NEEDS OF LEARNING TOOLS FOR ACQUIRING SCIENTIFIC ENGLISH IN A JAPANESE UNIVERSITY: A CONTROVERSIAL ISSUE

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ABSTRACT
Scientific English (SE) has recently been integrated in the education curriculum of progressive Japanese universities. However, Japanese students (JSs) may or may not be equipped with the necessary learning tools where SE is taught. In this study, we probed into the acquired abilities (AAs) of 2 classes (A, B) of pharmacy students (n=92) learning SE for the first time in our university to investigate if the use of learning aids/tools was necessary. Based on feedback after the midterm and final tests, Class A (n=50) JSs were categorized into groups (G) having: only printouts (G1, n=35); printouts and textbook (G2, n=4); printouts and compact discs (CDs; G3, n=4); and printouts, textbook and CDs (G4, n=7), while Class B (n=42) JSs were categorized into G1 (n=9) and G4 (n=33), according to tools JSs were equipped. The AAs of JSs in understanding SE contents was measured according to their mean scores in the two tests, which demanded listening and written abilities of science-relevant contents. Additionally, student achievements (student counts vs scores) were analyzed after tests. Statistical verifications of their mean scores between G1 (control) and other groups were executed with the Tukey’s (HSD) test, and differences where P <0.05 were considered significant. The results revealed that only G4 (81.1 ± 11.14%) achieved significantly higher scores than G1 (65.2 ± 11.75) in the midterm test. Although higher tendencies in scores for the midterm and final tests were indicated in G2-G3 than G1, no significant differences (vs G1) were obtained. However, the mean scores of G4 vs G1 in Class B JSs were not significant in either test. In both classes, student achievements portrayed a similar low-high biphasic performance pattern, except low-achievers obtained higher scores in Class B (≤65%) than Class A (≤55%). Therefore, it may be useful for below-threshold low-achievers (≤55%) to have a complete set of learning tools to effectively elevate their AAs in understanding SE contents, at least, during early-stage learning, even effective teaching may be executed with post-lecture printout distribution.

Field of Research: Scientific English, teaching tools, low- and high-achievers

5. Introduction
Apart from its use to name, describe, record, compare, explain, analyze, design, evaluate, and theorize how the natural world appears to us (Wellington & Osborne, 2001), scientific English (SE) is a form of English that is required for expressing thinking, persuasion, reasoning, valuation, exchange of idea, and common interactive communication in science-orientated disciplines, with technical terms and typical expressions relevant to transmitting scientific discoveries and concepts. Other than being different from literary or everyday English (Barnes, 1969; Gardner, 1974; White, 1988; Muralidhar, 1991), SE requires learning, understanding, and acquisition of various technical terms relevant to specific specialty disciplines of science for interactive and functional communication. Although teaching tools for teaching SE to Japanese students (JSs), such as pictures, diagrams, images, animations, illustrations (figures, charts, tables), textbooks, handouts/printouts and others (Wellington & Osborne, 2001), are inadequately innovated for SE-learning in Japan, useful teaching tools/aids have recently been developed (Foong, 2010). Because of an urgent need to help facilitate young JSs in reading, understanding, reviewing...
scientific literature, and writing scientific manuscripts, SE has recently been integrated in the education curriculum of progressive Japanese universities. Apart from the many essential multifaceted factors that influence the SE-learning process (e.g. program-supporting funds, availability of competent teaching staff, attitude and mentality of learners, facilities, and environment, etc.), comprehension-useful handouts/printouts and effective teaching tools play an important role in facilitating JSs in SE-learning. However, JSs may not want to have the relevant teaching/learning tools in SE classes even when the relevant tools are available, either because of economic reason, mere ignorance or just indifference to the needs of such tools in learning and future development. In fact, more than 20 - 30% of JSs (vs less than 10% in our university) are not equipped with the necessary learning tools in certain universities where SE is taught (personal communication with publishers catering for teaching/learning tools).

Hitherto, there is limited research on the impact of teaching tools on science-learning (Carpenter et al., 2006), especially in the case of SE-learning in Japan. As such, we investigated if there were differences in acquired abilities (AAs) in terms of performance in 2 third-year (Yr-3) classes, where JSs were equipped with either partial, complete set of learning tools/aids or without any aids in the present study. Our present findings revealed that the AA levels of JSs tend to rank better in students having equipped with than those without relevant learning tools.

6. Subjects and Methods

2.1 Subjects
In this study, we probed into the AAs of SE-learning in 2 classes (A, B) of pharmacy students (n=92; age range: 20 - 21 yr) of either gender studying SE for the first time, although they had undergone learning of literary English for two previous academic years in our university. As purchase of the relevant learning/teaching tools (a textbook with 2 CDs attached) was not obligatory, students prepared and equipped themselves either with partial, complete learning/teaching tools or without any tools, albeit printouts from the lecturer were distributed to all.

2.2 Assessing AAs: listening to SE basics
In this study, since the JSs were differently equipped with the relevant teaching/learning tools, they were categorized into four groups (G) based on feedback after the final test: those had only printouts (G1); those who had printouts and borrowed just the textbook from their seniors (G2); those who had printouts and had made copies of the original copyrighted CDs (G3), and those who had the complete set of tools (i.e. printouts, textbook and original CDs) (G4). The group distributions for Class A (n=50) JSs were: G1 (n=35); G2 (n=4); G3 (n=4); G4 (n=7), while those for Class B (n=42) were: G1 (n=9) and G4 (n=33). Student AAs in SE-learning was measured according to their mean scores in the two SE tests, which demanded listening and written abilities of science-relevant contents. Additionally, student AA performance (student counts vs scores) was analyzed after tests. Statistical verifications of their mean scores between G1 (control) and other groups were executed with the Tukey's (HSD) test: differences where P<0.05 were considered significant.

In both tests, listening questions were read by 3 different regional (American, British & Malaysian) narrators. Apart from listening, students were also tested on grammars, concept-based sentence constructions, etc. Total marks obtained in the test were expressed as the mean scores. The questions of midterm and final tests were derived from contents written in the textbook as exercises/reviews and which had been previously taught in lectures given to the JSS for the periods prior to the respective tests. The midterm was conducted in lecture 7 (i.e. after completing 6 lectures), while the final was tested in lecture 14 (i.e. after
completing 13 lectures). However, questions given in the midterm were not repeated in the final. JSs that did not participate in either test, or were 1 minute late for either test, or felt unwell during either of the tests were excluded from the study.

6.3 Statistical analysis

All the data were represented as the mean ± standard deviation (mean ± SD). Statistical analysis was performed using the Tukey's honestly significant difference test (HSD) test (R 2.15.1 for Mac OS X; The R Foundation for Statistical Computing, Vienna, Austria) for multiple comparisons. The mean scores of the differently tools-equipped groups (G2 - G4) were compared with the control (G1) respectively, and differences where P <0.05 were considered statistically significant.

7. Results

The mean scores of the midterm and final tests were expressed as a percent of the total scores for all questions given in each test. The test results in Class A revealed that only G4 (81.1 ± 11.14%) achieved significantly higher scores than G1 (65.2 ± 11.75) only in the midterm and not in the final test. Intriguingly, higher tendencies in mean scores of other groups (midterm, final) were indicated as compared with control G1 (midterm: 65.2 ± 11.75, final: 68.8 ± 10.23): i.e. G2 (71.0 ± 18.06; 74.8 ± 10.28); G3 (73.3, ± 5.38; 72.5 ± 5.00) and G4 (81.1 ± 11.14; 73.4 ± 10.24), although differences were not significant between any 2 of the groups or when each group (except G4) was compared with G1 in Class A using the Tukey’s test.

In the case of Class B JSs, however, the difference of mean scores in either the midterm or final test between the only 2 groups was not significant: i.e. G1 (midterm:?, final: ?) vs G4 (midterm:?, final: ?).

![Figure 1: Table 1: Mean scores of the midterm test in G1, G2, G3 and G4 were given 6 lectures prior to test in lecture 7: Data are represented by the mean ± SD, and differences where p <0.05 are considered statistically significant (*) when verified by the Tukey’s test. Note that only G4 was significantly different from G1 (see 2.2 for elaborations on G1 – G4).](image)

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When AA performance of both Classes A and B was assessed, a similar low-high biphasic pattern was portrayed in both classes, except low-achievers obtained higher scores (≤65%) in Class B than Class A (≤55%), while high-achievers indicated mean scores of negligible difference.
8. Discussions

Disparate research of the past 30 years reveals that learning science is learning scientific English (SE) or the language of science (Wellington & Osborne, 2001). ES-learning has to take into the account of concepts, language, reasoning, and valuation of sciences per se. Reading from the textbook is inadequate, reading should involve proper enunciation, understanding, interpretation, analysis, juxtaposition learning, and connecting sentences with proper grammars and choice of words and terminology, especially in the case of JSs. Students should also learn to connect different thoughts in a logical manner such that the connection be constructed with the right words in the form of sentences and paragraphs to formulate a concept for functional communication.

Factors influencing the outcome quality of JSs in SE-learning include the following: formulation of a systematic teaching program/system with proper curricula; training/employment of competent teaching staff; appropriating well-equipped environment, supporting facilities, teaching materials and tools, etc. Of these many factors, students (especially JSs) should be equipped with learning tools such as textbooks, tapes, and CD-ROM, especially in the pursuit of language learning, although additional materials and references may further facilitate SE-learning (Klymkowsky, http://www.lifescied.org/content/6/3/190.full). In fact, many instructors teaching a course would consider using teaching tools, or at least a textbook. In the case of JSs with poor listening ability, tape and CDs or CD-ROM are crucial tools in orientating them to understand what is spoken. As English is the lingua franca at global collaborative research & development projects, across-the-border meetings and international conferences, SE-teaching/learning involving listening, comprehension and writing is important for JSs to conduct interactive and functional communication. Despite limited development in ES-learning in Japan, useful teaching materials have recently been published (Foong, 2010). ES-learning may also serve as a factor in reversing the recent inward-looking trend of young Japanese (Open Doors 2010 International Studies in the U.S.; http://www.iie.org/).

Based on the above objectives, the present study investigated the necessity of using teaching/learning tools by Yr-3 JSs in SE-learning. Participating JSs, who had undergone learning of literary English for two previous academic years, were supposed to learn SE for the first time in English. The results of our study demonstrated that G4 JSs scored the highest among the experimental groups (G2 – G4), and their mean scores were significantly (p < 0.05) higher than controls (G1) in the midterm test in Class A (Fig. 1). This was most likely due to the advantageous learning tools G4 JSs had: viz., a complete set of tools with relatively useful and intensive information (acoustic and visual) inputs, thus facilitating ES-learning at a more efficient rate to secure the highest scores.

Moreover, the mean scores of G1 - G4 in Class A illustrated a gradual increasing trend in scores which was proportional to the availability of more sensation-aided tools, with their mean scores ranking in the following increasing order in the midterm scores (range: 65.2 – 81.1): G1 (65.2 ± 11.75) < G2 (71.0 ± 18.06) < G3 (73.3, ± 5.38) < G4 (81.1 ± 11.14). However, the differences were narrowed down in the final scores (range: 68.8 – 74.8): G1 (68.8 ± 10.23), G2 (74.8 ± 10.28), G3 (72.5 ±5.00), and G4 (73.4 ±10.24) without obvious ranking order in the partially and completely equipped groups; the non-equipped or printout-only group (G1) was still the group with the lowest scores. In both test, partially and completely equipped JSs were always performing better than the printout-only group, implying that tools-equipped JSs, whether partially or completely, were consistently performing better than the printout-only group. Furthermore, those partially equipped groups (G2, G3) vs printout-only group G1) could have obtained significant differences in scores if the sample-size of JSs was higher. As a majority of JSs are poor in listening to English, those CD-bearing G3 and G4 JSs were obviously placed at a more advantageous position, as they
would have more time and higher frequency in improving their listening abilities to exercises/reviews given in the textbook prior to the test. This is also the reason for higher scores in G3 than G2 JSs, who merely had the textbook and without CDs for listening practice before the test. However, G2 did have a better working foundation to acquire understanding of SE basics taught. As for G1 who had only printouts from the lecturer, they did not fare better than any other groups. G1 JSs were definitely disadvantaged as they had no CDs (i.e. limited listening practice during lectures), and were only learning fragmented pieces of ES contents extracted from the textbook (thus, missing out the basic components that made up questions/contents of the tests). Learning without basics provides limitations in further and higher development, and a grade as good as a pass may likely be achieved when students concentrate merely on the given printouts: a finding which we have actually found in the present study. Handouts/printouts are merely brief summarized notes on the lectures done, and may enable JSs a brief perspective of contents taught.

Results in the final test in Class A demonstrated no significant differences between any two groups (G2, G3, G4) or when any group (G2, G3) was compared with G1. This outcome could be due to the G1 JSs were made aware of their disadvantageous situation in the midterm, spurring them to resort learning the basics and contents from their classmates and seniors: i.e. time-related development that eventually narrowed the difference in scores (or AAs in SE-learning) between the different groups of students, albeit the mean scores of G1 did not improved significantly (see midterm vs final scores). In a reversed development, G4 JSs might have become complacent after having scored high scores (>80%) in the midterm, or they might felt over-confident after thinking that they had learned the essentials to handle the final test, and subsequently slackened in their routine revision and review of lectures in test preparation to finally yield mean sores lower than that of the midterm test. Interestingly, G2 and G3 had mean scores in the final test which were not markedly different from those obtained in the midterm test (range: 70-75%), showing levels that they felt comfortable and self-satisfied.

Different from Class A, no significant differences were derived between G1 and G4 in Class B in either the midterm or final test, even when G4 JSs were equipped with a complete set of teaching/learning tools, while G1 JSs relied only on the given printouts. As their scores did not differ markedly, we thought the students were conscientious and duty-bound in their pursuit of SE-learning, where G1 might have constantly liaised, discussed and consulted G4 JSs or their seniors about the lecture contents related to listening and understanding after lecture: viz., comparing and contrasting answers on listening and written exercise/review. Or the AAs of JSs in G1 and/or G4 JSs were different from that of G1 in Class A, so much so a difference in the statistical analysis results was impacted.

In fact, verifications of the AA performance of JSs in Classes A and B revealed a low-high biphasic pattern in achievements: viz., the low-achievers obtained higher scores in Class B (≤65%) than Class A (≤55%), while the high-achievers were rather similar in both Classes A and B.

The above results demonstrated that teaching/learning tools for JSs are essential for certain below-threshold low-achievers, although certain (above-threshold low-achievers) JSs who conscientiously and regularly do revisions and reviews of lectures done may not need those tools for passing tests (threshold = 55% in the present study). Despite being disadvantaged, poorly or incompletely equipped JSs in G1, G2, G3 of Class A and those in G1 of Class B were probably motivated more by the desire to attain credits rather than an inherent desire, or interest, to learn and further improve their SE levels, or it might be merely due to economic reasons. In a long-term view, they have to be made aware of their individual AA achievement status for further development in future endeavors: i.e. teaching/learning tools should be equipped for those (below-threshold low-achievers; mean scores of ≤55% in this study) who but have to be equipped with the tools, and for all with a keen interest to learn and a potential
to achieve further development to a higher dimension in SE-learning. Although there is no correlation between textbook purchase and the grade achieved (Carpenter et al., 2006), or science-teaching and science-learning may be done without textbooks (Klymkowsky, http://www.lifescied.org/content/6/3/190.full), our results revealed that a score as good as 70% or more was achieved in those with either partial or a complete set of relevant teaching/learning tools. In fact, the scores of G1 – G4 ranked in an increasing order as follows: G1 < G2 < G3 < G4 in the midterm test, implying that the more complete the students were equipped with the relevant tools, the more likely they were able to achieve higher scores/grades in tests at the early-stage learning in our present study. However, the late-stage learning showed a narrow difference in scores between G1 (lowest scores) and G2 (highest scores) of 11.6% (cf lowest-vs-highest scores in midterm: 24.4% difference), with no obvious ranking order due to narrow differences in scores of partially/completely equipped groups, where G2 (lowest) vs G3 (highest) difference only yielded a difference of ~3.1%. With relevant printouts, SE-learning can be done when basics have been secured, and listening ability can be elevated with repeated exposure. If post-lecture printouts were not distributed, the scores of JSs in G1, G2, and G3 of Class A and those in G1 of Class B could be lower. If this was the case, useful and relevant printouts are essential for ES-learning, especially for those who cannot afford the tools or are just interested to secure the designated credits for coursework. Therefore, in the case of low-achievers and those who have the potential for further development and those who want to improve themselves in SE as their future assets and skills in interactive and functional communication, equipping themselves with the appropriate and relevant teaching/learning tools is a useful and affirmative decision well made.

5. Conclusion
Based on the results in this study, it may be useful for (below-threshold: mean scores of ≤55%) low-achievers in our samples to have a complete set of the relevant learning tools to effectively acquire SE-teaching contents at early-stage learning, even effective teaching may be executed with post-lecture printout distribution.

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