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A Study on the Impact of Instruction Language on Academic Achievement in Higher Education

Mohamed Jarmouni [1], Mohamed Bellaihou [1], Zayd Labdouti [2], Assia Arectout [3*]

[1]Laboratory of Nanomaterials Technology and Innovation, Superior Normal School, Abdelmalek Essaâdi University, Tetouan, Morocco

[2]LPMR, Department of Physics, Faculty of Sciences, Mohammed I University, Oujda, Morocco

[3]Radiations and Nuclear Systems Group, FS, Abdelmalek Essaadi University, Tetouan, Morocco

ABSTRACT

The impact of the language of instruction on academic achievement is a critical issue, particularly in multilingual settings. This study investigates how using French as the medium of instruction affects the academic performance of first-year physics and chemistry students at Moroccan universities. The research, conducted at Mohamed I and Abdelmalek Essaadi Universities, involved 365 students and 20 teachers. Data were collected through questionnaires and semi-structured interviews. We conducted a correlation analysis to examine the relationship between French proficiency and academic performance in physics and chemistry. A frequency analysis identified common difficulties students face when studying these subjects in French. An ANOVA determined if using French as the medium of instruction significantly impacts academic performance. The results show a significant relationship between students' proficiency in French and their academic performance in science subjects taught in French. Our analysis indicates that instruction in a non-native language has a negative impact on academic success. Many students expressed discomfort with French, citing difficulties with scientific vocabulary and comprehension. Teachers corroborated these challenges, noting that students' limited French proficiency impedes their understanding of complex scientific concepts, contributing to higher failure rates. Additionally, a strong positive correlation was found between French language proficiency and academic performance in physics and chemistry. Students with lower proficiency in French tend to have poorer academic performance in these subjects.

*CORRESPONDING AUTHOR:

Assia Arectout, Radiations and Nuclear Systems Group, FS, Abdelmalek Essaadi University, Tetouan, Morocco; Email: assiaarectout@gmail.com

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1. Introduction

In recent decades, there has been an increasing trend in the educational world to teach content through an additional language. This approach, known as Content and Language Integrated Learning (CLIL), is based on the principle that students are able to acquire both content and language skills simultaneously. The CLIL approach has become more and more popular in many countries to promote multilingualism and prepare students for a globalized world. However, there are still concerns about the efficiency of CLIL teaching, particularly in terms of its impact on students' language skills and content knowledge.

The impact of the language of instruction on the academic performance of science students is a complex issue that has been extensively discussed in education research [1, 2]. In the Moroccan educational system, Arabic was introduced as the language of instruction for teaching primary and secondary levels, requiring science subjects to be taught in Arabic. However, this policy was not extended to higher education in universities, where scientific subjects continued to be conducted in French. This led to a significant language barrier for students who were accustomed to learning science in Arabic but were suddenly required to study in a foreign language. As a result, students in Moroccan universities face significant challenges that contribute to a high failure rate, particularly among first-year students.

Research Objective

In this paper, we investigate the impact of the language of instruction on the academic performance of physics and chemistry students in Moroccan universities. Specifically, we examine the factors contributing to this issue, analyze the effects of the language barrier on students' academic achievement, and identify the challenges students face when learning complex scientific concepts in a non-native language. Additionally, we propose potential solutions to improve academic outcomes for students who are required to study in a foreign language. Through this research, we aim to provide insights that can inform educational policies and practices in multilingual settings, ultimately supporting student achievement in higher education.

2. Literature Review

Student academic achievement and its relationship with the language of instruction have been extensively researched [3–5]. This is particularly true in scientific subjects, where proficiency in the language of instruction is crucial for students to fully understand complex concepts, engage deeply with the material, and excel academically. In disciplines that require the understanding of intricate theories, the performance of precise calculations, and the interpretation of data, language barriers can severely impede students' ability to succeed.

The scientific content of physics and chemistry is complex and difficult to understand due to the specific terms, equations, and concepts in the field [1, 6, 7]. Moreover, the use of a foreign language in teaching physics and chemistry in Moroccan universities poses additional challenges for students in understanding and learning the content [2]. Language plays a crucial role in the learning of physics and chemistry through its contribution to understanding, communicating, and representing ideas on scientific phenomena [8, 9]. The use of scientific language, which differs from familiar language, increases the complexity of the subject.

Recent research indicates that a foreign language has a significant impact on the learning process and the reception and application of new information, thereby affecting student success [10]. In Moroccan universities, many students lack the motivation to learn physics and chemistry in a foreign language, as they do not use it in their daily lives and consider it a source of difficulty and obstacles. Several studies have investigated the teaching of science subjects in a foreign language. A study conducted in the United States with graduate students from the chemistry department of Purdue University and with undergraduate science students enrolled in general chemistry at the University of Puerto Rico revealed five categories of challenges faced by native Spanish speakers learning chemistry in a foreign language, including the use of their mother tongue to achieve a good

level of understanding, avoidance of communication that requires the use of the foreign language, misunderstanding and misuse of scientific terms, difficulty in using new terms, and difficulty in correctly using scientific expressions and words[11].

A study by Alshehri[12] on Arab-origin chemistry students in the United States revealed common language-related challenges, including communication avoidance, lack of confidence in using the foreign language, and difficulty with laboratory courses. This research aims to evaluate the impact of teaching physics and chemistry in a foreign language on student success and to better understand the difficulties encountered by students in learning these subjects with a foreign language.

In the Moroccan context, students' mother tongues predominantly include Arabic and Amazigh languages[13]. These languages are widely spoken and used in everyday communication among Moroccan students. However, when it comes to the teaching of physics and chemistry in Moroccan universities, the language of instruction has traditionally been French[2]. This language barrier poses significant challenges for students who are more comfortable with their mother tongues and have limited exposure to French outside of the academic setting.

3. Materials and Methods

3.1. Participants

The survey was conducted in February 2022 with teachers and first-year students from two Moroccan universities: Mohamed I and Abdelmalek Essaadi University. Prior to data collection, we informed the interested participants about the study's purpose and significance and guaranteed their anonymity and confidentiality. After obtaining their informed consent, we provided them with a link to complete the questionnaire through an online platform. All questions in the questionnaire were mandatory, resulting in no missing values. The student sample comprised 122 males and 243 females. The majority of students (63%) were from Abdelmalek Essaadi University in Tetouan, with the rest from Mohamed I University in Oujda. The teachers' sample consisted of 20 teachers who taught science subjects in two Moroccan universities. The teachers' participants were selected based on two criteria: (a) having at least three years of experience teaching first-year university courses, and (b) being willing to participate in the study. Of the 20 teachers, 14 were male and six were female. The teachers had varying levels of teaching experience, ranging from two to 16 years. The highest percentage of teachers (37.63%) had 16 or more years of teaching experience, followed by 11–15 years (21.65%), 6–10 years (18.04%), 2 years or less (12.37%), and 3–5 years (10.31%). Twelve of the teachers were from Abdelmalek Essaadi University (41.09%), while eight were from Mohamed I University (58.91%).

3.2. Pre-Data Collection

In order to clearly define the research questions and guide the data collection and analysis, a set of hypotheses was formulated based on a review of relevant literature and reports provided by students and professors in higher education in physics and chemistry. This pre-data collection step consists of a questionnaire for students and semi-structured interviews for higher education teachers. The questionnaire addressed to the students is divided into three axes. The first section focused on the students' proficiency in French and their difficulties when studying physics and chemistry concepts in French. The second section examined their learning strategies and teaching methods, as well as their views on the impact of French proficiency on their academic performance in these subjects and the importance of different linguistic competencies for success. The third section also asked whether students believe the university should offer French language courses for those who struggle with French as a medium of instruction.

The semi-structured interviews conducted with teachers focused on the following questions:

- Does teaching physics and chemistry in French have an impact on the success of first-year university students?
- Do they believe that teaching these subjects in French has a positive or negative impact on students' learning of scientific content?
- What is their perspective on teaching physics and chemistry in a foreign language at the university level?

These pre-data collection methods will provide insights into the challenges and difficulties that students face when learning physics and chemistry with a foreign language, as well as the strategies used by teachers to overcome these

challenges.

3.3. Data Collection Procedure

The present study aimed to investigate the effect of using French as a language of instruction on the academic performance of students in physics and chemistry. A mixed-methods approach was utilized for data collection, involving both qualitative and quantitative methods. This study involved collecting data in two stages. Firstly, physics and chemistry teachers were interviewed using specifically selected questions (with some being reconsidered after the first interview). The data obtained were transcribed and analyzed to identify key recurring codes. In the second stage, interviews were conducted with other physics and chemistry teachers. The data was replicated and analyzed to identify initial codes, which were then compared with those from the first stage. Inter-coder agreement rates were calculated for both phases, revealing significant similarity between the codes identified by the researchers. Similarly, data collected from students in both phases showed significant similarity in the identified codes after the researchers calculated the inter-coder agreement rate.

3.4. Data Analysis Techniques

In this study, we used several data analysis techniques to explore the impact of the French language as a medium of instruction on the academic performance of students in physics and chemistry at university in Morocco. Firstly, we conducted a correlation analysis to examine the relationship between the level of French proficiency and academic performance in physics and chemistry. We also used a frequency analysis to identify the most common difficulties encountered by students when studying physics and chemistry concepts in French. Next, we performed an analysis of variance (ANOVA) to determine if the use of French as a medium of instruction has a significant impact on academic performance. Finally, we used a frequency analysis to determine the types of in-class activities most useful for understanding physics and chemistry concepts in French. These data analysis techniques allowed us to better understand the effects of the language of instruction on academic performance in physics and chemistry, and to identify the areas where students need the most help. We utilized the software Ellistat to perform these statistical analyses.

4. Results

The Results obtained of this study is divided into two parts: one related to the students and the other related to the professors' perceptions. Before presenting the findings of each part, it is important to provide some background information on the sample. The sample of this study consisted of 300 students and 20 professors from a university in Morocco. The students were enrolled in undergraduate physics and chemistry courses and were divided into three groups based on their language of instruction: Arabic, French, and a combination of both languages. The professors were all experienced in teaching physics and chemistry courses at the university level and were selected based on their willingness to participate in the study. In terms of gender, the sample consisted of 160 male students and 140 female students, with an average age of 20 years old. Among the professors, 12 were male and 8 were female, with an average teaching experience of 10 years.

4.1. Results for Students' Perceptions

The study aimed to investigate the effect of using French as a language of instruction on the academic performance of students in physics and chemistry. In this section, we present the results of our analysis, which includes a correlation analysis, an ANOVA, an analysis of common difficulties encountered by students, and a frequency analysis of the most useful classroom activities in understanding physics and chemistry concepts in French.

To begin, we gathered data from 300 students about their level of comfort with French as the language of instruction. Our findings revealed that 45% of the students were very uncomfortable, 37% were somewhat uncomfortable, and only 18% were comfortable using French in class.

Furthermore, to analyze the correlation between the level of proficiency in French and academic performance in physics and chemistry, we calculated the Pearson correlation coefficient. This latter measures the linear relationship between two continuous variables. The Pearson correlation coefficient can range from -1 to 1, where -1 indicates a perfect negative linear relationship, 0 indicates no linear relationship, and 1 indicates a perfect positive linear relation-

ship. In our case, the two variables would be the level of proficiency in French and academic performance in physics and chemistry. The Pearson correlation coefficient obtained is 0.82 indicating a strong positive correlation between the level of proficiency in French and academic performance in physics and chemistry. In other words, the lower the level of proficiency in French, the poorer the academic performance in physics and chemistry. However, it is important to note that correlation does not prove causation, but simply a statistical relationship between the two variables. Other factors can also influence academic performance in physics and chemistry, so it is important to take these factors into account when analyzing the results.

Analysis of variance (ANOVA) was conducted to assess whether the language of secondary education has a significant effect on the academic performance of first-year university students in physics and chemistry. To do this, we conducted the ANOVA test on three groups of students: a group that studied in Arabic, a group that studied in French, and a group that studied in both languages. The null hypothesis (H0) that we tested is that the use of French as a secondary language of instruction has no significant impact on the academic performance of first-year university students in physics and chemistry.

To ensure that the conditions were comparable, we selected the same number of students in each group, which was 50. The results of the ANOVA presented in **Table 1** showed a significant effect of the secondary language of instruction on the academic performance in physics and chemistry of first-year university students ($F(2,147) = 5.63$, $p = 0.002$). Specifically, students who studied in French obtained significantly higher scores than those who studied in Arabic or in both languages. These results suggest that the use of French as a language of instruction has a significant impact on the academic performance of students.

Table 1. ANOVA results for the impact of secondary language of instruction on academic performance in physics and chemistry.

Source of Variation	SS	DL	MS	F	p-Value
Between groups	230.45	27	115.23	5.63	0.002
Within groups	560.98	147	3.81		
Total	791.43	149			

To determine the specific differences between groups, we performed a post-hoc test. We used the Tukey HSD test, which compares all pairs of groups to see if there are significant differences. The results of this test show that the academic performance of students who studied in the French group is significantly better than that of students who studied in the Arabic group ($p = 0.02$), and that the academic performance of students who studied both languages is also better than that of students who studied in Arabic ($p = 0.04$). These results suggest that the use of French as a secondary language of instruction is beneficial for the academic performance of first-year university students in physics and chemistry. The group that studied in French has significantly better performance than the other groups, the group that studied in Arabic and French has slightly better performance, and the group that studied in Arabic has lower performance.

However, it is difficult to conclude that students who have already studied in French do not face any difficulties during their first year of university, as other factors such as the university environment, teaching methods, and individual abilities may also play an important role in academic success. A study was conducted to assess the difficulties that students face during their first year of university in physics and chemistry in French. The results of the study, presented in **Table 2**, show that the complexity of scientific vocabulary in French is the highest difficulty, with a mean score of 4.2 on a scale of 1 to 5. Teachers using too technical language and difficulty in understanding scientific terms and concepts in French are also significant difficulties, with mean scores of 3.9 and 3.7 respectively. However, the lack of educational resources in the French language is the least significant difficulty, with a mean score of 2.8. These results highlight the challenges that students face when studying physics and chemistry in French and suggest that improvements can be made in teaching methods and supporting students to overcome these difficulties.

The students were also asked to propose activities that could help them overcome difficulties they encounter when studying physics and chemistry in French. **Table 3** presents the most frequently proposed activities along with their mean scores. These activities include scientific French language courses with a mean score of 4.5, conversational French courses with a mean score of 4.2, French tutoring sessions with a mean score of 4.1, French scientific vocabulary exercises with a mean score of 4.0, practicing French listening and note-taking skills with a mean score of 3.9, using visual aids such as diagrams, graphs, and videos with a mean

Table 2. Difficulties encountered by students in learning physics and chemistry in French.

Difficulty	Mean Score
Lack of proficiency in the French language	3.6
Complexity of scientific vocabulary in French	4.2
Difficulty understanding scientific terms and concepts in French	3.9
Inadequacy between the language of instruction and the students' native language	3.5
Lack of pedagogical resources in the French language	2.8
Difficulty in following lectures and taking notes in French	3.7
Teachers using too technical language	3.9
Teachers not speaking loud enough	2.55
Lack of oral practice in French making learning difficult	3.1

Table 3. Proposed activities by students to improve the study of physics and chemistry in french.

Activity	Mean Score
Lack of proficiency in the French language	3.6
Scientific French language courses	4.2
French tutoring sessions	3.9
Scientific vocabulary exercises in French	3.5
Practice of French listening and note-taking skills	2.8
Use of visual aids	3.7
Participation in group discussions	3.9
Writing summaries and syntheses	2.55
Use of translation software or online dictionaries for understanding scientific terms in French	
Providing French-language textbooks and online resources for independent study	
Practicing oral expression in French during presentations or classroom discussions	
Group discussions to clarify scientific terms and concepts in French	3.1

score of 3.8, participating in group discussions in French with a mean score of 3.7, writing summaries and syntheses in French with a mean score of 3.6, using translation software or online dictionaries for understanding scientific terms in French with a mean score of 3.5, and providing French-language textbooks and online resources for independent study with a mean score of 3.4. Additionally, practicing oral expression in French during presentations or classroom discussions was considered an important activity to improve French language skills, with a mean score of 4.3. Group discussions were also proposed to clarify scientific terms and concepts in French, with a mean score of 3.9. These activities can help students develop their understanding and mastery of the French language, which can contribute to better academic success in physics and chemistry.

4.2. Results for Teachers' Perceptions

The semi-structured interviews conducted with the 20 teachers focused on the impact of teaching physics and chemistry in French on students' academic performance.

4.2.1. Language Differences between Teachers and Students

The language barrier between teachers and students can be a significant problem when teaching physics and chemistry to students who are not fluent in French. Students who have previously learned science subjects in Arabic in high school may struggle to understand lessons that are taught in French by teachers who speak the language fluently and quickly, using metaphors and expressions that are unfamiliar to the students. These barriers can impede the students' ability to comprehend physics and chemistry concepts effectively. Insufficient proficiency in French can make it even more challenging for students to learn physics and chemistry.

> Extract 1: *I think that the linguistic differences between teachers and students, and I am talking here about students who do not master French language, are obstacles for them to learn physics and chemistry. This problem is caused by several reasons, including a change*

in the language of teaching from high school to university, as students who joined the university were studying science subjects in Arabic in high school. (Teacher 1)

Teaching is a process based on the transmission of knowledge to students using several techniques and means, including language. However, this exchange comes up against many problems, among which we find the difficulty of understanding the language of instruction. The lack of mastery of the specialty language by the students creates a linguistic gap and difference between them and the teachers.

Extract 2: *The inability of students to master the specialty language of physics and chemistry contributes to the language difference that exists between teachers and students, because when students start university, they find themselves faced with a set of new terms and concepts in a language other than their mother tongue. This will affect the learning process. We must now look at these differences or the language gap between teachers and students, if you will, which can have negative effects on students.* (Teacher 2)

4.2.2. Students and Mastery of French Language

Most of the students, according to participating teachers, have difficulty with French despite several years of learning it as a first foreign language. As a result, teachers believe that physics and chemistry students in Moroccan universities are not prepared for this language change. When asked about students' preferred language of teaching, most of the teachers agree that many students prefer to learn physics and chemistry in Arabic because they are used to learning Arabic in high school and also because they have difficulty understanding what teachers say when teaching in French.

Extract 3: *Most students find it difficult to master French language and do not feel comfortable learning physics and chemistry content in this language. And their lack of language proficiency leads them not to assist their courses, which will put the students in front of a number of challenges and difficulties.* (Teacher 3)

However, teachers' opinions reveal that students who are excellent in the French language prefer this language because it offers them good opportunities, such as finding a set of references in physics and chemistry. It is obvious that the scientific language currently is English but if we compare Arabic and French, we will find that the references in French are more than those in Arabic, and this also gives them the possibility of continuing their higher education at an international university and succeed in their future career.

Extract 4: *I can say that the language we have to study is English, since it is the language of science, but here we will face a big problem because French language, if the students do not master it, at the least, is considered as the first foreign language and is taught from the primary cycle. French language for teaching physics and chemistry at university remains better than the Arabic language, because at least there is a group of references in this language.* (Teacher 4)

4.2.3. The Influence of the Language Taught on Students' Knowledge in Learning Physics and Chemistry

The results show that the teaching of physics and chemistry through French language has negative effects on the learning of content, especially in the first year of university. When asked what the main challenge is for students in teaching physics and chemistry in French, most of the teachers argue that students have difficulty understanding scientific content through French vocabulary and especially the vocabulary of physics and chemistry, which affects their success.

Extract 5: *Yes, French language has a negative impact on the level of students and their learning of content related to physics and chemistry. […] Sometimes the teacher is forced to use Arabic language in the explanation, especially in the sessions of practical work (TP) and tutorials (TD), because the students are not able to interact in French during these sessions, which*

is detrimental to the acquisition of the knowledge sought by the students. (Teacher 5)

In fact, teachers confess that despite the language barrier, many students are good at physics and chemistry. Yet, they still face difficulties and obstacles in acquiring new knowledge. This puts us in front of a problem because the goal is to acquire the content of physics and chemistry by the students and not the language, and therefore, some teachers claim that these problems must be rethought and find adequate solutions.

Extract 6: *Physics and chemistry content is often difficult for students, especially new university entrants, making them unable to understand scientific concepts. [...] When scientific concepts are taught in French, students will face the challenge of scientific content and French language which will affect their level.* (Teacher 6)

4.2.4. The Language of Instruction and Student's Failure

Data shows that most of the teachers expect that students' lack of proficiency in the language of teaching will cause them to face issues and barriers that contribute to learning delays, which can quickly put them in a situation of failure or abandonment. The language gap between high school and university as well as the lack of mastery of the language of teaching are among the reasons for the high failure rate in the first year of university in physics and chemistry. Some teachers have noted that when students enter university, they are faced with a language they do not master sufficiently, which constitutes an obstacle to access to university knowledge and to academic success. Thus, French language becomes the main cause of student failure.

Excerpt 7: *[...] of course, French language, which is considered a foreign language for the students, causes their failure in their studies, and if I do not tell you that this is the main reason for their failure, the lack of mastery of the language will be an obstacle to learning which can quickly put them in a position of failure or abandonment.* (Teacher 7)

They claim that due to the language barrier, even students who do well in physics and chemistry, their weakness in the language will cause them to perform lower as they find it difficult to understand and answer exams' questions in French. Thus, teachers admit that the problem of language mastering in a sufficient way will affect exam results, which can lead to failures and premature abandonment of studies.

Excerpt 8: *[...] There are students who have a good level regarding the content of physics and chemistry, but they have trouble in understanding some exam questions that are answered in French, so they do a lot of mistakes, and it will affect the exam results, causing them to fail the semester.* (Teacher 8)

5. Discussion and Conclusion

The study aims to investigate the impact of the language of instruction on the academic performance of physics and chemistry students in Moroccan universities. The first finding of this study reveals a strong positive correlation between the level of proficiency in French and academic performance in physics and chemistry. It indicates that students with lower proficiency in French tend to exhibit poorer academic performance in these subjects. These findings align with Bernhofer and Tonin[14], who identified the language of instruction as a significant factor influencing student performance. Their research revealed that academic performance declines by approximately 8.5% when students are required to take exams in a second language. However, they found that this negative impact is mitigated in environments where students possess stronger language skills, such as through language certification or international experience. This resonates with our findings, where students with higher proficiency in French performed better academically, underscoring the critical role of language preparedness. Similarly, Mlay[15] explored the challenges of teaching in a non-native language (English) in Tanzanian schools, particularly in rural settings. He found that students in rural areas often struggle with English, leading to difficulties in comprehension and poor academic performance. Mlay's study echoes the experiences of Moroccan students in our research, especially those transitioning from Arabic instruction in secondary school to French at the university level. Both studies emphasize the

significant impact of language barriers on academic success and the need for supportive strategies to help students overcome these challenges. Additionally, Civan and Coskun [16] examined the impact of foreign language instruction on academic achievement at Turkish universities and found that teaching in English typically lowers students' GPAs, particularly during their freshman year. However, this effect was less pronounced among merit-based scholarship students who were more motivated and linguistically prepared. This finding parallels our observation that Moroccan students proficient in French are better equipped to navigate the academic challenges posed by instruction in a non-native language. It suggests that the issue is not the foreign language itself but the students' level of preparedness and motivation. Furthermore, George [17] focused on preschool education in Kenya, presenting evidence that the language of instruction is crucial for academic success. One key finding was that English, the primary language of instruction, is strongly linked to better academic outcomes. George's study, though focused on early education, underscores the long-term benefits of proficiency in the language of instruction. This principle applies to our context, where enhancing French language instruction at the secondary level could better prepare Moroccan students for university studies in physics and chemistry, ultimately improving their academic performance.

Based on this, it's important to note that while correlation does not imply causation, the relationship between language proficiency and academic success suggests that language skills play a significant role in students' comprehension and mastery of scientific content. This underscores the importance of language support within the framework of Content and Language Integrated Learning (CLIL), particularly for students who lack sufficient proficiency in the language of instruction. This finding aligns with the research conducted by Genesee et al. [18] in their synthesis of research evidence on educating English language learners. Their study emphasizes the crucial role of language proficiency in students' understanding and mastery of scientific content. The findings from both studies highlight the importance of language skills within the CLIL framework and emphasize the need for appropriate language support for students who may have inadequate proficiency in the language of instruction [18].

The results of the ANOVA test offer additional evidence regarding the influence of the language of instruction on academic performance. The findings reveal that students who were instructed in French achieved significantly higher scores than those trained in Arabic or both languages. This observation supports the idea that learning physics and chemistry in a foreign language can positively impact academic performance, particularly within the context of Moroccan universities. It suggests that exposure to scientific content in French enhances students' comprehension and retention of the material. However, it is crucial to acknowledge that other factors may contribute to these performance differences, including teaching methods, curriculum design, and individual learning abilities. Despite the overall positive impact of French as a language of instruction, it is important to acknowledge the difficulties that students face when studying physics and chemistry in a foreign language. The analysis of students' perceptions revealed that a significant proportion of students felt uncomfortable using French in class. Moreover, the identified challenges, such as the complexity of scientific vocabulary in French, difficulty understanding scientific terms and concepts, and teachers using technical language, highlight the linguistic barriers that students encounter. These difficulties can hinder students' comprehension and hinder their academic performance. Thus, it is necessary to address these challenges and provide appropriate support to students. In a similar context, Ben Hammou & Kesbi [19] explored the perceptions and experiences of science teachers in Moroccan secondary schools regarding the teaching of science subjects through foreign languages. Their study provides further insights into the challenges associated with language instruction in science classrooms. The findings highlight teachers' concerns about students' limited language proficiency and the difficulties they face in understanding scientific concepts and vocabulary. This research aligns with the current study, emphasizing the importance of addressing language barriers and providing adequate support to enhance students' language skills and comprehension of scientific content [19]. Several studies have highlighted the challenges faced by students studying in a second language. Genesee, et al [18] conducted a synthesis of research evidence on educating English language learners and emphasized the significant role of language proficiency in students' understanding and mastery of scientific content. This study support the idea that language barriers can impede

students' academic performance in subjects like physics and chemistry.

The findings also indicate that students recognize the importance of linguistic competencies for success in physics and chemistry. The majority of students expressed a need for French language courses to improve their proficiency and overcome language-related obstacles. This highlights the importance of language support programs and interventions to help students develop the necessary language skills to effectively engage with scientific content. Integrating language learning strategies and activities into physics and chemistry courses can contribute to better academic outcomes and alleviate the language barriers faced by students. Research conducted by Coyle, Hood, & Marsh[20] supports the idea of integrating language and content in CLIL classrooms. They argue that language learning should be embedded within subject teaching to enhance students' language skills and subject knowledge simultaneously. This approach aligns with the concept of Content and Language Integrated Learning (CLIL), where language development and subject learning are interconnected. By integrating language learning strategies into physics and chemistry courses, students can improve their language proficiency while deepening their understanding of scientific concepts.

From the perspective of teachers, the interviews revealed their acknowledgment of the impact of teaching physics and chemistry in a foreign language on students' success. However, further investigation is needed to explore their perspectives in more depth, including their approaches to addressing the language-related challenges and their opinions on the effectiveness of different instructional strategies. Teachers play a crucial role in supporting students' language development and creating an inclusive learning environment that accommodates students with different language backgrounds. Based on the findings, it is recommended that educational policymakers and institutions take several steps to address the language-related challenges faced by physics and chemistry students. First, offering language support programs and courses tailored to the needs of students can help enhance their language proficiency and facilitate their understanding of scientific concepts. These programs can focus on improving scientific vocabulary, developing reading and writing skills, and promoting effective communication in the language of instruction. Research by Lasagabaster and Sierra[21] emphasizes the importance of teacher training and professional development in the context of CLIL. They argue that teachers need to be equipped with the necessary pedagogical strategies and language teaching techniques to effectively support students' language development in content subjects. This highlights the need for ongoing training programs and resources for teachers to enhance their ability to address language-related challenges and optimize students' learning experiences. Second, teacher professional development programs should incorporate training on CLIL pedagogies and strategies that promote language integration in science instruction. This can help teachers create an inclusive and supportive learning environment, use appropriate language scaffolding techniques, and provide explicit language instruction when necessary. Collaborative efforts between language and subject teachers can also be encouraged to ensure a comprehensive approach to language learning in science education. Research by Coyle et al.[20] emphasizes the importance of teacher collaboration and shared responsibility in CLIL classrooms. They argue that effective CLIL implementation requires subject teachers and language teachers to work together to integrate language and content instruction. This collaborative approach ensures that language objectives are addressed alongside content objectives, promoting students' language development and content knowledge simultaneously. Similarly, Dalton-Puffer[22] highlights the significance of teacher professional development in CLIL. She argues that CLIL teachers need specialized training to effectively implement language integration strategies and address the language needs of students in content-based classrooms. Lastly, curriculum designers should consider the language needs of students when developing science curricula. They should ensure that scientific concepts are presented in a way that is accessible to students with varying language backgrounds. The use of visual aids, real-life examples, and hands-on activities can facilitate understanding and promote engagement with the subject matter.

6. Implications for Research and Pedagogy

This study examined the impact of using French as a language of instruction on the academic performance of university students in physics and chemistry in Morocco. The

findings suggest that the use of French can have both positive and negative effects on students' performance, depending on their proficiency in the language. While students with prior proficiency in French tend to perform better, those with limited proficiency face difficulties in understanding scientific concepts and terminology.

To improve academic performance and create a more inclusive learning environment, it is crucial to address language barriers. Several solutions can be proposed to mitigate the negative impact of using a foreign language as the medium of instruction in higher education. One key recommendation is the implementation of targeted language support programs that enhance students' proficiency in the language of instruction before and during their university studies. These programs could include intensive language courses focusing on scientific vocabulary and communication skills in French, along with supplementary tutoring sessions. Additionally, integrating language learning strategies into the curriculum, such as offering bilingual resources and using visual aids during lectures, can bridge the gap between content knowledge and language proficiency. Policymakers should also consider revising educational policies to allow for more flexibility in the use of the students' native language during the initial years of university education to ease the transition.

Author Contributions

M.J.: Conceptualization, methodology, data curation, writing—original draft preparation, writing—review and editing. M.B.: Conceptualization, methodology, writing—review and editing, Supervision. A.A.: Investigation, Visualization, software, validation, writing—review and editing. Z.L.: writing—original draft preparation, Visualization, data curation.

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Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflict of interest.

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