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Abstract

In many contexts of English-medium instruction (EMI), the development of English language proficiency is an often-hoped-for outcome. Existing EMI research measuring English proficiency development reports gains in specific areas of English but not others. This study examines the growth of academic vocabulary knowledge among tertiary-level students studying in EMI. Academic vocabulary is crucial for effective academic communication, not least reading, and serves as a significant predictor of academic achievement. Hence, investigating its development is pertinent; however, development of academic vocabulary knowledge among EMI students has been largely neglected by previous research. The study was guided by three research questions: (i) What is the size of tertiary-level EMI students' receptive (reading) academic vocabulary?; (ii) Does their academic vocabulary knowledge develop over time?; and (iii) If there is development, does initial academic vocabulary knowledge influence how much EMI students benefit? A small longitudinal sample of EMI students enrolled in MSc programs in Sweden took a test of receptive academic vocabulary knowledge during the first and second year of their studies. Considerable variation in academic vocabulary size was observed. Some students had small academic vocabulary sizes, potentially impacting their engagement in academic tasks. Significant gains in receptive academic vocabulary knowledge occurred. The greatest vocabulary development was observed for those students who initially had smaller academic vocabularies. Implications are discussed for EMI learning environments.

Keywords: Academic vocabulary, English proficiency, English-medium instruction (EMI) higher education, testing.

Resumen

Desarrollo del conocimiento del vocabulario académico durante la instrucción en inglés como medio de enseñanza

En muchos contextos de enseñanza en inglés (EMI, por sus siglas en inglés), el desarrollo de la competencia lingüística en esta lengua es un resultado que a menudo se espera alcanzar. Las investigaciones existentes sobre EMI que miden ese desarrollo ponen de manifiesto avances en algunas áreas del inglés, pero no en otras. Este estudio examina el aumento del conocimiento del vocabulario académico en estudiantes universitarios que cursan programas en contextos EMI. El vocabulario académico es fundamental para una comunicación académica eficaz, especialmente en la lectura, y es un fuerte predictor del rendimiento académico. Por ello, resulta relevante analizar su desarrollo. Sin embargo, hasta ahora ha sido un aspecto en gran medida desatendido en la investigación sobre EMI. Este estudio está articulado en torno a tres preguntas de investigación: (i) ¿cuál es el tamaño del vocabulario académico receptivo (de lectura) de los estudiantes universitarios en contextos EMI?; (ii) ¿se desarrolla su conocimiento del vocabulario académico con el tiempo?; (iii) en caso de que haya desarrollo, ¿influye el conocimiento inicial del vocabulario académico en el grado de beneficio que obtienen los estudiantes? Se utilizó una pequeña muestra longitudinal de estudiantes de programas de máster en Suecia que realizaron una prueba de vocabulario académico receptivo en el primer y segundo año de sus estudios. Se observó una variación considerable en el tamaño del vocabulario académico. Algunos estudiantes presentaban un vocabulario reducido, lo que podría afectar su participación en tareas académicas. Se identificaron avances significativos en el conocimiento del vocabulario académico receptivo. El mayor desarrollo de vocabulario se produjo en los estudiantes con un vocabulario más limitado al inicio. El artículo discute las implicaciones para los entornos de aprendizaje EMI.

Palabras clave: Vocabulario académico, competencia en inglés, enseñanza en inglés (EMI) en educación superior, evaluación.

1. Introduction

English-medium instruction (EMI) has been defined as "the use of the English language to teach academic subjects in countries or jurisdictions where the first language (L1) of the majority of the population is not English" (Dearden, 2014, p. 1). In addition, Aguilar notes that while teaching content in English "is the priority [in EMI], […] some incidental language learning is expected due to exposure but without any specific language

learning goals" (2017, p. 726). Two expectations thus feature centrally in EMI: first, that English is used for some instructional purposes; and second, that such English usage will promote English language skills.

In this paper, our main focus is on the second expectation, English language development in EMI, which is poorly understood. According to Macaro et al., one reason we do not know enough about EMI's effect on English proficiency is the "paucity of language impact studies" (2018, p. 57). The present study heeds the call for more research exploring the impact from EMI on English language proficiency, focusing specifically on the development of EMI students' academic vocabulary knowledge. Previous research has established that academic as well as general vocabulary knowledge are important dimensions of (EMI and EFL) students' general academic literacy, central to reading, and that it contributes to students' academic achievement (e.g., Aizawa & Rose, 2020; Evans & Morrison, 2011; Masrai & Milton, 2021). Knowing many academic words contributes greatly to the lexical coverage of academic reading; Gardner and Davies (2014) showed that the Academic Vocabulary List (AVL) covers approximately 14% of the academic section of Corpus of Contemporary American English (COCA), and other sources have reported even greater coverage of the AVL in more specialized corpora. For example, Qi (2016) found that the AVL covered 26.13% of the engineering textbooks and other academic texts in an engineering corpus. In other words, knowledge of academic vocabulary is an important factor in success for those studying in the English-medium environment.

2. Literature review

EMI presupposes that students have the requisite proficiency in English to engage in varied academic tasks requiring receptive as well as productive command of English, e.g., reading academic texts, listening to lectures, writing course work, or giving presentations. Research has established links between students' levels of English proficiency and their success in EMI (e.g., Rose et al., 2020; Xie & Curle, 2022; Yuksel et al., 2023). Thus, for example, when Rose et al. correlated international business students' scores on the Test of English for International Communication (TOEIC) with their mid-term and end-of-term course (discipline) test scores, they found that "TOEIC scores statistically significantly predicted success as measured

by content examination scores: the higher the TOEIC score, the higher the content score" (2020, p. 2154). There is, however, considerable disagreement among stakeholders as to whether students know enough English to participate in EMI. Without doubt, many students do, but there are also strong indications that significant numbers struggle precisely because of limited English ability (cf. Macaro, 2018). Perhaps particularly in those cases there are expectations, or at least aspirations, that EMI will enhance English proficiency.

A large body of research speaks to English proficiency development as an often-hoped-for outcome of EMI. For example, according to Chin and Li (2021, p. 2), EMI in the Chinese context

> does not aim for English language improvement, [but] it is often implemented in Asian HE contexts with the expectation of improving domestic students' English proficiency. In other words, it is believed that EMI can maximize students' exposure to English and further lead to improvements in their English proficiency.

Similarly, Rose et al. (2020, p. 2150) note the widespread belief that EMI

> kills two birds with one stone; in other words, students simultaneously acquire both English and content knowledge […] it offers students exposure to English when the negotiation of content knowledge also takes place, making it an ideal learning situation for learners to achieve both goals.

The same sentiment was expressed in an editorial for a special issue relating to the role played by language(s) in EMI; the editors noted that "one of the objectives of EMI programmes is aimed at improving students' foreign language competence while learning content delivered in English" (Doiz & Lasagabaster, 2020, p. 258).

Such expectations regarding the positive effect of English-medium education on English language proficiency have been reported in diverse geographical contexts, e.g., in Japan (Chapple, 2015), in Sweden (Pecorari et al., 2011), in Spain (Aguilar & Muñoz, 2014) and in the United Arab Emirates (Rogier, 2012).

Expectations regarding the positive effect from EMI on English language proficiency are also held by several different groups of stakeholders. For example, Ali (2013, p. 74) notes that "policy-makers have positioned EMI classrooms as a tool to promote students' English-language development."

Universities and teachers likewise express strong beliefs in EMI as an (incidental) language learning environment (Galloway et al., 2017). Finally, many students hold beliefs about the English proficiency benefits of learning academic content through English (e.g., Guarda, 2021).

However, doubts concerning the effectiveness of EMI as a space for improving English proficiency have been raised by EMI researchers. For example, Chin and Li (2021) talk of a widespread "over-optimistic view" (2021, p. 2) regarding the language outcomes of EMI in Asian universities. In earlier work, we too have cautioned against such optimism in the European context of EMI, suggesting that stakeholders' expectations ought to be managed until further evidence of positive development of English proficiency becomes available (Malmström et al., 2016).

Macaro et al. (2018) reviewed research in this area and concluded that "there is a dearth of research, using *objective* tests rather than self-report, on the impact of EMI on improving students' English proficiency" (p. 64, emphasis added). The findings from the research that does exist, although inconclusive, generally indicate positive outcomes, particularly in certain English domains. For example, in Spain, Aguilar and Muñoz (2014) investigated the development of listening and grammar skills in a group of engineering EMI students; after one semester, the students had significantly improved their listening skills but not their grammar. In Rogier's (2012) study of EMI students in the United Arab Emirates, students' speaking, writing, reading and listening skills all developed positively and significantly over the four-year period of the study as determined by pre- and post-testing using IELTS; however, the gains made were small (the students improved most in speaking, where the gain was 0.5 of an IELTS band). Yang (2015) provided additional evidence of English skill development among Taiwanese EMI students. The study revealed enhanced receptive English abilities over 24 months, as indicated by improved scores in reading and listening on a local general English proficiency test. Finally, three recent reports from Turkey, authored by Soruç et al. (2021, 2024) and Yuksel et al. (2023), highlighted positive outcomes in student testing. These studies examined EMI students in their first and fourth years of business administration and mechanical engineering, using the Cambridge Preliminary English Test. They collectively demonstrated a statistically significant improvement in English language proficiency over the four-year period of EMI in both subjects. An example of a study showing no improvement in English proficiency is Lei and Hu (2014). They examined 64 Chinese EMI undergraduates who took a

standardized national college English test two years apart. Despite receiving support from ESP classes throughout this period, the students did not show any statistically significant gains in English proficiency according to their test scores.

Based on the small amount of available research, it is difficult to determine conclusively whether stakeholders can reasonably expect that English proficiency will improve as a result of EMI and further research on the impact of EMI on English proficiency development is called for.

3. Direction, rationale, and research questions

Students in EMI are faced with many types of English language challenges, cutting across all four communication skills (Aizawa & Rose, 2020; Evans & Green, 2007; Evans & Morrison, 2011; Kamaşak, et al., 2021). However, vocabulary (knowledge) has been cited as a specific challenge for some students, as reported by studies from Hong Kong, where a majority of EMI students self-reported as being particularly challenged by insufficient vocabulary knowledge (e.g., Evans & Green, 2007; Evans & Morrison, 2011), and from Japan, where vocabulary testing of students revealed that a significant minority did not have adequate knowledge of academic vocabulary (Aizawa & Rose, 2020; Uchihara & Harada, 2018).

Vocabulary knowledge of any kind is widely regarded a *sine qua non* for academic communication. For this reason alone, it is pertinent to study the development of academic vocabulary knowledge during EMI, but another reason is that knowledge of academic words has been shown to impact students' academic performance to a high degree. When Masrai and Milton (2021) investigated the contribution which general and academic vocabulary knowledge made to the gross point average of Arabic L1 EFL students, they found that general vocabulary size accounts for 47% of the variation in academic performance, while familiarity with academic vocabulary contributes an additional 11.5%. Masrai and Milton's conclusion is key: academic vocabulary "can make a distinct and measurable additional contribution to academic success over and above that of general vocabulary knowledge" (2021, p. 292). Several empirical studies (e.g., Aizawa & Rose, 2020; Evans & Green, 2007; Evans & Morrison, 2011; Lin & Morrison, 2010) confirm these findings by Masrai and Milton (2021), highlighting that it is not *general* English vocabulary

alone that should be investigated; additionally, *academic* vocabulary (Coxhead, 2016) deserves our attention.

Previous research concerned with the *development* of academic vocabulary in EMI over time has primarily focused on younger learners (e.g., Coxhead & Boutorwick, 2018), or students learning English following an EFL curriculum (e.g., Webb & Chang, 2012); in both situations, positive development of receptive academic vocabulary knowledge has been reported. To the best of our knowledge, the only study to date with a developmental focus on English academic vocabulary knowledge in tertiary EMI is Malmström et al. (2016), but that research investigated students' productive rather than receptive knowledge of academic words (and reported some very modest gains).

Because of the importance placed on knowing many academic words in EMI, not least for the purposes of academic reading (as evidenced by, for example, Aizawa & Rose, 2020; Curle et al., 2020), and because of the association with academic performance (Masrai & Milton, 2021) this study investigates the size of EMI (master's level) students' receptive (reading) academic vocabulary knowledge and whether there is any development in vocabulary knowledge over time. We are guided by the following research questions:

1. What is the approximate size of advanced tertiary level EMI students' receptive academic vocabulary?
2. Does their academic vocabulary knowledge develop over time?
3. If there is development, does initial academic vocabulary knowledge influence how much EMI students benefit?

4. Material and method

To investigate these questions, master's students in an English-medium environment were tested for their receptive knowledge of academic vocabulary, i.e., words that are particularly common in academic reading across disciplines (cf. Coxhead, 2016; Gardner & Davies, 2014).

4.1. Setting and participants

Data were collected at a university of technology in Sweden, as part of a larger study involving different types of data collection with different groups

of EMI students. Thirty-four students (73% male and 37% female; 61% domestic students and 39% international students; average age: 25 years), representing two different programs, power engineering and structural engineering, and constituting a self-selected sample, participated in the present study. A larger longitudinal sample would have been desirable; however, small sample sizes are a relatively common occurrence in second language acquisition studies (cf. Plonsky, 2013, who reported a median sample size of 19 individuals for the 606 studies that were part of his meta-analysis). Limited samples are also common in other studies of English proficiency development in EMI contexts (cf., the studies by Rogier, 2012, with 59 participants; Yang, 2015, with 29 participants, and Aizawa & Rose, 2020, with 47 participants). Participants were informed of the voluntary nature of the study and offered a small incentive (refreshments in conjunction with the test session). The study complied with the prevailing regulations involving informed consent and ethical approval.

All master's programs at the target university are two years in duration and taught through the medium of English. The MSc programs attract students from around the world, as well as local Swedish students (during the data collection period, international students made up approximately 35-40% of students at the master's level); inevitably, this means that students' previous experiences with EMI vary. The admissions requirement related to English language skills for all programs is, for local students, having taken and passed the final mandatory English course in upper secondary school (equivalent to the B2 level of the Common European Framework of Reference for Languages, or CEFR, according to the Swedish National Agency for Education, 2021). For international students, the admissions requirement is a score on a recognized test demonstrating equivalent proficiency. For example, the minimum IELTS score required for admission is 6.5, with no section scoring lower than 5.5, scores which equate with the higher and lower boundaries of CEFR B2 (IELTS, n.d). Because of the significant presence of non-Swedish students, English is the widely used *lingua franca* not only for instruction but for much communication for academic and social purposes amongst students. The participants in this study therefore represent a cross-section of world English competences and educational backgrounds, reflective of the significant diversity of many English-medium education settings, which tend to be "intrinsically bi/multilingual and bi/multicultural" (Saxena, 2009, p. 167).

4.2. Instrumentation and data collection

Participants were tested with the Academic Vocabulary Test (AVT, Pecorari et al., 2019). The academic vocabulary knowledge tested is at the level of meaning recognition (showing partial lexical knowledge) and the test uses a matching format similar to the widely used Vocabulary Levels Test (VLT; Schmitt et al., 2001). Figure 1 shows an example item from the test. Test takers are asked to match a definition with a target word; each test item contains three definitions and three target words, along with three distractors. The AVT comprises a total of 19 test items, with a maximum possible score of 57 points. All AVT target words are drawn from Gardner and Davies' (2014) AVL. The AVL includes just over 3,000 general academic words (lemmas) that have a particular affinity with academic texts across disciplines. The AVL items vary greatly in frequency; for example, *interpolation* occurs 387 times in COCA, on which the AVL was based, while *group* occurs over 319,000 times. The AVT was designed to be representative of the AVL, also in terms of frequency distribution and word class.

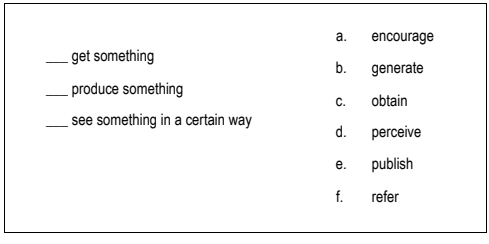

Figure 1. Example item from the AVT.
Test takers are asked to match the definition on the left with the best word on the right.

The AVT is an example of "a paradigm shift [in vocabulary testing toward] greater attention to test validation and optimal counting units" (Green et al., 2024, p. 161), and has been found to perform well in comparison with the VLT (Schmitt et al., 2001) when testing advanced learners of English, because the AVT (i) gives test takers better opportunities to display a broader scope of their vocabulary knowledge and (ii) provides vocabulary researchers in this context with an instrument that is better at discriminating variation in the test takers' academic vocabulary knowledge (Warnby et al., 2023). In the present study this was important because it was feared that the academic section of the VLT would create a ceiling effect (an effect which has been confirmed in similar settings; Busby, 2021).

The first-year vocabulary testing was done early during the first semester when students had been enrolled in their EMI program for a matter of weeks. In the second year of their EMI program, the students undertake workplace-based final-year projects outside the university. Consequently, data collection for the second year occurred towards the end of the first semester of their second academic year, when they had been in the EMI setting approximately 15-16 months.

The AVT currently exists in two forms which have been shown to be equivalent, and two forms were used in the present study. This practice is adopted and advocated widely (e.g., Carmines & Zeller, 1979; Coxhead et al., 2014; Laufer & Nation, 1999; Schmitt et al., 2001; Webb et al., 2017). Some researchers subscribe to the view that if sufficient time elapses between testing occasions, a learning effect causing recall of items on the first test is unlikely (e.g., Brown, 2014; Pan et al., 2018; Webb & Chang, 2012). The extent to which testing a word may promote learning of that word, and retention of it at a later time point, is unclear. However, a repetition priming effect (e.g., Elgort, 2011; Elgort & Warren, 2014) is possible.

. In other words, the presence of a word on the first test may cause particular awareness of it when it is encountered later, causing it to be learned. For these reasons, different forms of the AVT were used.

While the use of different test versions has the advantage of avoiding possible learning effects, via various pathways, it has the disadvantage that however carefully alternative versions are designed to be equivalent, the fact that they are not identical raises the possibility that different individuals will perform differently on them. For example, Schmitt et al. (2001, p. 78) conclude of their two carefully designed versions of the VLT that:

> Versions 1 and 2 cannot be considered truly equivalent, but […] they produce very similar results […]. Given the relatively small scale of the differences, the two versions can probably be used in programmes as alternate forms, as long as no high-stakes comparisons are drawn from a comparison between the two.

Similarly, analysis of the performance of the AVT has shown that the two forms of the test cannot be used to assess improvement at the individual level though they can be used to assess the improvement of a group (Pecorari et al., 2019).

5. Findings

This study found considerable variation in the academic vocabulary size of the EMI students who participated. Some students had small academic vocabularies sizes, potentially impacting their engagement in academic tasks. Significant gains in receptive academic vocabulary knowledge occurred between the first and the second year of the EMI program. The greatest vocabulary development was observed for those students who initially had smaller academic vocabularies.

5.1. What is the approximate size of EMI students' receptive academic vocabulary knowledge?

As Table 1 indicates, the test-takers had receptive knowledge of slightly less than three-quarters of the words on which they were tested in their first year, and slightly more in their second year. There was considerable variation in the scores, as indicated by the standard deviation and the range which was 34 (out of 57 points) in year one, and only slightly lower, 29, in year two. The lowest score in the first year was 17, while the highest was 51; in year two, those figures were 26 and 55.

Statistical measure	Year 1	Year 2	Difference year 1→ year 2
Mean score (%)[1]	40.12 (70.38%)	44.44 (77.97%)	4.32 (7.58%)[1]
Range	34	29	
Variance	61.56	56.01	
SD	7.85	7.48	
Mean score of top quartile (%)	48.83 (85.67%)	53.13 (93.21%)	4.30 (7.54%)
Mean score of bottom quartile (%)	29.75 (52.12%)	34.33 (60.22%)	4.58 (8.03%)

Table 1. AVT scores.

5.2. Does academic vocabulary knowledge develop over time?

A paired samples t-test was performed to compare the scores at the two data collection points. As Table 1 shows, there was a significant difference in scores for year 1 (M = 40.12, SD = 7.846) and year 2 (M = 44.44, SD = 7.484); $t(33) = -5.016$, $p < .001$). The results indicate, therefore, some growth in academic vocabulary knowledge from year one to year two. Five students scored lower on the later test (with the difference in scores ranging from one to seven points) and four attained the same score. The other 25 improved their scores by between one and 16 points. The mean result was an increase

of 4.32 points, and with a large effect size (Cohen's d=.860). Table 1 also shows that the increase in scores was slightly greater for the bottom quartile than for the top (4.58 points as opposed to 4.30).

5.3. Which EMI students benefit most?

As was noted above, it was observed that the difference between year 1 and year 2 scores was slightly higher for the 25% who scored lowest in year 1, compared with the top-scoring 25%. To investigate a possible relationship between initial scores and gains, a Pearson correlation coefficient was calculated. A moderately weak but significant negative correlation was found ($r = -.391$; $p < .05$). In other words, the lower the students' initial academic vocabulary scores were, the greater the receptive academic vocabulary knowledge development they experienced.

6. Discussion

This study set out to investigate the approximate size of advanced tertiary-level EMI students' receptive academic vocabulary knowledge and to see whether there is an increase in vocabulary knowledge over time and, if there is, whether particular students see more vocabulary development than others. In this section we discuss the significance of the findings relating to those three questions.

6.1. Receptive knowledge of academic vocabulary in EMI

It is relevant to ask what the level of knowledge demonstrated by the participants in this study means for these students as they engage with receptive academic tasks. We propose two approaches to addressing this question. The first is to consider that between 95% and 98% of the tokens in a text very likely need to be known in order to make sense of it (e.g., Hu & Nation, 2000; Laufer & Ravenhorst-Kalovski, 2010). As noted above, the academic vocabulary load in various corpora has been shown to vary greatly, but taking even Gardner and Davies' (2014) relatively modest estimate that 14% of the tokens in written academic discourse are academic words, it is clear that an ignorance of a substantial proportion of academic words could easily cause a student to fail to reach a threshold in the 95-98% range. It is possible that the EMI students with smaller receptive academic vocabularies,

relatively speaking, might belong to this group of potential strugglers. The weakest 25% of students, for example, knew just over half of the words on which they were tested in their first year, and 60% in their second year of the EMI program.

A second approach to considering the implications of these students' academic vocabulary knowledge is to apply the thresholds of mastery which have been used for interpreting scores on the VLT. Schmitt et al. (2001) used 87% (26/30 points) as a measure of mastery of each frequency level, while Webb et al. (2017) recommend a more stringent threshold of 97% (29/30) for frequent words, and 80% (24/30) for less frequent ones (see also McLean & Stoeckel, 2021). The lower figure –80%– was also used by Lin and Morrison (2010) and Aizawa and Rose (2020). A recent study has linked scores on the academic section of the VLT with those on the AVT (Warnby et al., 2023). It suggests that the lower threshold score of 24 on the academic section of the VLT corresponds to 26-28 on the AVT, and the higher threshold score of 26 on the VLT corresponds to 31-33 on the AVT. As indicated above, the bottom quartile of students missed this higher target in year 1 and just met it in year 2, and some students failed to meet even the more generous target.

In this study, some test takers scored close to a perfect score; there is little cause to fear that academic vocabulary size will stand between them and good comprehension of their academic texts. A further substantial proportion of the EMI students knew barely half the academic words on which they were tested, and this warrants concern, particularly bearing in mind that the type of vocabulary knowledge tested was meaning-recognition, i.e., a superficial level of knowledge. It is reasonable to assume that if students were tested on more complex aspects of academic vocabulary, they would likely face significant challenges.

The findings of the present study partly confirm earlier research. When testing the receptive knowledge of academic vocabulary in a cohort of EMI undergraduate students in Japan (using the academic section of the VLT), Aizawa and Rose (2020) recorded a mean score of 28.28, indicating adequate knowledge of academic vocabulary by the 80% threshold which they adopted. Similarly, in another study from Japan, the EMI students achieved the 87% threshold (Uchihara & Harada, 2018). However, some students –at least 25% of the two samples– did not have satisfactory knowledge according to these same benchmarks.

6.2. Development of academic vocabulary knowledge

The simple answer to our second research question –does academic vocabulary knowledge develop over time in EMI?– is yes. Here a further relevant but problematic question arises: how satisfactory or beneficial should the observed vocabulary development be considered? While the AVT is not a vocabulary size test, it may provide a reference point for participants' overall vocabulary gains. The AVL contains 3,015 items, while the AVT tests 57 of them. In this sense, a gain of one point on the AVT could be interpreted as indexing a gain of approximately 53 words (3,015/57). Thus, the 4.32 point mean gain might indicate that the students learned, on average, about 229 new academic words. While this would likely be considered a disappointing outcome for a fifteen-month language program featuring form-focused instruction, it does indicate that some incidental vocabulary acquisition occurred during their time in the EMI program.

Results concerning English proficiency development described by previous research have been mixed, but our findings are consistent with, for example, Rogier (2012), Yuksel et al. (2023), and Soruç et al. (2021), all of whom reported statistically significant increases of language proficiency. However, these findings, and ours, run counter to those from Lei and Hu (2014) for China. Their study reported no improvement in English proficiency after one year of EMI study, which the authors suggest may be due to the low quality of the English-medium program in focus. Taken together, however, the small body of work on the effects of EMI on English proficiency tends to suggest that they are positive, if limited.

For EMI students, and indeed other stakeholders, the findings of the present study constitute good news in the sense that increased English knowledge of academic words is positively associated with positive academic consequences (e.g., Masrai & Milton, 2021). Three remarks concerning the positive findings of our study are, however, in order. First, it is important to emphasize that the gains observed, just like those observed by Yuksel et al. (2023), Soruç et al. (2021), and Rogier (2012) were small, even very small against the background of a full year (or, as in these other cases, several years) of exposure to EMI. Thus, the improvement in the case of Rogier's (2012) EMI students corresponded to 0.5 IELTS bands, a finding which caused Macaro et al. (2018) to observe that "to move up on average only one half band score in four years would not seem to be a great validation of the beneficial effect on English in this

particular institution" (p. 58). Similarly, the four-year increase observed in mean scores on the Cambridge Preliminary English Test used by Yuksel et al. (2023) and Soruç et al. (2021) was between two to three points. The positive development documented for our own test group was for the most part equally limited. Incidental learning is a slow process and expectations of substantial improvement in proficiency as a result of EMI, whether as vocabulary knowledge or other dimensions of English language proficiency, should in all likelihood be carefully managed.

Second, it is important to acknowledge that any positive development of English proficiency, regardless of what dimension of proficiency it is, could be attributable to other factors than EMI alone. Thus, in our case, we studied development of academic vocabulary knowledge, but it is known that academic vocabulary knowledge correlates with a number of other factors, e.g., participation in extramural English activities (Warnby, 2021), meaning that the gains in academic vocabulary knowledge witnessed could have been caused by the students' engagement in non-academic activities involving exposure to English. Warnby (2021) found, for instance, strong correlations between reading English fiction, reading English non-fiction and reading English news and academic vocabulary knowledge.

Third, neither we, nor any of the previous studies referenced here reporting positive development of English proficiency, used a control group of non-EMI students. This inability, for all practical purposes, to have a control group is one aspect of the ecological validity which characterises studies in this area. In the Swedish context of MSc education, it would be exceedingly difficult to find such a group since only a very small proportion of master's-level programmes use Swedish as the language of instruction, particularly in the science, technology, engineering and mathematics (STEM) disciplines (Malmström & Pecorari, 2022). Indeed, at the target university, English is the only (nominal) teaching and learning language at master's level. Thus, even if we identify significant differences in academic vocabulary knowledge between the first-year scores and the second-year scores, it is impossible, given the absence of an experimental (randomized control group) design, to assert definitively that the difference is attributable to EMI and EMI alone.

6.3. Variation in development

The findings indicate not only that some students began their courses with larger academic vocabularies than others, but that some developed in terms

of academic vocabulary size more than others, and specifically that the students who initially had lower scores experienced more vocabulary development. This finding is surprising given other research which has suggested that stronger language skills are supportive of further incidental acquisition (e.g., Lee & Pulido, 2017; Webb & Chang, 2015). Webb and Nation (2017) suggest a mechanism for this: the larger the vocabulary size, the more capacity learners may have to attend to unknown words, and that "the accumulation of lexical knowledge may reduce the learning burden of unknown words" (p. 57).

It is not clear why the present findings differ from these earlier ones. It is worth considering the possibility of individual differences in terms of motivation to interact with English. Despite the widespread expectation that EMI must, to some extent, promote the development of English skills, working toward that development will inevitably be a greater priority for some individual participants in EMI than others. It may be the case, as Webb and Nation (2017) point out, that the boundary between incidental and deliberate learning is blurred, and that L2 users in an incidental setting may nonetheless sometimes engage in deliberate learning strategies, such as looking up an unknown word in a dictionary. It would be expected that the students more likely to engage in activities which reinforce the incidental exposure to English would be those who are particularly motivated to improve their English language skills; and it is not far-fetched to think that this group of motivated students might overlap with the subset of students who know, or believe, that their English language skills do indeed leave room for improvement.

The gap in terms of vocabulary increase can lead to cautious speculation that there may be two EMI constituencies: those who will attain good mastery of their subject area without struggle, because their English skills are strong, and those who will experience development of their English proficiency because there is room for it. To the extent that this speculation is grounded in fact, it is further demonstration of the need for the expectations of EMI participants to be informed and realistic; even if EMI delivers benefits, prospective participants should understand which benefits (and costs) it is likely to bring them.

6.4. Implications for teaching and learning

The findings of this study raise several questions for teaching and learning in EMI. As readers reflect on these issues, we encourage them to remember

that EMI classrooms are an unusual language learning context in the sense that there will not be a great deal of planned-for explicit focus on language *per se* during class (but see Lasagabaster & Doiz, 2021).

Teachers in EMI must be aware that they may be faced with a wide spectrum of English abilities relating to different communication modalities. This study has shown that there is a great deal of English proficiency variance as far as receptive academic vocabulary knowledge is concerned, at any given point in time, and other researchers have reported similar variance in relation to other language skills. Some students are already highly proficient in English when enrolling on an EMI program, and they are likely to sail through EMI unhindered by any English language obstacles; this group (approximately the upper quartile) is perhaps unlikely to learn a lot of English, but their incentive for choosing to study in EMI (if indeed they had a meaningful choice to make) was also likely not the opportunity to develop their English competency. At the other end of the spectrum are the strugglers (roughly the bottom quartile). These students may or may not have had any practical choice but to go to an EMI university, but they could have had expectations about the extent of the linguistic challenges, and/or the payoffs for facing those challenges. The findings of this research indicate, however, that this might be the group that has most to gain from EMI from a developing-English-proficiency perspective. Teachers have reason to be sensitive to these differences, and the sentiments and motivations characteristic of different profiles of EMI students, and to be prepared to vary their pedagogical strategies and approaches to accommodate all students on the English proficiency spectrum.

The differing ability levels identified in this study may also have implications for policy makers, such as program leaders or admissions officers. That the difference exists, despite a careful selection mechanism and competition for program places, may at one level seem surprising; however, some mechanisms contributing to it can be identified. The participants in this study had to meet a small number of universally applicable (across Swedish universities) eligibility requirements. These include a requirement for a level of English proficiency which is assumed to give adequate preconditions for success in carrying out academic activities in English (though little direct evidence is available to support that assumption). They also had to satisfy certain eligibility requirements specific to their degree programs. As the participants were all enrolled in STEM programs, it can reasonably be assumed that the majority of these requirements, and the most stringent of

them, were STEM-related. In other words, while a selection mechanism was in place, English played a relatively minor role in it. To the extent that the less proficient students may have experienced difficulties, or that classes with mixed proficiencies may present challenges for teaching staff, admissions staff may wish to reconsider the role which English plays in selection.

Teachers expecting English language learning to happen as a result of EMI should be forewarned that the development may not be very substantial, and to increase it, additional measures might be needed; incidental learning by itself can contribute only so much, so expectations of English proficiency development should be managed.

Teachers looking to maximize students' chances of English proficiency development could, at least to assist those students who appear to be struggling, consider lessons from research and practice in English for specific purposes (ESP) and English for academic purposes (EAP); supportive ESP classes in EMI have been found to have a stronger correlation with academic success than students' general English proficiency (Rose et al., 2020). If this option is chosen, researchers have suggested that "language support might best be operationalized in the form of specific classes which target the vocabulary, language, and academic needs associated with the subject area" (Rose et al., 2020, p. 2158).

Teachers/curriculum designers could also make concerted efforts to expose students to (more) text containing academic vocabulary and, if the teaching and learning environment allows it, draw attention to academic vocabulary in the reading; repeated exposure to the target vocabulary accompanied by occasional explicit attention/noticing is likely to lead to better incidental learning. To this end, tasks such as post-reading of key disciplinary texts after class (involving detailed re-reading of books, journal articles and other course materials and additional engagement with the texts, e.g., asking students to evaluate, compare or comment on texts) could prove to be helpful (and not just for the purpose of language learning). A recommendation that students read more, or read at all, might seem uncalled-for in some tertiary education contexts, but far from all teaching/learning involves reading. Pedagogical advice notwithstanding, the traditional lecture with minimal or no required pre- or post-reading is still a common form of teaching in many educational institutions, including in STEM universities like the one where this study was conducted (however, curricular design, beyond the language of instruction, was not a variable considered in this research).

Teachers reluctant to encourage more reading of academic texts, for whatever reason, could also point students to the benefits of extramural reading, or even viewing. Recent research has shown that there is much exposure to academic vocabulary to be had from extensive pleasure reading of general fiction and viewing of television programs and films. Green (2022, p. 14), acknowledging the curriculum time constraints facing many teachers in higher education, highlights that pleasure reading and viewing enable critical exposure to academic vocabulary: extensive reading and viewing pedagogies can alleviate "some of the learning burden for general and discipline-specific academic vocabulary […] there is enough exposure in extensive reading and viewing for the potential acquisition of particular academic vocabulary items." Obviously, telling students to read books and watch films is no silver bullet to developing a large academic vocabulary. However, as noted above, other researchers, e.g., Warnby (2021), have shown that there is indeed a correlation between the amount of pleasure reading and viewing and academic vocabulary knowledge, and it is known that pleasure reading increases automaticity, which frees up capacity for attention to vocabulary, including academic vocabulary (Hulstijn, 2001). Collectively, this research thus speaks to the potential advantages of students' extramural English engagement when the objective is to develop receptive academic vocabulary knowledge.

7. Conclusions

The present study has shed some light on the question of academic vocabulary size and development amongst students in one EMI setting, thus adding to the small body of work to date into the English proficiency of students in EMI. Given the criticality of language skills for success in higher education, considerably more research is needed. Meaningful participation in academic life involves many varied academic activities (listening to lectures; writing reports); semi-academic activities (taking part in study group meetings); and non-academic activities (socializing with classmates), and more research is needed on what (receptive and productive) skill levels underpin them. Very little is known about the preparedness of EMI students for this full range of activities, and further research into this question would be of great benefit.

Many observers of EMI have expressed concern about whether students' language proficiency is adequate for these specific purposes. The findings of

this study suggest that, at least as far as academic vocabulary knowledge is concerned, the answer is mixed; in some cases, yes, while in others, some element of struggle may be involved. This implies that there are different constituencies for EMI. EMI is often implemented for instrumental purposes and students frequently lack a choice about whether to participate or not. As experience with EMI grows, it may emerge that more meaningful choices about whether to participate in EMI and how to navigate it are needed.

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NOTES

[1] Scores out of a maximum of 57 points; percentages indicate the proportion of correct answers.