LANGUAGE OF INSTRUCTION POLICY IN SCIENCE PROGRAMS: SCIENCE UNIVERSITY STUDENTS' VOICES

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ABSTRACT

The language of instruction policy in science university programs is chosen by different stakeholders. The voice of science university students (SUSs) has been neglected in many science programs around the world. A review of the literature shows that among all stakeholders, SUSs are influenced most—both positively and negatively—by the medium of instruction policy. This study analyzed the perspectives of 186 SUSs regarding the use of the country's official language as the medium of instruction (OLMI) and a foreign language as the medium of instruction (FLMI) in science undergraduate programs. The results showed that the majority of the participants were negatively affected by the policy of using FLMI and that their voices have been neglected. Most of the SUSs supported changing the policy to OLMI. Thus, there were contradictions between the objectives of the current policy and its real outcomes. The policy reduced the achievement of learning outcomes in science programs. The study recommended an in-depth investigation of the outcomes of the medium of instruction policy among SUSs. Neglecting the voice of science students hindered their learning outcomes.

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INTRODUCTION

Universities throughout the world have different policies regarding the language of instruction in science university programs. Some undergraduate science programs use the country's official language as the medium of instruction (OLMI). Other science university programs adopt the policy of using a foreign language as the medium of instruction (FLMI). English is the most common foreign language used to teach sciences in different countries, and countries have different reasons for adopting English as the medium of instruction (EMI). The most common reason is that the English language has become the lingua franca of science and technology (Cook, 2017; Crystal, 2003; Dearden, 2015). Many educational institutions adopt EMI in order to connect with other scientific institutions around the world and remain up to date about the recent developments in scientific fields since most of the scientific research is published in English. Additionally, most of the international companies and institutions require English proficiency from the applicants. Thus, different universities, especially in developing countries, adopt an FLMI policy in science university programs. After reviewing 83 studies on EMI in higher education, Macaro et al. (2018) concluded that stakeholders have serious concerns regarding the introduction and

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implementation of EMI despite in some cases recognizing its inevitability. The authors reported that the research evidence to date is insufficient to assert that EMI benefits language learning or that it is detrimental to content learning. They emphasized that there are insufficient studies demonstrating, through the classroom discourse, practices that may lead to beneficial outcomes.

There is active debate among science instructors and science program designers regarding the language of instruction in science classes (Wanphet & Tantawy, 2018). The debate centers around the use of the country's official language to teach science subjects at the university level versus the use of a foreign language such as English, which has become the language of science. This debate seems to be ongoing and unsolved. Different perspectives are presented by different stakeholders, such as science instructors, science programs designers, and government officials (e.g., Alhamami, 2015). However, this debate neglects the voice of science university students (SUSs), who are future scientists. SUSs are essential stakeholders in the learning process, and any adopted policy will affect them directly. Analyzing previous studies shows that most of the advantages and disadvantages of language policy are related to SUSs (e.g., Macaro et al., 2018; Wanphet & Tantawy, 2018). This research study analyzes and discusses the perspectives of 186 SUSs at advanced levels in four departments (biology, chemistry, mathematics, and physics) regarding the use of OLMI and FLMI.

To understand the outcomes of the language of instruction in science programs, we need to compare and analyze the strengths and weaknesses of the use of the country's OLMI and the use of FLMI. Analyzing the previous studies reveals different results of using OLMI (i.e., using Arabic as a medium of instruction in an Arabic-speaking country such as Saudi Arabia) and using FLMI (e.g., using EMI in an Arabic-speaking country such as Saudi Arabia). The following sections investigate the major strengths and weaknesses of OLMI and FLMI in developing countries. The advantages and disadvantages of adopting the OLMI and FLMI can be classified under the three categories: science learning outcomes related to science students, science learning outcomes related to science instructors, and science learning outcomes related to government policymakers.

Analyzing the literature reveals that most of the advantages and disadvantages of the language of instruction policy in science programs are related to students (Uçar & Soruç, 2018; Yen, et al., 2018). For example, using the country's OLMI enables SUSs with lower proficiency in foreign languages to join science departments based on their ability to learn science and their knowledge about sciences rather than their proficiency level in a foreign language. Lee (2005) stated that assessment practices in science programs are differentially biased because students are often not assessed in their home language. These assessment practices may result in a significant underestimation of students' science knowledge in that such practices conflate science knowledge with other types of linguistic and cultural knowledge. For example, in the Arab world, SUSs might not achieve the required English proficiency and will not be able to join science departments that use FLMI regardless of their background in science in high school. EMI adds an additional condition and requires more preparation for high school students who would like to join science departments at the university.

Using the country's OLMI reduces the time and effort required by SUSs since they will focus more on learning sciences rather than learning sciences and a foreign language simultaneously. This reduced burden will help SUSs cope with the workload of science courses and enhance their grades in these courses (Brock-Utne, 2007). Research shows a strong correlation between English language proficiency and academic success in colleges that use EMI (Berman & Cheng, 2010; Evans & Morrison, 2011; Schoepp, 2018). In addition, SUSs will be able to communicate and participate in science course discussions easily since they will use the language that they speak fluently. Hengsadeekul, et al., (2014) found that only confident English speakers were sufficiently motivated to participate and discuss in EMI programs in Thailand. Another advantage of OLMI is that SUSs will be better able to talk about science with people outside the university. They will spread the knowledge of science among their relatives and friends and will know science terms in the official language.

However, FLMI provides SUSs with more job opportunities after they graduate since most companies use English as a medium of communication. These SUSs will also be able to attend graduate programs abroad more efficiently and continue their higher studies since most of the graduate programs use EMI. Dearden & Macaro (2016) surveyed lecturers in Austria, Italy, and Poland and found that a frequently cited advantage of EMI in these countries is giving students the same opportunities to study abroad. Additionally, these students will have access to the most

recent developments in their field and more learning resources. These SUSs will be able to both earn a science degree and be fluent in a foreign language. Chapple (2015) found that one of the main reasons to join EMI programs is to improve English language proficiency in Japanese universities. Rogier (2012) found that students who have been taught in English at United Arab Emirates universities show a statistically significant gain in their English proficiency after four years of study.

A review of the literature shows different advantages of using OLMI that are related to science instructors (Wanphet & Tantawy, 2018). Alhamami (2015) surveyed 27 science university instructors in a Saudi university. He found that the majority of the instructors preferred to use the official language to teach science. One of the most considerable advantages that affects science learning outcomes is the ability of science instructors to focus more on teaching science and saving time translating or repeating information due to the low proficiency of SUSs. Instructors will be able to cover the required learning outcomes since most of the science programs assume that learners are fluent in the language of instruction, and instructors will therefore not spend time and effort to translate and repeat information slowly for SUSs. In addition, using OLMI will motivate instructors to publish their research in the country's official language since there is a national audience for their science textbooks and articles. Interactions and in-class discussions between instructors and students will increase since it is easier for students to communicate in their mother tongue with their instructors.

However, using FLMI will increase the communication and research collaboration between the national scientists and international scientists abroad because English is the global language of the sciences. The scientists will be more motivated to write and publish research in international journals. There are more science journals published in English and more readers and researchers who subscribe to these journals (Fuentes & Gómez Soler, 2018). Today, instructors have more students who attend their online courses or learn their science watching YouTube videos from different countries around the world. Finally, national scientists will have access to the most updated research and modern technological innovations.

Language choice brings challenges to policymakers (Carroll, 2016; Evans & Morrison, 2017). Using OLMI in developing countries will strengthen the status of the official language and increase its influence by reinforcing its prestigious and historic position as the language of science in the minds of its native speakers, such as the status of Arabic in Arabic-speaking countries. This outcome will preserve the national identity, the national language, and local culture (Alhamami, 2015; Belhiah & Elhami, 2014; Carroll, et al., 2017; Ellili-Cherif & Alkhateeb, 2015). Besides, the use of OLMI will increase the feeling of independence from the previous colonizers. Most Arab countries use the language of their colonizers before independence. For example, French is used to teaching science in Algeria, Morocco, and Tunisia, and English is used to teach science in Iraq, Egypt, and Sudan. Pennycook (2001) has argued that the spread of English as the language of sciences serves the interests of certain colonizers; it is a politically and economically motivated expansion that contributes to the marginalization of small countries. OLMI will increase the employment of local students on a national level, making it easier for SUSs to learn science and become scientists. Furthermore, local people will increase their knowledge of science and education about science. The use of OLMI will also help universities save money that is spent on preparing SUSs and teaching them a foreign language.

However, using FLMI increases the job opportunities for SUSs internationally (Hillman et al., 2018). Bozdoğan & Karlıdağ (2013) interviewed 15 Turkish students. The interviewees believed there were instrumental advantages in studying in English. Improving their English would give them access to more job opportunities in Turkey and abroad. There is also a greater likelihood that national science programs will be recognized on an international level, and there will be more contact and cooperation between national universities and global organizations. Hu et al., (2014) emphasized that using EMI in Chinese universities increases the benefits both at the institutional and national levels, such as social mobility and career prospects. This approach also makes it easier to hire foreign scientists to work in national universities. Also, it will open more opportunities for international students to join universities in Arabic-speaking countries since English is an essential constituent of the internationalization process (Macaro et al., 2018). In Sweden, Airey & Linder (2006) noted that the use of English in Swedish universities makes it possible to accommodate overseas SUSs and visiting scientists, and this consideration is also applicable to Arab countries.

The research study focuses on the perspectives of SUSs regarding the effectiveness of the language of instruction policy on the science lear-

ning outcomes at the university level. Specifically, the study investigates how SUSs perceive learning their science subjects in Arabic, the country's official language, as a medium of instruction and English, a foreign language, as a medium of instruction. What do SUSs experience regarding EMI and Arabic as a medium of instruction in their university science departments?

METHODS

This research explores a context that has not been examined and presents the voices of stakeholders who have been neglected in many educational programs. The study was conducted in a science college in a Saudi public university that uses EMI. It is the only science college that offers science programs in the university. The science college offers four BA programs: biology, chemistry, mathematics, and physics. All of these programs are taught in English. The applicants are not required to take any particular English language tests such as TOEFL and IELTS that show their English proficiency. However, in Saudi Arabia, students start taking English language courses in the 5th grade. Students also start taking science subjects in the elementary schools in Arabic. When students are admitted to the College of Sciences, they must take an intensive English learning program during the first semester. This intensive English program offers four courses: reading, writing, listening and grammar. The program was designed to help students who cannot speak English read the textbooks, write the assignments and exams in English, communicate with their instructors in the College of Sciences, and become familiar with the academic environment and the language of instruction (English).

In this learning environment, the students are Saudi, and they share the same culture. They are between 19-24 years old. They speak Arabic as their mother tongue. They are all male. In Saudi Arabia, there are specific campuses and colleges for males and others for females. The participants in this study are advanced-level undergraduate students who enrolled in the undergraduate programs in the following departments: biology, chemistry, physics, and mathematics. This is a purposeful method. The participants are selected based on pre-selected criteria (advanced science levels' students) due to the objectives of the research study. So, it is a homogeneous sample because the participants share the same academic backgrounds. The reason for choosing a homogeneous sample is that the research questions are targeting a group of science students

who share specific characteristics. The total number of participants volunteering in this study is 186. The participants volunteered to participate in this study. Their instructors come from different countries, such as Algeria, Egypt, Canada, Jordan, India, Palestine, Pakistan, Saudi, Sudan, Syria, and Yemen. The instructors speak different first languages and dialects.

This study used a written questionnaire to elicit quantitative and qualitative data from 186 participants. The questionnaire was written in Arabic to ensure that the respondents could express their points of view clearly and without language constraints since Arabic is their mother tongue and most of them are not fluent in English. The questionnaire was distributed among the advanced undergraduate science students. The reason for choosing advanced-level students is that they have enough experience learning science in English. The questionnaire contains thirteen questions that explore the students' English learning backgrounds and experiences in learning sciences through EMI. Some of the questions are qualitative so that the participants can express their views in detail, and some of the questions are quantitative, allowing the researcher to compare the participants' answers. The researcher analyzed the results quantitatively and qualitatively using descriptive statistics and coding themes, respectively. The results are presented and discussed in five categories: SUSs' language proficiency, SUSs' attitudes, language of instruction and SUSs' achievements, language of instruction outside the university campus, and SUSs' plans. Appendix A contains translation of the questionnaire items.

RESULTS AND DISCUSSION

The first category presents SUSs' evaluation of their English proficiency. The first question examines the participants' view of their English proficiency after taking English courses in intermediate and secondary education. A total of 6 out of 186 (3%) of the participants think that their English learning outcomes from their intermediate and secondary education are excellent; 78 out of 186 (42%) of the participants believe that their English learning outcomes in their intermediate and secondary education are good; 101 out of 186 (55%) of the participants stated that their English learning outcomes from their intermediate and secondary education are weak. This finding indicates that most SUSs are aware that they do not have excellent proficiency in FLMI before joining the university. SUSs are

not satisfied with the outcomes of English learning courses in high schools. This result suggests that universities must provide SUSs with language programs to enhance their proficiency in the FLMI.

The next item in this category examines the participants' evaluation of the intensive English program during the first semester that is provided by the university. A total of 5 out of 186 (3%) of the participants think that the intensive English program that is provided by the university in the first semester is excellent; 97 out of 186 (54%) of the participants think that the intensive English course is good; 84 out of 186 (43%) of the participants think that the intensive English course is weak. Therefore, proficiency in FLMI cannot be obtained in providing intensive programs in the language of instruction. There are different reasons for these negative outcomes. The participants who think that the course is not excellent provide the following reasons. Most of the content of the textbooks is not used in the scientific field. Most of the vocabulary and tasks are not commonly used in science. The course does not provide enough science terms. Additionally, the participants think that the course contents are a repetition of what they have learned in the intermediate and secondary education. The intensive course is only for one semester, which is not enough to learn enough English since students' English proficiency is weak.

The second category presents the results of the participants' attitudes toward the language of instruction in science courses. In this context, attitude can be defined as the evaluation of the students toward certain learning process, ranging from extremely negative to extremely positive. The first item asks the participants which language is better for them to learn science, Arabic or English, in their university majors. A total of 154 out of 186 (82%) of the participants prefer Arabic as the language of instruction in their sciences majors, while 34 out of 186 (18%) prefer EMI in their science majors. This finding indicates that SUSs prefer OLMI more than FLMI. Thus, conflicts exist on the current policy and the students' attitudes. Most of the SUSs have a negative attitude toward FLMI.

To clarify this negative attitude, another item explores whether the participants think that teaching science in their mother tongue gives SUSs more benefits. A total of 29 out of 186 (15%) of the participants think that teaching sciences in Arabic does not give the SUSs more advantages than teaching sciences in English, while 152 out of 186 (85%) think that teaching science in Arabic will provide SUSs with more benefits and more positive learning outcomes.

Then, the participants were asked whether they prefer teaching science in Arabic at the College of Sciences and the reasons for their opinions. The 29 (15%) participants who do not prefer Arabic as the medium of instruction in their college have different reasons. Jobs in large companies require English proficiency. English is used as a means of communication in prominent organizations. Learning science in English will improve students' English proficiency. Arabic will not help the students to be updated with the latest developments in their major. Additionally, the resources in Arabic are limited and outdated as in other languages such as Korean (Kim, et al., 2014). Some SUSs might study or work in another country where English is the means of communication. Some scientific terms do not have Arabic equivalents. In addition, teachers who learn through EMI will find it challenging to teach in Arabic.

The 157 (85%) participants who prefer teaching sciences in Arabic have the following reasons. SUSs find it challenging to learn science through English since most of them lack English proficiency. SUSs find it difficult and time-consuming to translate the scientific learning materials into Arabic. They think that learning through English does not enable them to have an in-depth understanding of scientific concepts and theories. They believe that it consumes more time, money and effort. They state that they buy a dictionary and spend more time memorizing word spellings and pronunciations. English language prevents them from understanding science exam questions or writing exam answers. SUSs are familiar with learning science in Arabic since Arabic is the medium of instruction in science subjects at the intermediate and secondary education levels. Most of the students also plan to teach in intermediate and secondary education, where Arabic is the medium of instruction. Some of the participants also mentioned that teaching sciences in Arabic will promote their pride in their national language. Additionally, all the students in the college speak Arabic as their first language.

The third category analyzes the influence of the language of instruction on SUSs' achievements in science learning outcomes. The first item elicits the participants' views of the influence of EMI on their science educational level. A total of 40 out of 186 (12%) of the participants think that teaching sciences in English has positive effects on their science learning outcomes, while 146 out of 186 (78%) think that teaching sciences

in English has a negative effect on their science educational levels. Participants who reported that the effect of English on their level is positive gave the following reasons. SUSs can obtain more information from different sources. SUSs can also acquire English while they are studying sciences. In addition, there are science abbreviations in English that cannot be translated into Arabic. Participants who said that the effect of English on their learning level is negative gave the following reasons. SUSs depend on memorizing more than understanding. Additionally, most SUSs do not have any previous experience with studying sciences in English in high school. SUSs achieve lower GPA (grade-point average) because they do not have sufficient English. For example, unfamiliar words may appear on the exam paper, and SUSs do not know their meaning so they cannot understand questions.

The next item in the category investigates the participants' opinions regarding whether they think that their educational level in their major will improve if they study science in their mother tongue. A total of 15 out of 186 (8%) of the participants think that their educational level will not improve if Arabic is used as the medium of instruction in the college, while 171 out of 186 (92%) think that their level in the college will improve if Arabic is used as the medium of instruction.

Another item asks the participants whether they have experienced the following situation: An SUS could not answer a question due to his/her low proficiency in English, and he/she would answer the question if it were in his/her mother tongue. A total of 30 out of 186 (16%) of the participants do not have difficulty in writing their exams or assignments in English; 156 out of 186 (84%) have difficulty in writing their answers in English while completing their assignments and exams.

The fourth category illustrates the influence of the language of instruction of science classes outside the university campus. The first item in this category measures the participants' time spent searching for information related to their majors in English references. A total of 8 out of 186 (4%) of the participants always use English scientific references; 33 out of 186 (18%) often use English references; 52 out of 186 (28%) sometimes use English scientific references; 93 out of 186 (50%) never use English scientific references in their studies but instead always use Arabic references to learn about science subjects. This finding shows that most of the undergraduate SUSs use the official language (Arabic) to learn and research in their field.

The next item depicts the participants' perspectives regarding teaching sciences in English at the intermediate and secondary education levels. A total of 95 out of 186 (51%) of the participants would like to learn sciences in English in their intermediate and secondary education. They state that this approach will help them to become familiar with learning sciences from the early stages of their learning. SUSs would not find a great difference between college and high school. A total of 91 out of 186 (49%) of the participants do not want sciences to be taught in English in intermediate and secondary education. These SUSs state different reasons. SUSs do not have sufficient English proficiency since English is not taught in most of the elementary school levels well. In addition, science instructors in the intermediate and secondary education lack proficiency in English. Teaching science in English at these stages would prevent sharing science knowledge among Saudi populations since most of Saudi parents do not speak English. These participants also think this might affect their knowledge of Arabic. They would not learn scientific terms in Arabic. Additionally, some of the students in the intermediate and secondary education would not major in sciences in colleges. They might join the other colleges such as the College of Arabic Language and the College of Arts, where they need a deep understanding of their mother tongue (Arabic).

The last category depicts the future of teaching and learning sciences using OLMI and FLMI from SUSs' perspectives. The first item in this category checks whether SUSs have plans to do higher studies abroad. A total of 97 out of 186 (52%) of the participants would like to continue their education in a foreign country where English is the medium of instruction; 89 out of 186 (48%) of the participants do not want to attend higher studies in a foreign country where English is the means of communication. Another item asks the participants whether they plan to teach science in intermediate and secondary education, where Arabic is the medium of instruction. A total of 22 out of 186 (12%) of the participants do not plan to teach in intermediate and secondary education, while 164 out of 186 (88%) of the participants would like to teach in intermediate and secondary education after graduation from the College of Sciences. This finding demonstrates that most participants are planning to teach science in intermediate and secondary education.

The last item in the research tools is an open-ended question for the participants as to

whether they have any comments and suggestions regarding teaching and learning science subjects in the official language and English as a foreign language. The participants provide different suggestions and comments about teaching sciences in English in their college. The participants state that the intensive English program should be two semesters instead of one. The intensive program should include speaking skills. This approach would help the students to communicate with their professors who cannot speak Arabic. The participants also suggest that the materials in the English learning program should focus more on sciences rather than general English. Additionally, students should be informed about EMI in the College of Sciences before they are admitted. Students should be informed when they are at the secondary education level so that they pay more attention to English learning classes. Some participants also suggest that the college should have two tracks: Arabic and English. SUSs who want to work in international companies or pursue their higher studies in a foreign country can join the English track. SUSs who plan to join government sectors and to teach sciences in elementary, intermediate, and secondary education can join the Arabic track.

Analyzing the current study results and the previous studies on science education reveals different causes of negative learning outcomes in programs that use FLMI. The most important factor is the lower proficiency of SUSs in the foreign language. Lower proficiency is the crucial factor leading to different adverse learning outcomes, as illustrated in the above sections. The second important factor is the awareness about the importance of learning a foreign language in high school and the university preparatory programs. Some high school students are not aware of the importance of having a higher proficiency level in a foreign language that is used in the College of Sciences. The third factor is instructors' and students' negative attitude toward FLMI. This negative attitude might be caused by lower proficiency or the negative image of the language in the minds of local people. For example, the language of instruction might be the language of colonizers.

When adopting OLMI, the literature shows that instructors are not able to teach in their native language due to their training. The instructors were educated and trained in a foreign language. This training prevents them from being able to teach and write in their national language. Additionally, many updated science materials are written in English. Some scientists have difficulty finding updated science research in the official language of some countries, especially in developing countries. Graddol (2000) emphasized that the ease of finding modern materials in English has led to an increase in the number of courses that use EMI.

The results of this study show negative views that strongly affect the learning outcomes in the science program. A review of the literature shows different strategies and solutions to overcome the challenges that arise when adopting FLMI. The first solution is to design two tracks based on the language of instruction. SUSs can join the program that uses OLMI or the program that uses FLMI. Providing two tracks that use two different languages will help SUSs to join the program that fits their future goals. SUSs who would like to pursue higher studies and join international companies can join the FLMI program. SUSs who would like to teach in elementary schools or join government sectors might join the OLMI program. In one track that uses FLMI, university administrators might design programs to help students change their negative attitude toward foreign language and be aware of its importance in the field of science. Thus, SUSs will be aware of the importance of proficiency in a foreign language such as English in the Arabic-speaking countries. University administrators can also provide English learning programs for SUSs that increase SUSs' English proficiency and knowledge about commonly used science terms and vocabulary. English for scientific purposes can help SUSs to improve their English skills to understand the written and spoken scientific discourse. Another solution is to design science learning materials that target low-proficiency speakers of English. Providing SUSs with science materials that are designed for SUSs with lower English proficiency will help SUSs learn science and overcome the challenge of language proficiency.

CONCLUSION

This study has highlighted the complexity of current debates about the use of the official language or a foreign language as a medium of instruction in science undergraduate programs. It is important to emphasize that SUSs are important stakeholders whose views have been neglected by science education policymakers but whose views should be accounted for in research and curriculum design. The results of this study reveal interesting perspectives on teaching sciences in Arabic and English at the undergraduate level. The majority of the SUSs who participated in

the study expressed a negative attitude toward the use of FLMI and favor the use of their OLMI. The analysis of the results indicates that governments, educational organizations, and policymakers should take a major role in implementing SUSs' opinions in planning science programs at the university. Without taking SUSs' perspective into account, teaching science subjects at the university level might not be effective or even possible. This condition will affect the learning outcomes significantly. The language of instruction policy needs to include students' views because conflicts between students' views and the policy in place might create obstacles to achieving the learning outcomes effectively in science subjects. Students' proficiency in a foreign language is a major problem; one alternative solution to this problem is to teach science courses in the country's official language, which most of the SUSs are fluent in. Based on the results, adopting OLMI offers the best means of overcoming language and communication barriers in the College of Sciences. From SUSs' perspective, this approach would help to solve many of the problems in science education in developing countries, especially in Saudi universities. Notably, this study focused exclusively on the SUSs' perspectives. The views of other stakeholders, such as instructors, parents, and policymakers, should be studied and analyzed.

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