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# SPECIFICITY OF TEACHING EXACT SCIENCES THROUGH ENGLISH TO NON-ENGLISH SPEAKERS IN HIGHER-EDUCATION

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## *Abstract*

Amid worldwide shift towards adopting English as a medium of instruction (EMI) within the scope of higher education, various views have been expressed regarding the importance of English language proficiency among students in acquiring mathematics and mathematics-related content. Considering a diverse array of factors involved in the role of the language in the learning process, more emphasis should be placed on approaching the issue from a different angle. With this purpose in mind, this paper is aimed at supporting a differentiated approach pertaining to teaching varied content disciplines through the language within the framework of English for academic purposes. According to the approach, an effective transfer of knowledge can be provided by suiting the language of instruction to different studied fields taking into account their specificities. As a result of adopting the approach into the fields, decision makers will be able to create fertile ground for equipping students with necessary language skills suitable for their field of study. The process of creation of the ground needs to be based, among other things, on establishing and conducting differentiated policies and strategies matching with the contents to be learned. This, in turn, will promote students' understanding of the taught material. As an example of such a strategy, EMI students taking math courses are not supposed to encounter serious language difficulties and will cater their educational needs. The paper argues that drawing on specific discipline versions of English will yield appreciable results due to the highest possible degree of realisation of EMI potential.

**Keywords:** English as a medium of instruction, English language proficiency.

## 1. Introduction

There has been continued growing interest towards delivering academic content through English in the arena of higher education of non-English speaking countries (NESC) over the last decade. More and more higher education institutions (HEIs) in the countries plunge actively into the process of adopting English as a medium of instruction (EMI) to align with the accelerating trend. According to the British Council interim report (Dearden, 2014), the latter is deemed as a 'global phenomenon in both public and private education in all stages of education' (p.3). Among major incentives of the worldwide phenomenon is institutions' dire need to sharp their international profile with a view to raise their ratings (Linn, 2016). The objective exerts considerable influence on a number of students, both international and local, enrolled in the HEIs. In addition, it plays a significant role in attracting high-calibre academic staff capable of providing high-quality education in different academic fields. By being actively involved in the process of acquiring and delivering various academic contents using EMI, the stakeholders create fertile ground for enhancing the institutions' prestige and form the backbone of their solid academic reputation.

Yet the endeavour to keep abreast with the ongoing changes within a non-English higher education context is fraught with challenges requiring practical and durable solutions. Among the challenges, particular attention should be accorded to the stakeholders' inadequate grasp of English. The aspect of the ever-increasing shift towards a full-scale implementation of EMI within different academic settings seems the most worrisome due to its crucial importance in reaching the highest possible degree of realisation of EMI potential. With the emerging and mushrooming demand for the EMI approach, it is of utmost priority that the unsatisfactory English proficiency be addressed through joint efforts of policy makers and educators. Not taking necessary measures to make up for the shortfall in stakeholders' English competency, or even postponing such measures, may lead to adverse consequences resulting in impeding an effective transfer of relevant knowledge in English. To complicate matters even further, the devastating impact of the failure in delivering educational material will inevitably lead to stifling students' knowledge acquisition with ensuing deterioration in the quality of higher education. The deterioration, in turn, may constitute a stumbling block to the fast-moving transition towards EMI.

### 1.1. Stakeholders' Unsatisfactory English Proficiency: Possible Solutions

A broad spectrum of strategies has been applied to resolve the issue of the insufficient command of the language on the part of decision-making bodies, lecturers and students. Among them is the idea mentioned in the study exploring 'the potential possibilities' (Ghorbani & Alavi, 2014, p.1) of using EMI in Iranian higher education institutions. According to the study, special emphasis should be laid upon raising students' English proficiency levels and equipping them with appropriate language skills 'prior to being accepted in the university' (p.10). It seems plausible to assume that the strategy will provide a solid foundation for catering learners' educational needs drawing on their robustly proficient knowledge of English. The latter may be gained by means of resorting to preparatory, pre-EMI language courses designed and offered by HEIs. Examples of such preliminary training may, for example, take form of 'pre-university courses in English as a Second Language (ESL) programs' (Corrigan, 2014, p.444), or of more advanced preparatory courses 'in English for Academic Purposes (EAP)' (p.444).

The problem of learners' linguistic limitations has also been approached from a different angle. Facing the urgent need to overcome the major impediment to a deep understanding of content subjects delivered through English, students develop and employ an array of survival strategies, some of which were described in Airey and Linder's (2006) study in two Swedish universities. The findings of the study identified a number of such techniques used by physics students who participated in it. One of the techniques was based on asking fewer questions during EMI-based content lectures in contrast with those taught in their mother tongue (L1). In a similar vein, the learners were reluctant to answer questions in the course of the English-medium lectures. In their bid to ensure a better comprehension of academic material, the interviewed students tended to come 'forward at the end of each session to ask questions' (Airey, 2009, p.79).

To get on top of the linguistic challenge, learners also have recourse to survival strategies associated with undertaking certain preliminary work prior to EMI lectures. In this regard, it is worth mentioning a case study conducted at a major Chinese university (Hu, Li & Lei, 2013). The study's participants reported translating unknown words in their English textbooks along with 'previewing the content of a lecture by reading relevant sections of the assigned textbook' (p.35) before EMI classes in order to tackle the issue of their inappropriate command of the language. Alongside the English language, a number of novice students attached due value to their L1 by relying 'on Chinese readings to make sense of the EMI lectures or the English textbooks' (p.35).

Not unexpectedly, the aspect of stakeholders' L1 is an essential factor strongly affecting the ever-accelerating transition towards embracing the EMI approach. The unsatisfactory English proficiency leads to a convincing rationale for reliance on the powerful tool on the part of academic staff and may manifest itself into codeswitching (CS) to learners' L1 while teaching various content subjects via English. Among a variety of reasons for switching to L1 are the ones related to finding effective ways to get into the essence of varied concepts including 'difficult but important' (Floris, 2014, p.8) ones. It should be borne in mind, however, that an excessive use of the technique may have an insidious effect upon the EMI approach, and undermine its main purpose. In this regard, it is of paramount importance that educators, along with students, avoid over-reliance on their first language in fostering transfer and acquisition of knowledge within diverse EMI formats. Ignoring potential adverse consequences of the insidious effect would be a largely myopic stance, which will necessarily lead to hindering and stopping of the worldwide transition towards varied EMI settings. The stop will inevitably be followed by reversing to a previous educational landscape based on L1 of those involved in the learning process.

In the light of the foregoing, it is worth noting another mechanism used by decision makers to effectively bridge the frequently encountered gap between learners' limited English skills and high demands of HEIs. With this need in mind, decision-making bodies establish certain thresholds that students are required to reach in order to eliminate the existing mismatch. Resorting to the 'gate-keeping policies and practices, such as mandating students to take English language proficiency tests (e.g. TOEFL, IELTS, or universities own language tests)' (Karakaş 2014, p.115) prior to embarking upon EMI-based courses will not only preserve the essence of the approach based on adopting English as a primary medium of instruction, but also will act as a catalyst to its across-the-board implementation in NESC.

However reasonable this mechanism may seem, it might be misleading to assume that it, and other currently applied strategies, reflect specificity of each academic discipline taught through English in HEIs. This brings us to the question as to whether there is a need for equipping learners with particular language skills that are essential for and consistent with specific contents to be learned. To effectively address the question, it is of utmost importance to provide meaningful insights into commonalities and differences of delivering different content subjects via the language within the framework of English for academic purposes (EAP). The insights are required to ascertain the extent to which English varies, if it does, in accordance with the discipline being taught and studied. According to 'ESP classification by professional area' (Liu et al., 2014, p.828), adopted by the authors from Huhta (2010), EAP is considered as one of the domains of English for specific purposes (ESP). Liu et al. (2014) 'adopted the term English for scientific purposes (EScP)' (p.828) referred to as one of the disciplines of ESP. In a similar vein, the researcher is favour of getting into the essence of the paper's key ideas, centring on mathematics and mathematics-related subjects, through the lens of EScP.

## 2.      Problem Statement

There appears to be a general consensus regarding availability of mathematics-specific language stakeholders adhere to within the confines of EMI. Among factors laying a solid foundation for the standpoint is a direct relationship existing between students' command of English and their academic performance (Aina, Ogundele & Olanipekun, 2013). According to the research conducted by the investigators among one hundred twenty-one students of a college of education, there exists a correlation between the learners' English level and their academic attainments in science and technical education. The finding emerging from the research places a high value on obtaining a satisfactory level of the language competence before admitting them into EMI courses. Interestingly enough, in a similar vein, linguistic limitations, along with other factors, constituted an obstacle to good performance in mathematics among pupils of a primary school in Nigeria. The findings of the research pointed to a positive contribution of satisfactory English proficiency to the pupils' good academic performance in the subject.

The aforementioned strong relationship between the valuable factors underscores a vital role of a language of instruction in the process of learning and studying of mathematics. The role becomes even more vital and crucial when the discipline is delivered through L2 within different academic patterns. According to the preliminary investigation that involved non-native English undergraduate students learning mathematics (Barton & Neville-Barton, 2003), the latter should not be considered 'language-free' (p.9). The study's findings attribute particular significance to technical language, 'not just everyday English' (p.9), as a factor strongly affecting mathematical understanding of L2 learners. Resorting to the type of medium for knowledge acquisition implies in its turn according due attention to specific 'vocabulary, syntax and discourse' (p.9). As to the everyday language, which comprises words that are expected to be used by students without experiencing any serious difficulties, it may pose a linguistic barrier to the understanding of mathematics content (Halai, 2007). A qualitative study embracing non-native speakers of English learning mathematics in multilingual classrooms of Pakistan raised awareness concerning the students' inability to connect day-to-day words with 'mathematics concepts or relationships' (Halai, 2007, p.11). The inability stemmed from their failure 'to understand the mathematical purpose' (p.11) of the words.

In addition to drawing upon the aspects of teaching mathematics in the classrooms, the derived data indicate that the process of understanding of the problem statement consists of at least two levels of interpretation: making sense of 'the language … and … the mathematics involved [in it]' (p.10). Due to the fact that the learners used their L1 in solving and reflecting on mathematical problems, whereas the subject content was delivered via English, such issues as semantics, vocabulary and grammar carried additional weight and add value to the medium of instruction (Halai, 2007).

## 3.     Research Questions

The research questions revolve around the issues regarding implementation of the EMI approach in Israeli HEIs, as well as identifying criteria for the most effective implementation strategies within varied academic patterns of NESC.

## 4.     Purpose of the Study

It is worth pointing out, however, that the results of the above-noted bodies of research and studies are partially inconsistent with that of the researcher, who oriented his efforts towards developing a set of durable and appropriate solutions directed at equipping both stakeholders and policy makers with tools necessary for an effective implementation of the EMI approach in HEIs of NESC. The efforts were undertaken bearing in mind that in their endeavour to seize upon the ever-increasing transition to a full-scale implementation of the EMI approach, a substantial number of decision-making bodies have been too swift and have performed poorly in sidestepping different pitfalls on the path. Among the reasons of the aspiration on the part of institutions of higher education to avoid lagging behind the global shift towards EMI is a dire need for sharpening their profiles. The latter has a high degree of importance for their position on the international ranking scales as it carries a clear-cut financial component.

## 5.     Research Methods

With this purpose in mind, the qualitative stage of the research, which followed its quantitative stage associated with a thorough examination of academic papers concerning strategies used to ease EMI implementation, was based on conducting semi-structured interviews with Israeli academic staff members, as well as Israeli students, who had experience in either teaching, or studying various academic subjects in HEIs of Israel, and other countries. The researcher resorted to content analysis considering the technique highly beneficial and effective in processing of a large amount of data obtained from the semi-structured interviews and discerning meaningful patterns. The process of identifying the patterns, which stemmed from a vast stock of valuable information related to various problems arising in the process of EMI implementation, provided fertile ground for a subsequent sorting of the problems into themes and conceptual categories. Content analysis was also employed in the first stage of the research resting on meta-analysis.

## 6.    Findings

The findings emerged from the interviews data indicate that the stakeholders hold diverse viewpoints pertaining to the role of EMI in delivering and studying mathematics-related content. In addition, the diversity manifests itself in similarities and differences between the groups of the interviewees in ascertaining the need for an acceptable level of English proficiency on the part of the learners and the lecturers. In contrast to previously described views attaching a high importance to the medium of instruction in the learning process, a number of the interviewed lecturers from a range of disciplines placed decreased value on the aspect. Evaluating its role through the prism of the exact sciences, mainly mathematics, some of the educators even claimed that the English language knowledge is unnecessary. A plausible reasoning behind the view is supposedly based on their prevailing stance towards specificity of vocabulary in the field, considered to be quite limited as opposed to humanities subjects. The limited nature of the vocabulary, comprising also an array of standardised mathematical symbols, and as a consequence of this, its high frequency of recurrence in delivery of lectures' content confers notable advantages in terms of easing the linguistic burden for those involved in the field. Along with that, much significance was assigned to students' mathematical understanding, considering it to be a crucial factor in reducing the linguistic burden.

Being quite polarised on the aspect of EMI and the degree of its impact on an overall understanding of mathematics-related subjects, the findings of the researcher's study resonates with the ones emerged from Halai's (2007) qualitative study, according high value to linguistic structures of the medium of instruction. The aforementioned issues of the structures, which received due attention during the semi-structured interviews, were approached, among other things, taking into account a peculiar nature of Hebrew. The peculiarity of the language manifests itself in a lack of an appropriate technical Hebrew in certain fields with all the ensuing consequences, among which are problems related to translation of technical terminology, and an insufficient number of publications at disciplinary level.

There are yet a variety of other issues, apart from the ones indicated above, that were identified over the course of the semi-structured interviews. A brief snapshot of only some of the issues is presented in Table 1.

**Table 01.** Themes emerged from the semi-structured interviews with the academic staff and the students

| 36 Lecturers (L) / 21 Students (St) | |
| --- | --- |
| Theme A (L)/Theme A (St) | Psychological Factor |
| Theme B (L)/Theme B (St) | Specificity of Teaching in English |
| Theme C (L)/Theme C (St) | The Role of Computer Literacy in EMI |

The benefits deriving from the identification of the issues, or themes as they are called in the study, and related to them researcher-generated categories can make an appreciable contribution to a full-scale implementation of EMI in different academic patterns. In addition, the benefits will create a breeding ground for designing an algorithm on the basis of which decision-making bodies will develop and adopt a differentiated approach taking into account a specific nature of existing higher educational systems and a

varied background of their stakeholders. Resorting to the strategy can yield appreciable results which are intended to be inclusive of various fields of exact sciences, as well as their other branches. The type of approach resides upon an idea of defining specific discipline versions of English, in accordance with the taught material, and ensuring that EMI learners are adequately equipped with linguistic skills essential for a broad understanding of educational material. In this regard, drawing on the specificity of mathematics-related disciplines, expressed, among other things, in using a limited vocabulary and standardised mathematical symbols, policy makers will provide a solid ground for building an effective mechanism with the view of eliminating existing obstacles standing in the way of adopting EMI in NESC.

## 7. Conclusion

Amid increasingly deepening shift towards conveying a vast amount of knowledge through English in the sphere of higher education, a more measured view is required in reference to the emerging issues. Deeply rooted as they are, the issues need to be thoroughly tackled bearing in mind that the problem of stakeholders' language inadequacies can be effectively addressed by focusing more attention on specificities of content disciplines. Employing a 'one-size-fits-all' approach would be a short-sighted stance owing to a wide spectrum of the disciplines, and associated with them sciences. With the aid of previously mentioned differentiated approach, that implies suiting the language of instruction to disciplines taught via it, students will be provided with an opportunity to enhance their understanding of the studied content by alleviating, or even eliminating, the linguistic burden. To properly accommodate the approach and maximise its benefits, there is a need for developing specific versions of English in accordance with the requirements of the studies subjects. The versions of the language should be acquired by means of resorting to various strategies used to improve EMI learners' command of the language. However reasonable this approach may seem, the findings of the researcher's study leave a question mark over the role of EMI in teaching mathematic and mathematics-related disciplines. In the light of these findings, more light should be shed upon the aspect of EMI to reach the highest possible degree of realisation of its potential.

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