

## **Ascertaining the Role of Language in Teaching Mathematics through the Medium of English: Is It a Factor of Influence in Educational Processes within Various Academic Settings?**

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**Abstract:** Amid a fast-moving global shift towards implementing English medium of instruction in the sphere of higher education of non-Anglophone countries, contrasting views have been held regarding a role of the language of instruction in comprehension of educational content in the field of mathematics and mathematics-related disciplines. This intrigued the present paper, which is aimed at providing literature review on a gamut of aspects exerting a considerable influence upon effective mathematics-oriented content delivery, such, for instance, as teachers' insufficient command of English, a peculiar nature of vocabulary used in the domain and the necessity to resort to stakeholders' first language. The academic literature emphasizes a significant impact of those variables upon the quality of the content delivery and students' understanding of the taught material. The paper concludes with suggestions concerning additional, in-depth research that needs to be conducted to shed further light upon the factor of language with the view of identifying its value in the mathematics educational landscape.

**Keywords:** English medium of instruction, mathematics.

### **1. Introduction**

There appears to be an emerging consensus on the pivotal role of the English language as a primary medium of instruction in the arena of higher education of non-Anglophone countries. Among the most vivid manifestations of this ever-growing interest towards delivering various academic subjects through the language of instruction is an increasing number of non-English speaking countries (NESC) plunging actively into the rapidly evolving process. Being regarded as a 'global phenomenon in both public and private education in all stages of education' (Dearden 2014, p.3), it is highly intertwined with globalization, which in its turn is deemed as a key factor in changing the status of English making it a global lingua franca (Cogo & Dewey 2012). The global proliferation of the language is reflected through its profound impact upon a broad spectrum of domains including, inter alia, cutting-edge knowledge, international communications, business, commerce, science and research. It is of importance to note that the latter two domains are assigned a high weight because the global predominance of English can be viewed through

the prism of its hegemony in the academic field where a great majority of scientific publications are written in the language (Abello-Contesse et al. 2013). Not unexpectedly, the pervasive dominance of the language in academic publishing brings to the fore the aspect of satisfactory English proficiency, on the part of both academic staff and students, which can never be overemphasized. Ignoring potential adverse consequences of the stakeholders' insufficient English competence may constitute a serious stumbling block for higher education institutions (HEI) of NESC in their aspiration to implement English medium of instruction (EMI).

## **2. Lecturers' Inadequate Grasp of the English Language: Some Cases of its Pernicious Influence**

Coming from this angle, it is worth providing meaningful insights into a wide range of problems that were incurred on account of the poor command of the medium of instruction on the part of both students and educators. As to the educators, there is no dearth of literature on the various challenges pertaining to the use of English as the instructional language by the group of stakeholders in the arena of higher education. Amidst the challenges are those related to teacher credibility (Lavelle 2008), which is predicated upon 'comfortably comprehensive pronunciation' (p.143). Among other things, the author attributes considerable significance to recurrent and high-profile contrastive errors as the ones that may constitute a threat to teachers' credibility. The former type of errors is associated with mistakes in grammar, vocabulary and pronunciation, whereas the latter is brought to the fore when learners and a teacher are native speakers of the same language. Not less important is that along with the damage of credibility, the errors may strongly affect students' attention detracting it from the content of EMI lectures (Lavelle 2008).

The aspect of credibility goes hand in hand with teachers' competence to lecture which rests upon their ability to be fluent and accurate in English (Ibrahim 2001). In that respect, Ibrahim (2001) is of the opinion that educators' inaccuracies falling within the scope of grammar, lexis and pronunciation will, with a high probability, retard learners' understanding of the content delivered through EMI or even become an impediment to their grasp of the content. Another aspect of concern emphasized by the author revolves around a detrimental effect of the inappropriate level of the medium of instruction upon educators' reading comprehension of English-based textbooks. The adverse consequences of the effect may hinder their understanding or 'may cause them . . . even a misunderstanding' (p.126). In this regard, it is of importance to highlight that, according to the author, there is a danger of compromising learners' academic development since the misunderstanding may be transformed into misinformation, which in its turn, might be of pernicious nature with regards to the development.

Coming from this angle, the latter should also be viewed in conjunction with construction of knowledge as it plays an important role in the process. In their case study, Hu, Li and Lei (2014) devoted a particular attention to various difficulties experienced by EMI teachers, along with EMI students, in their bid to be competently engaged in the discursive knowledge construction owing to their weak command of English. Amongst the difficulties are the ones associated with explaining technical terms, scientific concepts, and analyzing complex cases.

An additional challenge triggered by lecturers' inadequate English competence may arise in the context of informal English (Tange 2010). Drawing on the study carried out at three HEI in Denmark, teachers lack linguistic competence when it comes to spontaneous or informal conversations with students. The reports indicated that the lecturers' confidence declined when the interactions with the students fell outside the scope of previously planned lectures oriented toward domain specific medium of instruction.

With respect to domain specific medium of instruction, diverse views have been expressed as to the interdependence between subject-related disciplines and the required English proficiency level on the part of the stakeholders. Given the scope of the paper, the interdependence is considered through the prism of the adequacy of educators' English skills.

### **3. Teaching Exact Sciences via EMI: Mathematics**

Interestingly enough, there appears to be an emerging consensus concerning necessary linguistic competence enabling lecturers to effectively deliver their subject matter courses via the language of instruction. The consensus lies in agreeing that when it comes to teaching exact sciences via the medium of English, lecturers place a decreased value on the aspect of the language. In this regard, it is worth mentioning a study conducted in three European countries exploring the attitudes of lecturers towards EMI (Dearden & Macaro 2016). Some of the participants of the study, university teachers, expressed the view that technical nature of the disciplines attaches minor importance to having a robustly proficient knowledge of English. The reasoning behind the responders' view was based upon the standpoint that the vocabulary used in teaching the disciplines is quite limited. From their perspective, science and mathematics were considered easy for teaching and 'required little language' (Dearden & Macaro 2016, p. 471).

In a similar vein, the peculiar nature of vocabulary, its limitedness, used in exact sciences emerged in the research conducted by the researcher while working on his doctoral thesis centering on developing a model of EMI implementation strategies within the scope of higher education (Michaelan 2018). The research was oriented towards equipping stakeholders with a range of effective tools necessary for a successful implementation of

EMI in the arena of higher education of non-Anglophone countries. It is worthy of note that among diverse opinions touching upon the role of the medium of English in conveying and learning educational material of mathematics-related content, there were a number of the interviewed educators who accorded low significance to the medium of instruction in the field. Interestingly enough, some even doubted the necessity of the English language knowledge for the process. It is feasible to assume that the stance is based on the belief that the high frequency of recurrence of the limited vocabulary used in delivering the content of the disciplines, along with standardized mathematical symbols the vocabulary consists of is highly profound in its impact upon alleviating the linguistic burden on the stakeholders. As a result of the reduction of the linguistic burden, the significance of the language in the process is downplayed.

Along similar lines, the attribution of little or no value to the language of instruction comes to the fore in the study conducted in Turkish universities (Dearden, Macaro&Akincioglu 2016). The study ascertained the extent of 'success of collaboration in lesson planning between English language specialists and content teachers' (p. 51) in the universities that embraced the EMI approach in teaching academic subjects. Among other things, due attention needs to be attributed to the position of an EMI teacher concerning the role of language in dealing with mathematical problems. What emerged unambiguously from pre- and post-intervention interviews with the teacher is that before the intervention the interviewee places decreased importance, if any, on language as in calculations it 'doesn't come into play' (p. 63). Additionally, the teacher is of the opinion that language skills carry no value whatsoever in solving certain mathematical problems such, for example, as multiplication of two entities. The attitude towards the medium of instruction significantly changes, however, after the pre-intervention interview and prior to the post-intervention interview. The educator admitted that mathematics needs to be supported by language.

Laying special stress upon the influence of language in the field of mathematics manifests itself through a number of publications. According to Smith (2017), understanding of language is substantial and assigned a high weight when it comes to efficiency of math instruction. DelliCarpini and Alonso (2014) are of the view that the learners' ability to understand the language is essential for teaching mathematical content. Another noteworthy aspect of mastering mathematics by non-English speakers that can never be overemphasized is the learners' proficiency in conversational and scientific English as the proficiencies are the prerequisites for the stakeholders to be successful in mastering the subject (Gerber et al., 2005). In addition to that, Barton and Neville-Barton (2003) mention a possible connection between mathematical performance and learners' general English proficiency. The researchers' expectation is that mathematical achievements of the students 'at undergraduate level or below' (p. 3) is influenced by the students' general proficiency in the language. As to the purpose of the researchers' study, it revolved around ascertaining the required level of the

language proficiency for the second language learners to be successful in undergraduate mathematics study. One of the conclusions stemming from the study is that language is an integral part of mathematics and it is the technical language in particular that is 'important, not just everyday English' (p. 9).

The study's conclusion resonates with the stance of Molina (2012) bringing to the fore the bond between mathematics and language which, according to the author, are 'inextricably intertwined' (p.11). The author attaches high value to language considering it a key vehicle by means of which mathematics knowledge is conveyed, and claims that understanding of the latter by students depends upon 'their comprehension of both the academic language of mathematics as well as the instructional language' (p.11). The common belief is that to capture the breadth and depth of central concepts falling within the scope of mathematics it is vital for students to have a rich vocabulary of the field (Molina 2012). The writer holds that a lack of understanding of the language in various aspects of teaching mathematics constitutes an impediment to a successful learning of the subject. In addition, the writer accords a high significance to the vocabulary development program that needs to be an inalienable part of instruction in order to maximize the achievement in the field.

There is yet another valuable aspect related to mathematics vocabulary instruction, mainly its effectiveness, Molina (2012) believes can never be overemphasized. The author underscores the significance of teaching the vocabulary of mathematics 'as an intrinsic part of math lessons' (p. 12) because providing practice and vocabulary instruction isolatedly does not necessarily serve as a fertile ground for problem - solving ability or conceptual understanding (Molina 2012).

In addition, the writer brings to the fore the issue pertaining to the acquisition of math-oriented vocabulary owing to the fact that certain terms related to the field are hardly used outside of mathematics lessons. Viewed from this angle, an emphasis is laid upon unique differences between math and reading instructions, and a major distinction that needs to be taken into consideration revolves around the amount of reinforcement required for the language of the field in comparison with the one used in various settings on a daily basis, i.e., everyday language (Molina 2012). Being restricted in its use within the scope of mathematics lessons, mathematics language is also put at a disadvantage due to a paucity of 'formal structure or system to enable or support the reinforcement of mathematics vocabulary outside of the math classroom' (Molina 2012, p.13).

Along with the above-mentioned issues pertaining to the vocabulary of the discipline, there are other, even more serious issues, according to the author, that need to be taken into account with respect to the complex nature of the English language itself. The complexity of the latter comprises, among other things, a considerable amount of rules

frequently having scores of exceptions, a large number of idiomatic expressions and words with numerous meanings (Molina 2012). To this can be added that the complexity of the language can lay an indelible imprint on the difficulty of the subject raising its level and, therefore, leaving 'students, particularly those who are younger or are learning English, dazed and confused' (Molina 2012, p.13).

Keeping those constraints in view, the author emphasizes that due attention should also be accorded to the fact that a significant number of terms in mathematics are deemed as abstracts and represent concepts. The latter brings to the fore the problem associated with representations of the terms in real life to assist the students in attaining their meaning (Molina 2012). This difficult to define abstract concepts related to the field of mathematics serves as a trigger for defining 'mathematical terms in context' (p. 13).

Without detracting from the importance of the above-mentioned aspects linked to the role of the medium of English in the educational process of teaching mathematics, considerable significance needs to be attributed to the students' first language owing to its positive impact upon learning the discipline. Drawing on the results obtained from the study described by Clarkson (2007) pertaining to Vietnamese students in Australia, it can be surmised that being bilingual provides a breeding ground for a more efficient learning of mathematics due to certain advantages identified among some bilingual learners. The researcher's suggestion lays particular emphasis upon a greater degree of confidence on the students' part when it comes to solving difficult problems and a greater degree of their metalinguistic skills allowing the students 'to self-correct when solving problems' (Clarkson 2007, p. 191).

In that respect, it is unlikely to expect high confidence among students experiencing difficulties with mathematics itself rather than with language. Drawing on the interviews with the teachers participating in the study conducted in various Swedish schools, mathematics will always be considered as a central issue regardless of the language it is delivered in (Dhia Peter 2020). It is plausible to assume, according to the author, that the teachers' views stem from a lack of understanding concerning the potential value of the English language in mathematics education. The educators' standpoint is based on the fact that being experts in teaching math, the teachers apparently are unable to appreciate a vital role of the language through which the discipline is taught (Dhia Peter 2020). This inability goes hand in hand with the one of understanding 'what kinds of language-related challenges mathematical word problems can contain' (p. 19). The researcher is of the view that if the latter is the case, learners will continue to encounter difficulties solving the problems.

In a similar vein, the vital role of language in the field of mathematics is touched upon by Boero, Douek and Ferrari (2008), who wrote about the connection between



mathematics and languages: natural and symbolic. The authors claimed that students can perform in a satisfactory way 'only if [they] reach a sufficient level of familiarity with the use of natural language in the proposed mathematical activities' (p. 262). The authors' focus centers upon considering natural language as a mediator between a host of aspects, among which are mental processes, experience and concepts. Owing to the importance of these and other, mentioned by the writers, aspects it is expected of the teachers to raise awareness regarding the problems associated with teaching math to EMI learners in the sphere of higher education of NESAC.

#### **4. Implications and Recommendations**

Without belittling the significance of the earlier mentioned studies, it would be misleading to assume that the studies form the backbone for developing practical and far-reaching recommendations with a view to alleviate, redress, and if possible, avoid various hurdles created by the new learning environment hinging on a non-native (NN) medium of instruction. The current literature review provides diverse insights into the matter of teaching exact sciences, focusing particularly on the field of mathematics, via the medium of English to NN speakers of the language. In the light of the aforementioned research, the author suggests a number of recommendations for the stakeholders involved in the educational process that could be applied across varied educational landscapes and disciplines.

##### **4.1. Gate-keeping Policy: Adequate Level of Math Teachers' English Proficiency**

It is fundamental for yielding fruitful results to identify barriers hindering a smooth and effective transfer of mathematical knowledge within EMI learning environments. Amongst these barriers is math educators' insufficient command of the language of instruction, namely English, which may seriously jeopardize a firm grasping of mathematics educational material by the students. In this regard, decision-making bodies and HEI need to devote special efforts towards establishing various gate-keeping strategies in order to effectively address the problem. The strategies may manifest themselves through certification tests similar to that developed in the Centre for Internationalization and Parallel Language Use (Kling & Stæhr 2011). Along with assessing teachers' level of English language proficiency, the authors believe that the certification test needs to provide additional information concerning qualification skills required to be acquired to effectively deliver academic contents. Being based upon the information obtained from the type of test, the gate-keeping approach would confer distinct advantages to the stakeholders assisting them in establishing and consolidating multilateral mechanisms for a successful adoption of EMI in teaching mathematics to NN speakers of the language.

##### **4.2. Professional Collaboration with English Language Specialists and Native English-speaking Mathematics Teachers**

An effective realization of the EMI approach can also be achieved by means of collaboration between experts in the fields of the English language and mathematics. With regards to the specialists of the latter field, it is vitally important that EMI math educators work closely with their native English-speaking colleagues or highly experienced in teaching the subject through English NN colleagues. The reason for attaching high importance to the collaboration lies in acquiring and maintaining native-like competence pertaining to diverse linguistic aspects of the adherence to the English language mathematical environment. Not less important to allocate a sufficient amount of time for collaborating with certified English teachers in order to effectively sharpen EMI teachers' general language proficiency skills, possession of which plays a substantial role in upholding the highest standards of content teaching through the medium of English.

#### **4.3. EMI Language Center for NN Mathematics Teachers**

It is recommended that decision-making bodies and policy makers establish EMI language centers where the a fore noted professional interaction with native, or native-like, teachers of mathematics and their peers in the field of English can occur. The centers can serve as a focal point for EMI math educators, as well as educators teaching other, mathematics-oriented disciplines, to provide them with an opportunity to enhance and upgrade their language skills by dint of organizing joint training sessions, seminars and expert workshops. To maximize the efficiency of the mechanisms, it is imperative that they are dynamic and can be optimized based upon linguistic competence of the stakeholders along with the data gathered through delivering subject matter courses within different education institutions. The center may, for example, adopt certain strategies of the language support center mentioned by Kim (2014).

#### **4.4. Data Collection**

In this regard, it is highly suggested to resort to different data collection techniques for analyzing and interpreting the collected information in order further to discern meaningful patterns with the help of which the stakeholders will be able to evaluate the quality of the ongoing educational processes and take all necessary measures to correct potential drawbacks hindering a successful delivery of educational contents. Among the techniques is students' evaluation of their teachers, as well as the quality of the conveyed by the teachers EMI courses. In addition, it would be beneficial that EMI educators should be evaluated by specialists from different HEI in the field of the English language and the educators' areas of expertise in terms of the quality and effectiveness of delivered through English educational contents. The evaluation of the experts needs to be formed by means of processing of information that can be obtained through observation of the educators' teaching.

#### **4.5. Resorting to the Stakeholders' First Language**

It would be a largely myopic stance to ignore a valuable role of the stakeholders' mother tongue (L1) with its significant impact upon existing EMI settings. In this respect,



code switching (CS), either spontaneous or intentional, to L1 of those involved in the learning process can reduce language barriers in EMI classrooms. Being defined by Ibrahim (2001) as 'the introduction of items (words, phrases, or sentences) from another language into the base language, which occurs within sentences or between sentences within the course of a single conversation' (p.134), CS is considered to be an effective tool used to clarify and facilitate students' understanding of difficult concepts (Floris 2014; Hu, Li & Lei 2014).

There is yet another noteworthy aspect revolving around negative influence that L1 may exert on delivery of mathematical content reducing the degree of comprehension on the part of the students. In this regard, it is worth paying heed to a study conducted at one of the universities of Kazakhstan where a number of Chinese professors resorted to sentence structures based on their mother tongue to build sentences in English (Karabay 2017). The adherence to Chinese-based English sentence structures constituted an obstacle for understanding the sentences.

#### **4. 6. Quality of Educational Resources**

Coming from this angle, it is essential that learning resources with mathematics-related content (e.g., textbooks) include vocabulary lists of mathematical terms and expressions translated into L1 of the stakeholders, and, if necessary, the terms and expressions need to be introduced with clear explanations in their first language to translate complex ideas or concepts into an understandable language. Additionally, it is advisable to provide the translations with a variety of visual elements (e.g., symbols, graphs, etc.) to achieve increased depth of understanding on the part of the students.

#### **5. Suggestions for Further Research**

The foregoing literature review provides a brief glimpse into the issue of using English as a primary medium of instruction and knowledge acquisition within the scope of mathematics and mathematics-related fields, along with bringing to the fore diverse viewpoints as to the role of the language in conveying mathematical and math-oriented content within confines of EMI. Owing to the complexity of the matter, it is worth looking further into the intricacies of the role of the medium of instruction and its possible impact upon the learning process. With this purpose in mind, there is a dire need for further research into the function of the language in the domain by gearing more efforts towards looking at the function from multiple angles.

1. To conduct in-depth research into significance, or insignificance, of the medium of instruction in teaching other exact mathematical sciences with a view to make comparisons and detect commonalities and differences within different math-oriented domains.

2. It is expedient to conduct a further research to explore the role of EMI across varied higher education settings of Israel taking into account views of specificity of Hebrew, i.e., its unscientific nature, a paucity of technical terms, academic sources and Hebrew-based textbooks in a number of academic domains (Goldstein 1998; Michaelan 2018).
3. To investigate the stakeholders' attitudes towards the role of EMI in teaching mathematics in Israeli higher education institutions in consideration of the above-mentioned peculiar nature of the Hebrew language.

## 6. Conclusion

With emerging and mushrooming demand for a firm grasping of various educational contents via the EMI approach within diverse academic patterns of NESC, the issue of language is of paramount importance as it is inextricably intertwined with the process of adopting the medium of instruction in varied higher education formats. Deeply rooted as it is, decision-making bodies consider the issue through the prism of parameters associated with a variety of hurdles and challenge the entire implementation of an EMI policy is fraught with. Among the parameters is a multi – layered argument ascertaining the degree of significance of the instructional language in the field of mathematics and mathematics-based disciplines? There seems to be no one-size-fits-all approach when it comes to determining the status of English and developing a deeper understanding of the math content in English-based lectures of HEI in NESC. Both low and high attitudes have been developed towards the status of the language in the domain of mathematics by policy makers and the stakeholders. It is yet to thoroughly examine the role of English in the educational process in order to keep abreast with the ongoing shift towards implementing the EMI approach across varied non-Anglophone educational landscapes. Resorting to further in-depth research into the rapidly evolving field will establish a clearer picture comprising a whole gamut of aspects that are central for evoking a hospitable atmosphere towards uncovering the true status of the language in different branches of mathematics.

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