	30.0	27.0	2.30	3.0	****	****	1.31	53	39

MEASUREMENTS											
PHYSICS LABORATORY	29.32	27.96	30.0	28.5	1.36	1.5	****	****	0.91	274	56

Tab 3. Statistics of Astrophysics Students Grades With at Least 15 Students Per Group and Significant Differences

Course	Italian Mean Grade	Intern. Mean Grade	Italian Median Grade	Intern. Median Grade	Mean Difference	Median Difference	T-test	Mann-Whitney	Cohens d	Num Italian	Num Intern.
GENERAL RELATIVITY	27.13	24.10	27.0	25.0	3.02	2.0	****	****	1.03	183	77
ASTROPHYSICS LABORATORY 1: INFRARED AND OPTICAL	27.58	24.86	28.0	25.0	2.72	3.0	***	***	0.88	62	36

INSTRUMENTATION											
ADVANCED ASTROPHYSICS	29.07	26.41	30.0	27.0	2.65	3.0	****	****	1.08	123	56
OBSERVATIONAL ASTROPHYSICS	28.70	26.23	29.0	27.0	2.47	2.0	****	****	0.97	98	61
THEORETICAL PHYSICS	28.65	26.21	29.0	26.5	2.44	2.5	***	****	1.30	72	24
MATHEMATICAL AND NUMERICAL METHODS	28.88	26.52	30.0	28.0	2.36	2.0	****	****	0.91	188	100
EXOPLANETARY ASTROPHYSICS	29.11	26.82	30.0	27.0	2.29	3.0	***	***	1.04	42	28

COMPACT OBJECT ASTROPHYSICS	28.92	26.65	30.0	27.0	2.28	3.0	***	***	1.03	93	31
ASTROPARTICLE PHYSICS	28.81	26.60	29.0	27.0	2.21	2.0	**	**	1.03	77	25
MULTIMESSENGER ASTROPHYSICS	29.00	26.81	30.0	28.0	2.19	2.0	**	***	1.00	39	21
STELLAR ASTROPHYSICS	29.18	27.23	30.0	27.5	1.95	2.5	****	****	0.97	90	48
OBSERVATIONAL COSMOLOGY	29.30	27.35	30.0	28.0	1.94	2.0	**	***	0.93	62	31
ASTROPHYSICS LABORATORY 2	28.83	26.90	30.0	28.0	1.93	2.0	**	**	0.73	76	41

RADIATIVE PROCESSES IN ASTROPHYSICS	28.81	26.88	30.0	27.0	1.93	3.0	**	***	0.93	67	25
GRAVITATIONAL PHYSICS	28.34	26.60	29.0	27.0	1.74	2.0	***	****	0.85	73	30
ASTRONOMICAL SPECTROSCOPY	29.03	27.45	30.0	27.5	1.58	2.5	****	****	0.94	62	38
ASTRONOMICAL INTERFEROMETRY	29.26	27.79	30.0	28.0	1.47	2.0	*	*	0.87	23	19
FUNDAMENTALS OF ASTROPHYSICS AND COSMOLOGY	29.59	28.19	30.0	29.0	1.41	1.0	****	****	0.82	81	86

PLANETARY ASTROPHYSICS	29.44	28.17	30.0	29.0	1.28	1.0	*	**	0.88	52	24
ASTROPHYSICS LABORATORY 1: HIGH ENERGY INSTRUMENTATION	29.19	27.97	30.0	28.0	1.22	2.0	****	****	0.75	101	60
ASTROPHYSICS OF GALAXIES	28.56	27.35	29.0	28.0	1.21	1.0	**	**	0.60	64	46
ASTRO-STATISTICS AND COSMOLOGY	28.93	27.86	30.0	28.0	1.07	2.0	*	*	0.63	61	22
COMPUTATIONAL ASTROPHYSICS	29.87	29.41	30.0	30.0	0.46	0.0	*	*	0.73	60	27

Tab 4. Categorization of Courses

Category	Courses
Astro	● ADVANCED ASTROPHYSICS ● ASTRO-STATISTICS AND COSMOLOGY ● ASTRONOMICAL SPECTROSCOPY ● ASTROPARTICLE PHYSICS ● COMPUTATIONAL ASTRODYNAMICS ● COMPUTATIONAL ASTROPHYSICS ● COSMOLOGY ● COSMOLOGY OF THE EARLY UNIVERSE ● FLUID AND PLASMA DYNAMICS ● GALACTIC DYNAMICS ● GENERAL RELATIVITY FOR ASTROPHYSICS AND COSMOLOGY ● GRAVITATIONAL PHYSICS ● MATHEMATICAL AND NUMERICAL METHODS ● MULTIMESSENGER ASTROPHYSICS ● OBSERVATIONAL ASTROPHYSICS ● OBSERVATIONAL COSMOLOGY ● PLANETARY ASTROPHYSICS ● RELATIVISTIC ASTROPHYSICS ● SELECTED TOPICS IN MODERN ASTROPHYSICS ● STELLAR ASTROPHYSICS ● SUBNUCLEAR PHYSICS ● THE PHYSICAL UNIVERSE ● THEORETICAL COSMOLOGY
Biology	● ASTROBIOLOGIA ● BIOLOGICAL DATASETS FOR COMPUTATIONAL PHYSICS ● BIOLOGICAL PHYSICS ● BIOMETRICS ● COMPUTATIONAL NEUROSCIENCE ● EPIDEMIOLOGY AND RISK ANALYSIS ● IMAGING FOR NEUROSCIENCE ● LIFE DATA EPIDEMIOLOGY ● MEDICAL PHYSICS ● MODELLING AND CONTROL OF ENVIRONMENTAL SYSTEMS ● MOLECULAR SIMULATIONS ● NEUROROBOTICS AND NEUROREHABILITATION ● NUMERICAL METHODS IN SOFT MATTER ● PHYSICAL MODELS OF LIVING SYSTEMS

	• QUANTITATIVE LIFE SCIENCE • STRUCTURAL BIOINFORMATICS
Complex Networks	• NETWORK ANALYSIS AND SIMULATION • NETWORK MODELLING • NETWORK SCIENCE • PHYSICS OF COMPLEX NETWORKS: STRUCTURE AND DYNAMICS
Data Science	• ADVANCED TOPICS IN COMPUTER SCIENCE • BIG DATA COMPUTING • COGNITIVE, BEHAVIORAL AND SOCIAL DATA • CONCURRENT AND REAL TIME PROGRAMMING • DATA MINING • DISTRIBUTED SYSTEMS • FOUNDATIONS OF DATABASES • HIGH LEVEL PROGRAMMING • LAW AND DATA • OPTIMIZATION FOR DATA SCIENCE • PROCESS MINING
Engineering	• APPLIED ELECTRONICS • NUCLEAR FISSION AND FUSION PLANTS • PHYSICS OF THE ATMOSPHERE • PROGRAMMABLE HARDWARE DEVICES • QUANTUM CRYPTOGRAPHY AND SECURITY • QUANTUM INFORMATION AND COMPUTING • QUANTUM OPTICS AND LASER • SOLID EARTH GEOPHYSICS
Finance	• BUSINESS ECONOMIC AND FINANCIAL DATA • COMPUTATIONAL FINANCE • ECONOMICS AND MANAGEMENT OF INNOVATION • ENVIRONMENTAL ECONOMICS AND RESOURCE VALUATION • INDUSTRIAL ECONOMICS • SVILUPPO IMPRENDITORIALE E INNOVAZIONE
Humanities	• ANTROPOLOGIA CULTURALE • DIGITAL CITIZENSHIP AND LAW • ELEMENTI DI DIDATTICA E PEDAGOGIA SPECIALE PER LA SCUOLA SECONDARIA • FILOSOFIA DELLE SCIENZE UMANE NELL'ETA' CONTEMPORANEA • FOOD, WINE AND NUTRITION • HUMAN COMPUTER INTERACTION

	• LINGUA INGLESE B2 (ABILITA' PRODUTTIVE) • PROGETTAZIONE PEDAGOGICA • PSICOLOGIA DELL'APPRENDIMENTO STRATEGICO E DELLA MOTIVAZIONE • PSICOLOGIA GENERALE
ICT	• 3D AUGMENTED REALITY • COMPUTER ENGINEERING FOR MUSIC AND MULTIMEDIA • DIGITAL SIGNAL PROCESSING • ICT FOR INDUSTRIAL APPLICATIONS • INTERNET • INTERNET OF THINGS AND SMART CITIES • PROGRAMMING FOR TELECOMMUNICATIONS • WEB INFORMATION MANAGEMENT
Machine Learning	• 3D VISION AND EXTENDED REALITY • ARTIFICIAL INTELLIGENCE • COGNITION AND COMPUTATION • COMPUTER VISION • COMPUTER VISION - VISIONE COMPUTAZIONALE • DEEP LEARNING • HUMAN DATA ANALYTICS • NATURAL LANGUAGE PROCESSING • NEURAL NETWORKS AND DEEP LEARNING • REINFORCEMENT LEARNING • VISION AND COGNITIVE SERVICES • VISION AND COGNITIVE SYSTEMS • COMPUTER VISION AND COGNITIVE SYSTEMS
Management	• APPROCCI METODOLOGICI E AMBIENTI TECNOLOGICI PER LA DIDATTICA DELLA SCUOLA SECONDARIA • ENERGIA E SOSTENIBILITA' NEL XXI SECOLO • INDUSTRY AND COMMUNITY PROJECT • INNOVATION AND ENTREPRENEURSHIP • INTRODUCTION TO RESEARCH ACTIVITIES • MANAGERIAL LAB 2 • PROJECT MANAGEMENT • START-UP IN ICT
Mandatory	• ADVANCED STATISTICS FOR PHYSICS ANALYSIS • FUNDAMENTALS OF ASTROPHYSICS AND COSMOLOGY • GENERAL RELATIVITY • INFORMATION THEORY AND COMPUTATION

	• INFORMATION THEORY AND INFERENCE • LABORATORY OF COMPUTATIONAL PHYSICS (C.I.) • MACHINE LEARNING • MANAGEMENT AND ANALYSIS OF PHYSICS DATASET (C.I.) • MODELS OF THEORETICAL PHYSICS • NUCLEAR PHYSICS • QUANTUM INFORMATION WITH ATOMS AND PHOTONS • STATISTICAL MECHANICS • THEORETICAL PHYSICS • THEORETICAL PHYSICS OF THE FUNDAMENTAL INTERACTIONS
Math and Stats	• ADVANCED TOPICS IN COMPUTER SCIENCE: PROBABILISTIC AND STATISTICAL VERIFICATION • CALCOLO DELLE PROBABILITA' • FINANCIAL MATHEMATICS FOR DATA SCIENCE • GAME THEORY • GAME THEORY - TEORIA DEI GIOCHI • INFORMATION RETRIEVAL • INFORMATION THEORY • INTRODUCTION TO PARTIAL DIFFERENTIAL EQUATIONS • INTRODUCTION TO STOCHASTIC PROCESSES • MATHEMATICAL MODELS AND NUMERICAL METHODS FOR BIG DATA • NUMERICAL METHODS FOR HIGH PERFORMANCE COMPUTING • STOCHASTIC DIFFERENTIAL EQUATIONS, WITH NUMERICS • STOCHASTIC METHODS • STOCHASTIC METHODS FOR FINANCE • STOCHASTIC PROCESSES • TYPE THEORY
Physics	• ACCELERATOR PHYSICS • ADVANCED OPTICS AND METROLOGY • ADVANCED PHYSICS LABORATORY • ADVANCED PHYSICS LABORATORY A • ADVANCED PHYSICS LABORATORY B • EXPERIMENTAL SUBNUCLEAR PHYSICS • INTRODUCTION TO MANY BODY THEORY • INTRODUCTION TO NANOPHYSICS • INTRODUCTION TO QUANTUM HARDWARE • INTRODUCTION TO RADIATION DETECTORS • MATHEMATICAL PHYSICS

	• OPTICS AND LASER PHYSICS • PHYSICS EDUCATION • PHYSICS LABORATORY • PHYSICS OF COMPLEX SYSTEMS • PHYSICS OF FLUIDS AND PLASMAS • PHYSICS OF NUCLEAR FUSION AND PLASMA APPLICATIONS • PHYSICS OF SEMICONDUCTORS • RADIOACTIVITY AND NUCLEAR MEASUREMENTS • SOLID STATE PHYSICS • STANDARD MODEL • STATISTICAL MECHANICS OF COMPLEX SYSTEMS • STRUCTURE OF MATTER • TEACHING AND LEARNING PHYSICS • THEORETICAL PHYSICS OF THE FUNDAMENTAL INTERACTIONS • THEORY OF STRONGLY CORRELATED SYSTEMS

Tab 5. Categorization of Companies

Sector	Company Name
AI & Data Technology	Radarmeteo, Omnys, Porini, E4-Analytics, Accenture Argentina, PatchAI, AXYON.AI, U-Hopper srl, Akamas, Certego, Quandl, Uqido, Fore, Chiron, Tensor Solutions
Finance	XOr Capital, PwC, Credit Agricole, CREDEM, Eurex Clearing AG, Deutsche Bank AG
General Technology	Bending Spoons, Eneryield, Alten, Innovation Piacenza, Axxon, Digital Hub Trento San Paolo, Microtec, Qualcomm, ToBusy, HITACHI ENERGY, Ippazio, Telsa.com
Industrial and Manufacturing	FK, Micromed, UNOX, Sony, Gunnebo, DuckDuckGoose, Galdi, Infineon, HILTI, Thales Alenia Space Italia, Metalmaker3d, Sony Entec, Wilico, Volvo Cars

Fig 2. Career Preferences (Multiple Choices Allowed)

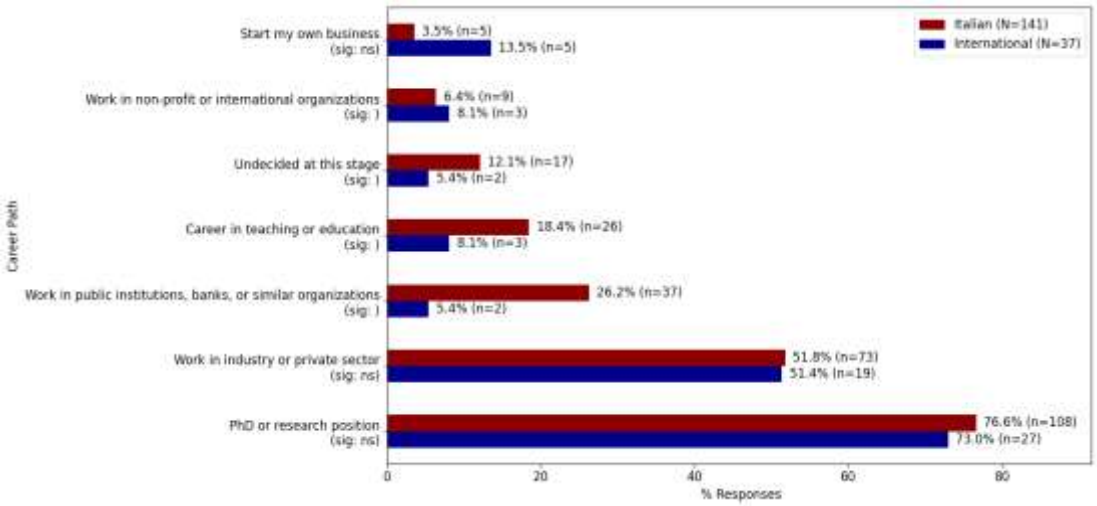


Fig 3. Challenges Faced by Students to Find a Job/PhD (Multiple Choices Allowed)

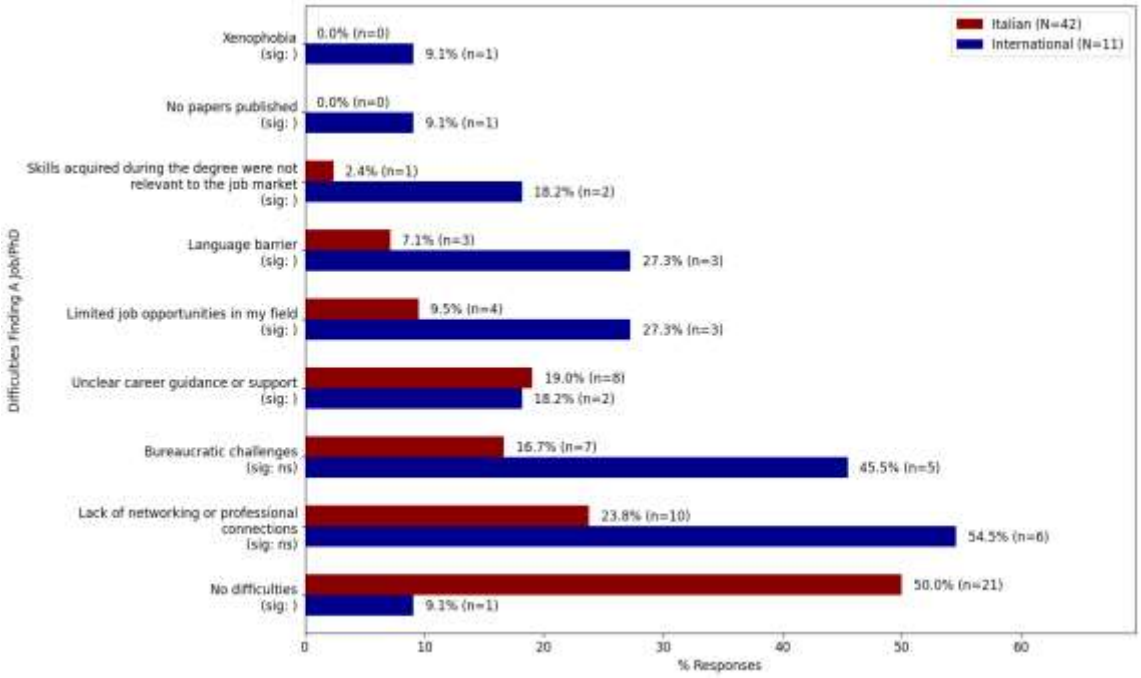


Fig 4. Challenges Faced by Students (Multiple Choices Allowed)

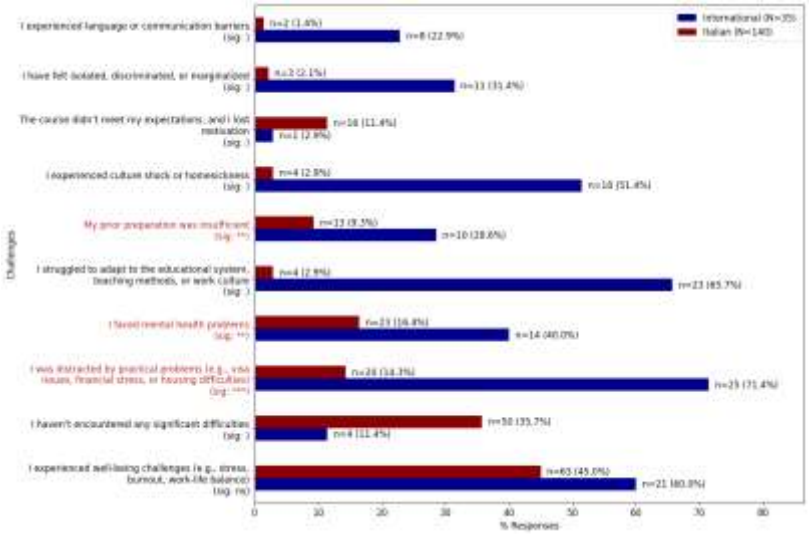
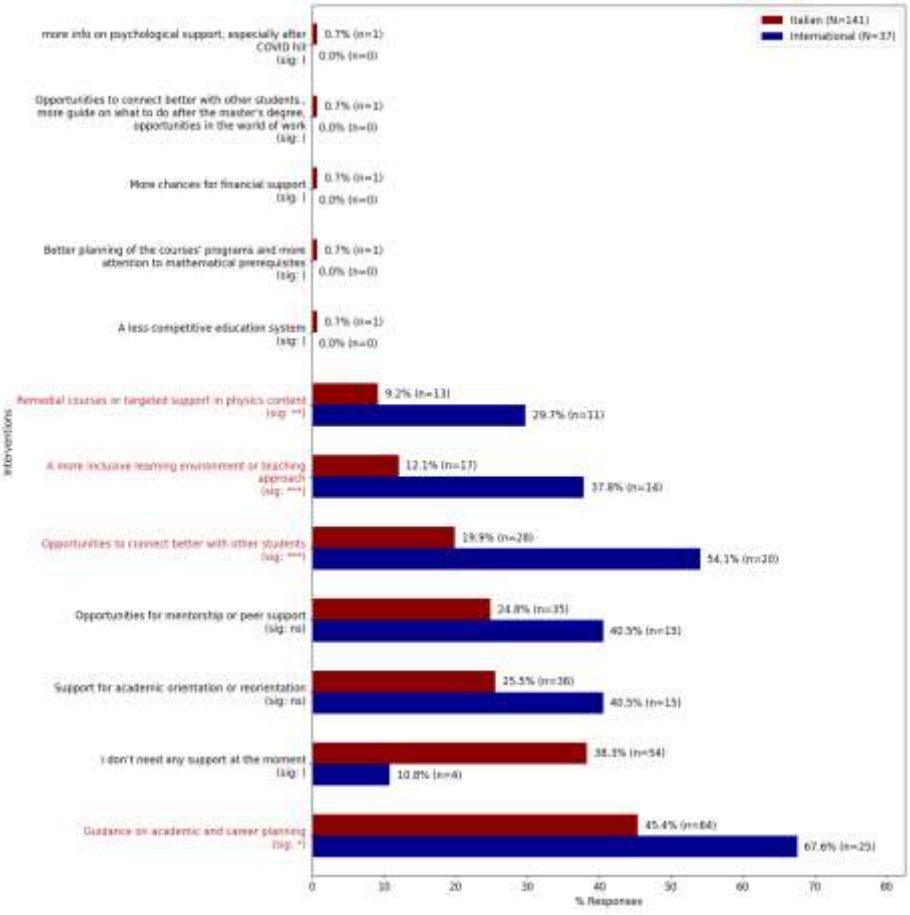


Fig 5. Intervention Suggested by Students (Multiple Choices Allowed)



Tab 4. Additional Problems Experienced By Students

Additional Problems Experienced by Italian Students	**Additional Problems Experienced by Intern. Students**
• 'Mostly stress about which path to follow and what to do precisely in the future (e.g. Erasmus'), • 'exams tend not to match the CFU workload one should expect', • 'Teamworks were most of the times difficult due communication with other cultures being too servile. Then some courses required too much work during the semester for a 6 CFU exam', • 'Some minor health issue out a set back in the First year', • 'Course choice)', • 'Keeping up with all the homework deadlines makes it difficult to study for theoretical courses step by step', • 'Intership', • 'I had tò finish my Bachelor thesis project',	• "The course didn't meet my expectations, and I lost motivation., despite the lectures being wonderful I am very dissapointed in the professors' lack of interest for the students", • 'Oral exams (I think they are very useful but had never done one before and found it challenging)', • 'For international students it was not enough explained how the system in Italy works, which gave Italian students a privilege', • 'Having taken a break from studying I've found it difficult to catch up'

• 'I felt a lack of support from the university regarding what concerns the preparation necessary for a PhD application (for example PhD students talking to MSc and giving suggestions on how to choose a PhD or how to write a strong application)', • 'I faced physical health problems', • 'I experienced culture shock or homesickness., the programming skill required', • 'some courses did not motivate me and I ended up changing the	

Tab 5. Additional Problems Experienced By Students

Suggested Interventions by Italian Students	**Suggested Interventions by International Students**
• More guidance on course and career planning (e.g., mentors, tutors, dedicated advisors) • Workshops and peer-to-peer connections are helpful and should be expanded	• More extracurricular and social activities to build community • Earlier guidance on thesis/internship procedures

• More recorded lectures for accessibility and flexibility • Simplify workload and make examination methods less complex • Better planning of CFU and realistic course workloads • Greater support in finding internships and research opportunities • Orientation sessions on PhD options and applications • Clarify academic expectations, especially in theoretical courses • Need for structured mentoring (e.g., mentors assigned to each student) • Improve infrastructure (e.g., study rooms, access to labs) • Provide clearer communication and reduce bureaucratic complexity • Facilitate better understanding of course prerequisites • Encourage group study and collaborative learning • More inclusion of students in departmental labs	• More support finding part-time jobs and financial aid options • Courses should offer stronger Moodle support for accessibility • Simplify and support the internship process • Offer bridge courses to fill gaps in mathematical or technical backgrounds • Mentors or TAs for programming and research direction • Clearer guidance on the thesis process, especially for non-Italian speakers • Foster more inclusive classroom dynamics and mentoring relationships • Increase flexibility in customizing academic paths • Professors should offer more active career support beyond course content • Address exclusionary group dynamics in project work • Assign mentors from similar study tracks (e.g., MSc students in same field)

• Additional support during thesis and internship selection • Highlight post-MSc opportunities earlier in the program • Improve student-professor guidance throughout projects and courses • Offer seminars introducing current research topics • Use peer support networks and organize events with alumni • Create space for honest discussion of struggles and solutions	• Randomize project groups to encourage diversity and inclusion • Assign accessible TAs to courses with advanced content • Organize welcome events and networking opportunities early on • Host talks on academic and career paths • Provide remedial support and study method sharing for tough courses • Organize more events that support social and academic integration

Tab 6. Answers To Questions “Can you describe any strategies that helped (or hindered) your success in this program?”

Strategies That Helps/Hinders From Italian Students	**Strategies That Helps/Hinders From Intern. Students**
• Being a workaholic • 1 credit = 25 hours	• Study daily

• Weekly homework can be difficult for working students; grading clarity is important • Keep grinding. Overcome mediocrity • Having in mind my own goal • Find the right people for a group project • Studying and working in teams • Prefer research-oriented paths over classical physics • Balancing mental health with studies and life responsibilities • Hitting a wall often — persistence matters • Courses are packed; need earlier support for course selection • Being organized and planning breaks • Talking to senior students for advice • Just try, especially with coding and life transitions • Repeating exercises to deepen understanding • Consistent class attendance and study; unclear career paths hinder motivation	• ADHD makes assignments and lecture focus difficult; Moodle content helps • Work hard • Need more mathematical foundations to support lab courses • Oral exams were a new challenge • Adaptability, discipline, and time management are key • Bureaucratic difficulties are stressful and demotivating; praise for Stefania Camporese's help • Lack of integration into research groups is frustrating • Reading books and lecture notes • Understanding how oral exams work is a challenge at first • Talking with professors helps clarify concepts • Studying with classmates • Supportive teams and shared materials help a lot • Keeping up with lessons regularly • Understanding how Italian exams work

• Detaching self-worth from academic success; excessive competitiveness is harmful • Theoretical physics in bachelor was the toughest • More support needed in programming • Study from reference materials • Organization, constancy, passion • Ask advice from students who've taken the course • Study groups help solve problems more effectively • Being committed and structured in schedule • Study a lot, code a lot, be passionate • Collaborate with other students • Build a strong network and team • Commitment and passion • Learning through real projects helped most • Hands-on approach and doing things directly • Studying with colleagues • Being curious	• Don't care too much about grades • Listen to Italian students and match their effort, as they are more familiar with the system

• Project-based exams helped increase engagement • Unclear academic direction slowed progress • Adaptability is the most useful soft skill • Collaborating with both peers and professors • Recorded lessons allowed deeper understanding and sharing • Adapt and network • Studying with friends • Clarify objectives before starting any project	

Tab 7. Answers To Questions “If you wish, you may add other adjectives to better describe how you felt.”

Italian Student Feelings on This Program	**International Student Feelings on This Program**
• The program is cool • I feel I am growing during this degree	• Stoic • It seems very unlikely that one can finish the full program within the expected 4 semesters.

• I feel stressed from the exam session, also proud of being able to achieve the objectives that I have now • I felt that I did not have enough computational skills so I had to work to obtain them. • Exhausted, the session is over and I barely have been able to do 3 exams out of 5 that I am supposed to EVERY session. Now propagate that over the master and I will go *fuoricorso* for sure. • Overwhelmed • I feel that I need to force myself to keep my mental focus and discipline always high, because if I experience weakness or doubts I can very easily fall behind. • I am excited, I'd like to dig deeper into many topics but at the same time I feel like I'm in a rush • From the first semester I recall being scared of the future, insecure about my knowledge and abilities • Curious and happy • In the right place	• Disappointed, I came here to do more research and I have found nothing but obstacles. I also struggled adapting to a different way of examination, but that is the kind of obstacle that, although frustrating at first, I believe teaches me something once I (hopefully) overcome it. • Happy. • A bit confused. • When I faced the Machine Learning and Python for Physicists course and FPFA course without any programming background, it was like a nightmare to me! Others seemed OK with these courses, especially Italians, but I had no background. My physics knowledge was more than enough, but my programming knowledge was zero! I studied 12 hours a day in the first semester to learn Python and Machine Learning since it was a challenge for me and I had no mentor to guide me on what to do! • Eager to make more effort • Happy

Tab 8. Answers To Questions “Do you have any comments or anything else you would like to share about your experience as a (international) student at UniPD?”

Extra Notes From Italian Students	Extra Notes From International Students
• Very interesting questionnaire! • I sometimes feel like many topics are repeated in different courses, such that each course gives mostly the same basic knowledge and just a few advanced topics. • Coming from the bachelor in UniPD it's a bit easier to pass exams, but like from PTSD level to anxiety level. • This is too long. • I’m facing some difficulties socializing with others due to pre-existing friendships; this affects my confidence. • Why did it take 8 months to repair the DFA toilets? • I felt very disappointed with the Observational curriculum in Astrophysics and Cosmology; switched to theoretical due to poor quality. • Avoid putting lessons at lunchtime. • I would enroll again in Physics of Data without hesitation.	• International students are very isolated; without Italian friends we miss out on key course info and feel at a disadvantage. • It was extremely fulfilling and rewarding. • I enjoy lectures, but there are too many overlaps; I’d like more research opportunities and access to labs. • The course is very good and complete; I am totally satisfied. • It’s the best decision I’ve made so far. • Cosmology offers many courses, but Astrophysics does not; schedule overlaps and building distances are a problem. • There were cases of sexist and xenophobic behavior from the professors which even after being reported didn’t resolve. Additionally, my friends and I personally had a horrible experience with a specific professor(doesn’t even matter if it’s a professor, from the point of view of just humans treating each other it

• It was overall a great experience; I'd still choose Padova even if I now work in AI. • I chose Physics of Data for its collaborative mindset with colleagues and professors.	was horrible) which we reported to different people in power, however literally nothing was done. And to my knowledge this professor continues teaching and treating the students the same way. I also felt like when I first started the course there was not enough guidance to international students. However, overall I liked the course materials and the projects that we did. And I think this was a perfect choice in terms of the content for me personally. Minus maybe the fact that some physics classes were unnecessarily hard, which I later found out that in the next years changed • Advice: Start job/PhD applications early; do internships abroad to build a stronger CV. • The gap between international and Italian students needs to be addressed; course content good, but physics side lacks structure and flexibility. • Social interaction is key; UniPD failed in organizing social events to connect international and Italian students — needs urgent improvement. • I felt surrounded by kind peers and great teachers; please keep making this program a welcoming space for curious minds.