Research into Reading Grants

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An investigation into how various textual features of academic journals can interact with students' engagement with these texts: A case of novice and non-traditional learners in STEM subjects

RESEARCH IN EFL READING AND READING ASSESSMENT

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ABSTRACT

This case study investigated the interaction between text features of academic journal articles in engineering subjects and two cohorts of students' (i.e., young undergraduates and post-experience, company-based, mature, students: N=40) comprehension of these articles. To this end, different sections of a sample journal article selected from the reading list provided to these students were modified in terms of three textual features — syntax, lexis and cohesion. The student participants' comprehension of these sections was measured using an experimental reading test. Their perceptions regarding the accessibility of the different sections of the text were sought using an exit questionnaire.

The results showed that, improving textual features of those amended parts of the article could have positively contributed to the participants' performance in the reading test used. However, relatively high comprehension seemed to have occurred in relation to modification to syntactic and organizational (cohesion) features of the text with lexical modification showing no major impact on facilitating students' comprehension. Such results were also reiterated in students' responses to the post-experiment questionnaire where their perceptions regarding the perceived difficulty of the text different parts were sought.

The findings of this study can provide useful guidelines for academics on what factors to consider when selecting reading materials in order to include scaffolding and differentiation in their teaching approach.

AUTHORS

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Professor Ian Tuersley

Professor Ian Tuersley started his academic career at Warwick University in 1992, after completing an undergraduate apprenticeship with Rolls-Royce and his PhD. Originally appointed to Warwick Manufacturing Group (WMG) as a researcher investigating laser machining of advanced composite materials, he subsequently became more involved in teaching on various undergraduate and postgraduate programmes, both in the UK and overseas. A Fellow of both the IMechE and the IMarEST and a PFHEA, in 2018 he was awarded a ‘WATE’ – the Warwick Award for Teaching Excellence, the university’s highest recognition for teaching, and in 2019 the IMarEST’s ‘Outstanding Contribution to Marine Education’.

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1. BACKGROUND

It is widely acknowledged that academic styles of writing (in common with many other professions) have a tendency to use complex language. This practice would seem to be expected, even regarded as 'good' and certainly common practice. This may be appropriate when the writing is aimed at similarly expert peers but has the potential to be very discouraging if it is deployed in publications that are accessed by many learners, especially those who are new to a subject and /or lack confidence in higher education (HE) environments. A great deal of feedback from students who study engineering subjects at the School of Engineering and Warwick Manufacturing Group (WMG, where one of the researchers, Ian Tuersley works as a professor) specifically mentions their appreciation of having taught material 'demystified' with simple, plain language explanations of concepts. Such feedback, gathered via such channels as the Student-Staff Liaison Committees (SSLCs) and the Engineering Society, was received specifically from two cohorts of students: 1) students who have come to their degree courses with lower degrees of familiarity with the academic conventions and literacies of the disciplines; and 2) part-time 'non-traditional' students who have come to complete a degree following a gap in their studies.

As such, this project sought to address this issue among these groups of students. The project was based on the belief that this could result in practice which could discourage many potential students from higher education, due to a lack of confidence in their ability to engage with learning at this level and consequently impact upon some efforts of widening participation.

2. LITERATURE REVIEW

2.1 Student (both L1 and L2 users of English) engagement with academic texts

Reading undoubtedly plays an important role in student learning (e.g., Fernald, 2004; Bharuthram, 2012). Most university courses are based around textbooks, and course handbooks almost always dedicate a part to reading materials related to a course suggesting that students are expected to actively engage with reading materials during their study. There is evidence in research that students who read more tend to display better performance in their academic studies (Sappington, Kinsey & Munsayac, 2002). Research has also showed that reading can improve classroom participation in lecture and seminar discussions (e.g., Leeming, 2002). Additionally, reading regularly helps students improve their reading skills as well as their writing (Mokhtari, Reichard, & Gardner, 2009).

Nevertheless, research has also shown that students tend not to get actively engaged with the reading materials recommended to them by academic staff (Clump, Bauer and Bradley,2004; Artis, 2008; Henderson & Rosenthal, 2006; Jensen & Moore, 2008; and Starcher & Profitt, 2011). (Note that these studies were conducted with students in HE contexts, but with no indication of whether English was the students' L1 or L2.)

In addition to examining the extent to which students read recommended sources, research has also investigated factors contributing to lack of engagement with academic reading materials. Such factors include: lack of time (Erdem, 2015; Hoeft, 2012; Marek & Christopher, 2011; Starcher & Profitt, 2011; Sharma, Van Hoof, & Pursel, 2013); low reading comprehension levels (Ryan, 2006); negative attitudes towards reading (Marek & Christopher, 2011); lack of confidence with reading (Lei, Bartlett, Gorney & Herschbach, 2010); and lack of motivation and engagement (Derryberry & Wininger, 2008; Hatteberg & Steffy, 2013).

Regarding motivation and engagement, while the former refers to 'the reader's self-perceived reading competency, value attributed to reading tasks, and ability to succeed given the reading task presented' (Unrau & Quirk, 2014: 264), the latter indicates 'action in and interaction with the environment, such as number of words read, evidence of comprehension, and actual strategies used in the reading process' (ibid).

As for lack of confidence as a factor in the level of engagement with academic texts, this can be linked to the accessibility of academic texts; in other words, how well they match students' reading abilities (Lei, Bartlett, Gorney & Herschbach, 2010). Some research suggests that text-features (i.e., vocabulary load, linguistic structure, cohesion, discourse style and genre) have a great effect on the accessibility of texts (Linderholm et al., 2001).

A majority of the studies mentioned above used interviews or questionnaires, rather than more evidence-based methods perhaps because engagement cannot be measured like other constructs such as comprehension. By using a mixed-method approach, this case study aimed to address this gap by both measuring comprehension as one way to measure engagement, as well as seeking students' perceptions using a follow-up survey.

One way this study aims to investigate the students' engagement (here measured through evidence of comprehension) with academic articles in engineering subjects is through showing the interaction between genre features of these texts (e.g., syntax, lexis and cohesion in academic articles) and students' comprehension of these texts. Considering this aspect of the study, a brief review of literature investigating the relationship between these features and text comprehension will be provided here.

2.2 Textual features and text readability

While the impact of text difficulty on comprehension was traditionally (e.g., Perfetti, 1985) measured mainly based on word frequency and sentence length (with less frequent words and longer sentences making texts more difficult to read), recent research includes text cohesion as another feature representing readability to take into account inter-sentential factors contributing to text difficulty. According to this new body of research, the manner in which ideas are organized and presented in a text can also determine its difficulty; a text presented in an explicit and meaningful manner (high cohesion) is considered easier to comprehend than a text with less explicitness, both structurally and conceptually, relying more on background knowledge (e.g., McNamara, Louwerse, McCarthy & Graesser, 2010; Graesser & McNamara, 2011).

The two sources of variation in text cohesion are known as referential and deep cohesion. Regarding referential cohesion, a cohesion gap occurs when a sentence has no words or ideas that connect to other sentences in the text. As for deeper cohesion however, this is more concerned with how ideas in the text are explicitly linked via cohesive devices. It is often important for texts to have cohesive signal words (such as *however, consequently, likewise*) to show the link between the ideas in a text overtly. It is suggested that high levels of cohesion (both referential and deep) would significantly increase comprehension as it reduces the need for making inferences to connect different parts of a text (Graesser, McNamara & Louwerse, 2003; McNamara, 2001). High cohesion texts therefore seem to be more suitable for instructional purposes (e.g., an article in a reading list) as they require less background knowledge (Nelson, Perfetti, Liben & Liben, 2010).

2.3 Readability measures

Considering the impact text features discussed above can have on text comprehension, various readability formulas to measure text difficulty have been created. These measures are usually used by educators, especially at primary and secondary level, as one way to inform their decisions regarding selecting reading materials for students. While some readability formulas (e.g., Lexile) are based on quantitative text parameter theories according to which texts containing longer words and lengthier sentences are more difficult to read, some (e.g., Coh-metrix) use qualitative text parameters such as narrativity, syntactic simplicity, word concreteness, referential cohesion, and deep cohesion. As Lexile (the readability measure provided by one of the sponsors of this study) and Coh-Metrix measures were used in this study to measure lexical and syntactic, as well as cohesion features of an academic text respectively, features of these readability tools will be briefly reviewed below.

2.3.1 Readability measures: Lexile and Coh-Metrix

The Lexile Framework for Reading is a tool which measures both the reading ability of readers (a distinctive feature of this tool) and the difficulty of reading materials. Lexile measures (e.g., Lexile reader measure and Lexile text measure) are shown as numeric measures followed by an ‘L’ (for example, 1120L). Higher measures indicate a higher difficulty level for a text. In this study, this measure refers to the Lexile text measure only as the focus here is on the impact of text features on the comprehension of those students who seem to have less familiarity with a particular genre

(journal articles) in their field. These measures are placed on the Lexile scale (e.g., ranging from BR300L and below for beginner reader (Grade 1) to 1300L and above for college and career ready reader (Grade 11&12). Measuring the reader ability and text complexity, the Lexile measure is used to predict how the text matches the reader's ability. All Lexile products and services rely on the Lexile measure and Lexile scale to match reader with text. The variables used in this tool are word frequency and sentence levels. The measure is based on quantitative text parameter theory where text complexity is determined based on the frequency of words as well as the length of sentences used in a text. (For more information, see: https://lexile.com/educators/measuring-growth-with-lexile/college-and-career-readiness/)

As the project sought to also address a qualitative feature of a research article in an engineering subject (i.e., text organization in terms of cohesion), Coh-Metrix was also used to measure this textual feature of the given article. Unlike Lexile, this readability measure analyzes the ease of texts on five different dimensions: narrativity, syntactic simplicity, word concreteness, referential cohesion, and deep cohesion. Each of these dimensions is given a score for a given text. As for cohesion, two levels are measured: referential cohesion (i.e., the overlap between sentences with respect to major words and explicit ideas); and deep cohesion (causal and temporal relations between events, actions, goals, and states). This work focuses on this aspect of cohesion. In contrast to Lexile, the *higher* the scores on Coh-Metrix, the *easier* the text is to comprehend. (For more information, see http://cohmetrix.com/)

3. RESEARCH AIMS

The current study explored engagement with reading practices (here measured by evidence of comprehension) of a group of undergraduate and part-time postgraduate learners in engineering degree programmes at the University of Warwick. The study aimed to examine how three textual features of an academic journal article genre (i.e., syntax, lexis and cohesion) in STEM subjects interact with students' engagement with such texts. To address the research focus above, the following research questions were formulated.

Primary research question

How does the choice of text with various readability features (organization (cohesion), syntactic and lexical complexity) impact on students' engagement with academic resources?

Secondary research questions

1. How do readability features (organization (cohesion), syntax and lexical complexity) interact with reading comprehension?
2. How do readability features interact with individual reading comprehension items (i.e., those measuring local vs those measuring global comprehension)?
3. How do the participants perceive the effect of the three readability features investigated in this study on their comprehension of the text and how do they perceive the inclusion of reading questions for academic reading materials?

4. METHODOLOGY

4.1 Research design

An embedded mixed methods approach was employed to gain a broader perspective on this research topic, and to provide further explanation of possible significant or non-significant observations. Both quantitative and qualitative data were collected simultaneously in one phase, and a concurrent embedded strategy of mixed methods (Creswell, 2009) was used. Figure 1 demonstrates the general procedures in this design.

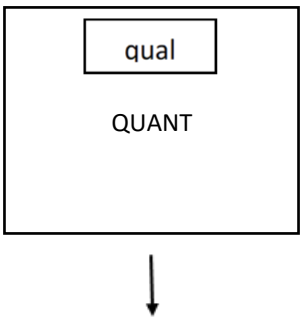

Figure 1: *Concurrent embedded design (Creswell, 2009: 210)*

According to this design, the primary set of data in this study entailed the quantitative data (students' reading test scores and responses to closed-ended questions in the exit questionnaire), which is shown in uppercase in the figure above, then followed by the secondary data shown in lower case (students' responses to the text-based questions in the questionnaire) in order to expand results gained via quantitative data.

Regarding weighting, the quantitative method is the primary method applied, with the qualitative method nested in it. The predominant method in this research addresses the outcomes from the experiment. After collecting these sets of data, the quantitative and the qualitative data were analyzed, and the results were mixed for final interpretation and discussion. Figure 2 shows the specific procedures in the mixed methods used in this research.

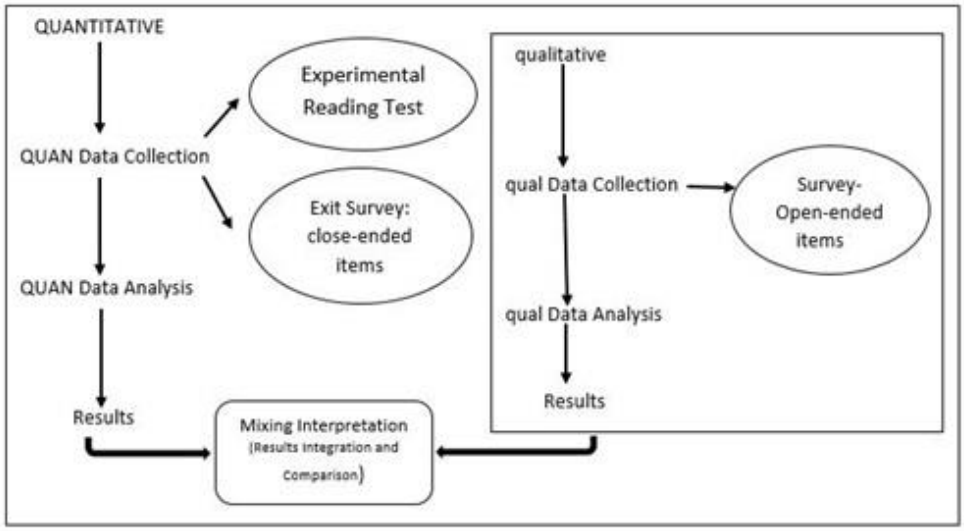

Figure 2: *Mixed-methods procedure used in the study (adapted from Haghi, 2016)*

4.2 Participants

Forty (40) undergraduate and non-traditional post-graduate students participated in this study. They were all students from engineering subjects. These participants were home, EU, and international students. They were either young undergraduates with a mix of domestic /overseas etc. (henceforth referred to as novice students) or post-experience, company-based, mature, students who had not been involved with HE before or for many years (henceforth referred to as non-traditional).

With regard to their English language proficiency, the international students were all at upper-end of C1 (CEFR) language proficiency level. These participants' English proficiency level was determined based on their IELTS reading score (for international and EU students). As such and in order to participate in the study, a minimum IELTS reading score of 8 (borderline C1/C2) was required. The reason for setting such a requirement for non-native English participants was to control for general English language proficiency as an extraneous variable given that the focus of this study was on the accessibility of a specific genre of reading materials (i.e., academic journal articles) in engineering subject to novice and non-traditional students in terms of their academic literacy (e.g., conversancy in subject genres) rather than general English language proficiency. According to the Common European Frame of Reference (Council of Europe, 2001, overall comprehension at C2 level entails:

> *…understand[ing] and interpret[ing] critically virtually all forms of the written language including abstract, structurally complex, or highly colloquial literary and non-literary writings. C2 can understand a wide range of long and complex texts, appreciating subtle distinctions of style and implicit as well as explicit meaning.* (Council of Europe, 2001: 69)

As for home students, they all were native L1 users of English, who, as educated native speakers, were considered proficient users of the language.

4.3 Data collection tools

The materials used in this project consisted of an experimental reading test and an exit questionnaire. For the reading test, an article on a generic topic in the engineering discipline and from a reading list used in the relevant programmes was selected. (The article was: 'Engineering the virtual enterprise: An architecture-driven modeling approach', written by Presley, Sarkis, Barnett and Liles in the *International Journal of Flexible Manufacturing Systems*, 13(2), 2001: 145–162.) The text was then shortened to suit a reading test session where the participants would read the text and respond to a series of questions. Once the text was condensed, it was then divided into four parts based on the overall text main ideas. The readability level of each section was then measured using Lexile and Coh-Metrix measures. In order to examine how textual features of an academic text interact with the comprehension of the readers (i.e., the participants), these four sections of the text were amended each based on one aspect of the textual features investigated in this study (e.g., cohesion, syntax and lexis). Following the treatment of the text, each section's readability scores were measured again to see the difference made to the measure based on the modifications made to the text in each part.

Once the text had been modified, a series of reading comprehension questions were designed for parts 1 to 4 of the text.

Finally, an exit questionnaire was also designed to investigate the participants' self-assessment of the ease of understanding of each part, as well as their engagement with these parts. It should be noted that while engagement was measured via evidence of comprehension (as suggested by Unrau & Quirk, 2014: 264), it was also investigated based on students' understanding of engagement given that, in their feedback to their tutor (one of the investigators in this study) during SSLC meetings, they had repeatedly referred to their reading materials as disengaging. The student cohort addressed in this study specifically referred to engagement as their willingness to continue reading a text. In responding to question 3 of the exit questionnaire, therefore, they were asked to consider engagement as how willing they were to continue reading each section in order to see whether there is any relationship between their level of understanding of each parts of the text and engagement with those parts.

5. RESEARCH PROCEDURE

5.1 Designing data collection tools

At this stage of the project, the research materials, consisting of a reading test and an exit questionnaire, were designed and developed. This included reviewing a series of selected academic articles from the reading lists used in the programme at the School of Engineering and finding a text which could be modified for the experimental reading test. As part of the text selection for developing the experimental reading test, a representative group (N=12) of the participants were asked to read a selection of texts and respond to a series of questions regarding the text difficulty and the reading time. The participants were given two types of tasks consisting of 'while reading' tasks (e.g., *As you are reading each part, please highlight any parts of the text, sentence(s) and/or words which you find difficult to understand* or *Please time your reading for the whole article*) and 'after reading' tasks (e.g., *Were there any parts that you found particularly difficult to understand (please choose as appropriate)* or *If you found (a) part(s) of the article difficult to understand, which of the following factors would you relate it to? You can choose more than one option.)*

Based on the feedback from the students (e.g., timing, suitability of the text for the given experiment which required dividing the text into four parts), one article was selected for inclusion in the reading test and modified for use in the test. The modification of the text consisted of the following stages:

- dividing the article into four parts based on overall main ideas of the text (excluding the *Introduction* and *Conclusions* sections), so that three parts could be modified according to the three textual features investigated in this study and one remained intact to be used later for comparison with other parts
- shortening each part (i.e. summarising some parts in tables or lists, and omitting blocks of text – independent of the broader context – in each section) so that the experiment could be conducted within a practical time slot (i.e., maximum of 90 minutes)
- modifying three parts of the article (i.e., parts 1–3) according to one of the textual features investigated in this study for each part (i.e., cohesion, syntactic complexity and lexical complexity) so that comparisons could be made in relation to the understanding of each part.

The readability level of each section was measured using Lexile and Coh-Metrix tools once before and once after modification of the text. As mentioned above, in order to examine how textual features of an academic text interact with the understanding of the readers (i.e., the participants), these four sections of the text were modified based on different aspects of the textual features investigated in this study.

To this end, the first section was amended by inserting cohesive devices to the text in this section while the second part was modified syntactically (i.e., reducing sentence length and using less complex structures). The third section was amended lexically through inserting glossary for technical terminology and also replacing less frequent words with more frequent synonyms from the Academic Word List (AWL) whenever possible. It should be noted that the glossary was not included in the readability score as it was not embedded within the text. No other modifications were made to this part. Finally, part 4 of the text remained intact with no amendment made to the text. Following the modification of the text, each section's readability score was measured again to see the difference made to the measure based on the modifications made to the text in each part.

Table 1 provides more details regarding features of each part of the text in terms of their word count, textual features focused on, and readability (easability) measures before and after the modification of parts.

Table 1: *Text features of Part 1, Part 2, Part 3 and Part 4 of the text*

Text parts	Word count	Textual feature modified	Lexile measure before modification	Lexile measure after modification	Coh-metrix measure before modification	Coh-metrix measure after modification
Part 1	937	Organization (deep cohesion)	1200L	1210L	29%	40%
Part 2	1009	Syntactic complexity	1260L	1180L	60%	45%
Part 3	1002	Lexical complexity	1385L	1330L	59%	62%
Part 4	978	None	1310L	1310L	38%	38%

As mentioned earlier, while with Coh-Metrix, the higher a measure, the easier a text is to read, with the Lexile it is the opposite. For example, in Table 1 above, part 1 of the text, which was improved in terms of cohesion (deep), showed a higher Coh-metrix measure after modification (i.e., increased from 29% to 40%). It is interesting to note that, while the Coh-metrix measure increased in part 1 after organizationally modifying the text (e.g., inserting cohesive devices) suggesting that the text became less difficult by improving deep cohesion, the lexile measure for this part increased. As mentioned earlier, on the Lexile scale, higher measures indicate a higher difficulty level for a text. As seen in Table 1, part 1 (organizationally modified) increased in difficulty on the Lexile scale after modification. One possible explanation could be that since the Lexile measure is based on quantitative text parameter theory (i.e., text complexity is determined based on the frequency of words as well as the length of sentences), the increase in sentence length resulting from inserting cohesive devices could have contributed to the increase in the Lexile measure of part 1 after the modification.

On the other hand, part 2, which was modified syntactically, was at Lexile text measure of 1260L (i.e., 11 & 12 grade: college and career ready level) before the modification, while it reduced to 1180L (grade 10) after modification. While the new Lexile measure suggests that the text became less difficult in part 2, the Coh-metrix readability measure decreased meaning that the text became more difficult based on this tool. Since the modification in part 2 included summarizing dense blocks of text and presenting them in tables or lists, one possible explanation for such contrasting measures of readability could be that fewer instances of cohesive devices used in shorter sentences and tables/lists resulted in a decrease in the Coh-metrix measure for this part indicating that the text became more difficult in terms of the deep cohesion of the text.

Part 3 (modified lexically), however, decreased to 1330L on the Lexile scale after modification, and it also increased on Coh-metrix (only marginally) showing that it became less difficult based on both measures. It should be noted that while there seems to be a decrease in the measure after modification for this part as well, suggesting the text became easier to read, the grade remained the same (i.e., texts with 1185L–1385L Lexile measure are suitable for grade 11&12) and at the same level as part 4.

As shown Table 1 above, it seems that replacing some less common words with more frequent (less abstract) ones resulted in new measures indicating a decrease in the difficulty of the text according to both readability tools. However, since the main modification to part 3 included adding a glossary of technical terminology which did not include any direct interventions within the text, such modification was not detected by the tools and possibly explains the fairly moderate change in both readability measures after modifying this part.

A series of reading comprehension questions were designed. These questions were designed to assess comprehension at both local and global levels with the former focusing on the comprehension of detailed information explicitly stated in the text and the latter focusing on the comprehension of information provided implicitly in the text (Alderson, 2000). These two levels of comprehension were selected based on intended learning outcomes of core courses at undergraduate and postgraduate programmes at the School of Engineering and WMG. The number and format of items used in each of the four parts of the test were identical, with the use of short-text and extended-text response questions in all parts (these are the two formats usually used in summative assessment especially at undergraduate level). Likewise, the number of questions assessing local and global comprehension in each part of the test was equally distributed across the four parts of the text (i.e., 4 local and 5 global items in each part).

In addition, an answer key was created in consultation with the subject specialist involved in the project (one of the researchers) and later used in the standardization session conducted by both investigators when marking participants' responses following the main data collection stage. In judging the answers in the standardization session, the markers would then refer to the answer key for their judgement. In the case of items measuring comprehension of explicit information, it was agreed that as long as the responses referred to the information addressed, they would receive a full mark (spelling mistakes which did not imply comprehension errors were not penalized).

As for items measuring comprehension of arguments (implicit information), different variations in responses in comparison to the wordings of the answer key were discussed between the markers (the PIs in this study) until they reached an agreement. It was agreed to refer to a third marker in case no agreement was reached; however, this did not happen as there were no cases of disagreement.

5.2 Ethical approval and compliance with GDPR regulations

Prior to the pilot and main data collection, ethical approval was sought in accordance with Warwick University's ethical approval regulations. It should be noted that, before the collection of any primary data could be conducted, recently revised and tightened university regulations regarding research ethics stipulated that full ethical approval for the study be sought via the University's Science Faculty Ethics Committee. Ultimately this was acquired (approval reference REGO-2018-2137) but the delay in processing this application and the requirements that the approved procedure placed on the gathering of data from individual persons was to quite notably impact upon the number of respondents for the remaining period of the study. As a further constraint, during the research period the university also introduced its procedures for compliance with the General Data Protection Regulation (GDPR), enforcement of which commenced on 25 May 2018. This also had the effect of making it more difficult to approach and recruit suitable participants for the study.

As a consequence, given the constrained timeframe of the work, it became necessary to conduct the analysis for this study with a significantly reduced data-set from that which had been anticipated initially.

5.3 Piloting data collection tools

The second step of the research consisted of a pilot study. This included a series of test sessions with representatives of the sample population (N=15) taking the experimental reading test and completing the exit questionnaire. The purpose of the pilot study was three-fold. First, to conduct an item analysis of the individual comprehension questions used in the test. Second, to seek student feedback on the timing of the test, as well as the difficulty of each part of the text and the accompanied questions. Third, to check the clarity of the questions used in the exit questionnaire and the time needed to respond to them.

The data collected in the pilot step was used to amend comprehension questions, the text in each of the four parts of the test, as well as adjusting the timing for completing the reading tasks and the exit questionnaire. Following the item analysis of the 40 reading comprehension questions used in the test, four items (one from each part) with negative -total correlation were deleted from the test. The Cronbach's Alpha for the remaining 36 items was (α = .81) which, given the size of the pilot sample, was considered acceptable.

5.4 Collecting the main data

Following modification of the reading test research materials, the main study was conducted with a series of test sessions arranged for students to take part in the experiment. Each session took 90 minutes. The sessions were scheduled during lunch breaks so they did not interfere with student lectures. For this reason, a free lunch was provided 30 minutes prior to the start of the experiment.

The experiment sessions then started with an introductory part where the researchers briefed the participants about the project and instructed them on how to complete test tasks and respond to the exit questionnaire. The participants were given 15 minutes to complete the tasks for each part of the text (i.e., parts 1, 2, 3 and 4) plus five minutes to take a break between each part to control for fatigue effect (refreshments were available in the room where the experiment was conducted for participants during the breaks).

6. RESULTS

RQ1. How do readability features (organization (cohesion), syntactic and lexical complexity) interact with reading comprehension?

Following the experiment, the data from the reading test and the exit questionnaire were analyzed and mixed to respond to the research questions.

The initial descriptive statistics of the reading scores showed that the participants' scores in part 4 (non-modified text) and part 3 (lexically modified text) were lower than those in part 2 (syntactically modified text) and part 1 (organizationally modified text). Table 2 shows the descriptive statistics of the scores across the four parts of the reading text, along with the Lexile text measures for each text part. It should be noted here that while part 3 (lexically modified) had a higher Lexile measure than part 4 (non-modified), both parts were still within the same difficulty range (i.e., 1185L–1385L range belongs to grades 11 and 12). It is interesting to note that part 1 (organizational modification) and part 3 (lexical modification) remained within the same difficulty range on the Lexile scale after modification as part 4 (non-modified) and yet the students gained higher scores in parts 1 and 2. One possible explanation for this could be that the modifications made to parts 1 (organizational) and 3 (lexical) provided a form of scaffolding to facilitate participants' comprehension of the text. Further research (e.g., including a control group), however, is required to thoroughly explore such possible effect and better control the effect of other extraneous variables such as fatigue.

Table 2: *Descriptive statistics of scores for parts 1–4*

	Lexile text measure	N	Mean	Range	Std. deviation
Part 1	1200L	40	7.4	2-9	1.9
Part 2	1180L	40	7.3	4-9	1.2
Part 3	1330L	40	5.7	1-9	2.2
Part 4	1310L	40	4.9	1-9	1.9

Similarly, the analysis of responses to questions 2 and 3 of the exit questionnaire (*Which part(s) of the text did you find most difficult to understand (Q2)/engage with (Q3)*) revealed that the participants found the parts in which they scored lower more difficult to understand and engage with. Figure 3 summarizes these results.

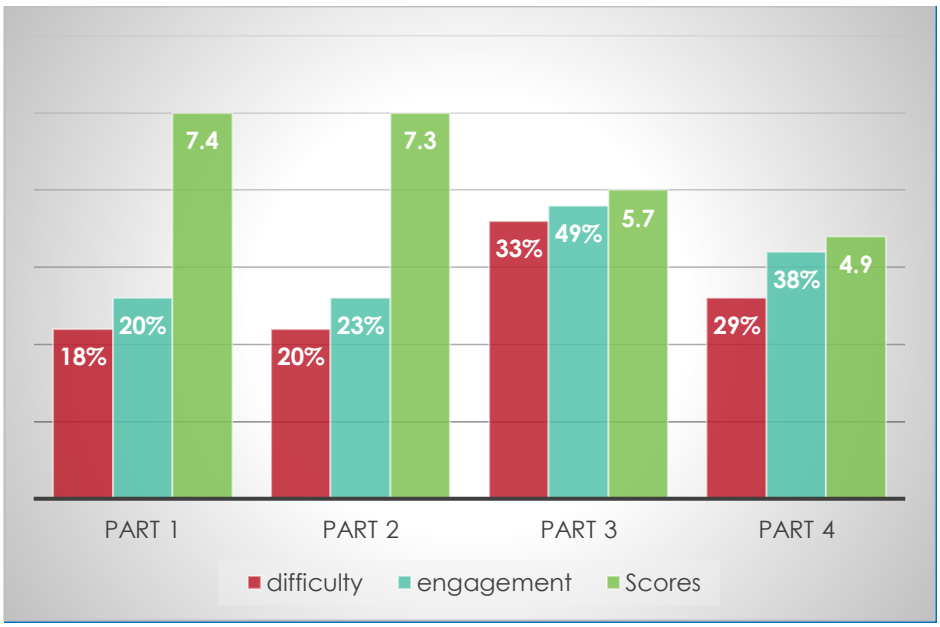

Figure 3: *Mean scores in parts 1–4 of the reading test and responses to questions 2 & 3 of the exit questionnaire*

As seen in Figure 3 above, the participants gained higher scores in both part 1 and part 2 of the test in comparison to part 3 and part 4. Such results suggest that, although the question type and the reading comprehension (global and local) assessed in all parts were the same, the participants scored lower in parts which were measured as more difficult by the readability measures used in this study.
The results of the analysis of the responses to questions 2 and 3 of the exit questionnaire (*Which part(s) did you find difficult to understand/engage with?*) also show that participants found parts 3 and 4 more difficult to understand and engage with (here referred to as willingness to continue reading a text) than the first two parts. Such results agree with their performance in each of those parts.

In other words, the parts the participants found more difficult to understand and engage with, were the parts they scored lower in.

To see whether the differences observed among the four parts of the test in terms of the participants' performance were statistically significant, a further series of analyses was conducted. First, a within-group one-way ANOVA was conducted to see whether there was any statistically significant difference between each participants' scores across the four parts of the test. The results (see Table 3) showed a significant difference between the scores of the four parts (p <.0005).

***Table 3**: One-way ANOVA*

	Sum of squares	df	Mean square	F	Sig.
Between groups	173.369	3	57.790	16.692	.000
Within groups	540.075	156	3.462		
Total	713.444	159			

Next, a one-way between groups ANOVA with multiple comparisons was performed to see whether there was any significant difference in scores between different parts. As can be seen from Table 4 below, the results showed a significant difference between parts 1 (cohesively modified) and 3 (lexically modified) (p=.001) and between parts 1 and 4 (non-modified) (p<.0005). Similarly, there was a statistically significant difference between parts 2 and 3 (p=.001) and between parts 2 and 4 (p<.0005). This is perhaps not surprising since the mean scores for each of the two later sections (parts 3 and 4) were somewhat lower than for the first two sections (parts 1 and 2). However, no statistically significant differences were observed between parts 1 and 2 (p=.998, ns) or between parts 3 and 4 (p=.276, ns).

***Table 4:** One-way ANOVA multiple comparisons*

Parts		Mean difference	Sig.
1	2	.07500	.998
	3	1.67500*	**.001**
	4	2.42500*	**.000**
2	1	-.07500	.998
	3	1.60000*	**.001**
	4	2.35000*	**.000**
3	1	-1.67500*	**.001**
	2	-1.60000*	**.001**
	4	.75000	.276
4	1	-2.42500*	**.000**
	2	-2.35000*	**.000**
	3	-.75000	.276

According to such findings, comprehension scores for those text parts that were modified in terms of the organization of the ideas (cohesion) and the syntactic structure of the text (sentence length and complexity) were significantly higher than the comprehension of the parts which were either lexically modified or not modified at all. It is important to note that without including a control group taking the same test with an intact text in all parts, it is hard to make any conclusions that such significant differences in performance were directly linked to the text modifications. Additional research is therefore required to further explore this.

The analysis of responses to question 4 in the exit questionnaire also corresponds to these findings. That is, when asked what factors the participants felt contributed to the difficulty of the parts in the text, they referred to syntactic complexity and cohesion of the text as factors contributing the most to the difficulty. Figure 4 illustrates these results.

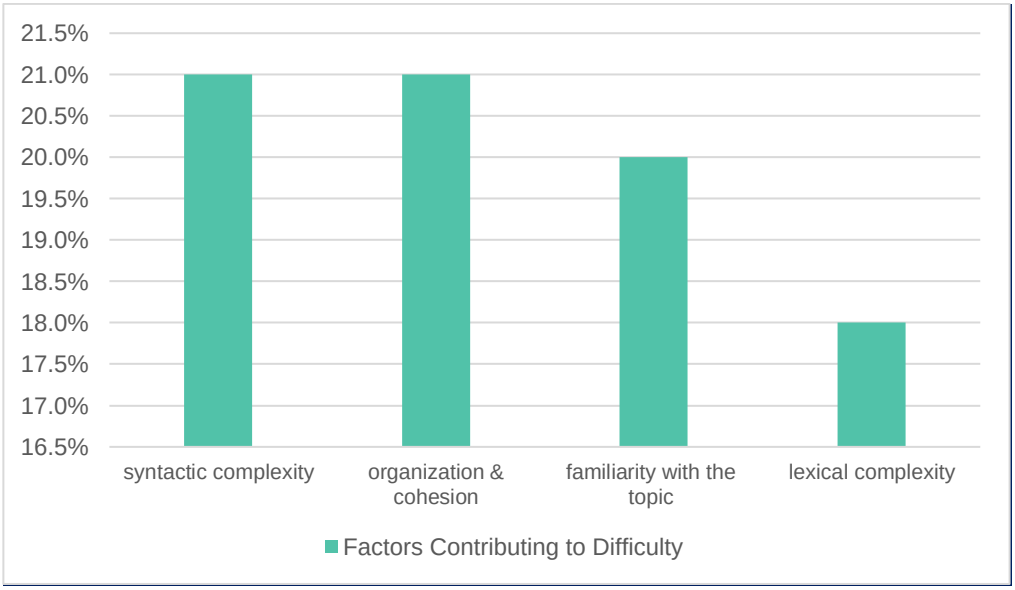

Figure 4: *Responses to question 4 of the questionnaire: If you found (a) part(s) of the article difficult to understand, which of the following factors would you relate it to? (You can choose more than one option)*

RQ2. How do readability features interact with individual reading comprehension items (i.e., those measuring local vs those measuring global comprehension)?

Item Facility (IF) index was calculated (using Excel spreadsheet) for all items to see how the participants performed in relation to each individual item in each test part (see Table 5). The IF for each item showed that more difficult items belonged to part 3 (lexically modified) and part 4 (non-modified). In other words, the participants scored the lowest in these items which belong to the last two parts of the test with one modified lexically and one left intact in its original format.

Table 5: *Item facility and item discrimination for items in all four parts*

Text	Items	IF%	ID	Comprehension level
Part 1	1	*65*	0.15	Global
	2	85	0.08	Global
	3	87.5	0.08	Global
	4	75	0.61	Global
	5	80	0.31	Global
	6	82.5	0.46	Local
	7	82.5	0.54	Local
	8	92.5	0.15	Local
	9	87.5	0.30	Local
Part 2	10	93	0.2	Local
	11	87.5	0.38	Local
	12	87.5	0.23	Local
	13	93	0.2	Local
	14	85	0.2	Global
	15	93	0.2	Global
	16	63	0.4	Global
	17	*57.5*	0.38	Global
	18	72.5	0.08	Global
Part 3	19	**20**	0.5	**Global**
	20	**58**	0.5	**Global**
	21	70	0.6	Local
	22	80	0.2	Local
	23	*63*	0.3	*Local*
	24	83	0.4	Local
	25	80	0.5	Global
	26	**65**	0.54	**Global**
	27	**52.5**	0.46	**Global**
Part 4	28	*60*	0.54	Local
	29	*60*	0.46	Local
	30	85	0.3	Local
	31	90	0.3	Local
	32	*40*	0.5	Global
	33	*30*	0.0	Global
	34	77.5	0.07	Global
	35	*20*	0.1	Global
	36	*33*	0.4	Global

As seen in Table 5, these results also show that in the lexically modified part (part 3), most items assessing global comprehension (i19, i20, i26, i27) were among the most difficult ones (*IF<70%*) compared with those assessing local comprehension (i21, i22, i24) with the exception of i23 (slightly lower than i26). Such findings can suggest that while the lexical modification of the text in part 3 might have had an impact on comprehension of the text at the local level, it might not have had a major impact on global items. One explanation for this could be that providing a glossary for technical terminology used in the text or replacing low frequency words with their high frequency synonyms might have assisted participants with their understanding of the detailed information presented within a smaller context (e.g., sentence or paragraph level). However, such modification did not assist the participant as much in understanding larger stretches of the text at discourse and global level.

Such findings are in line with some other studies examining the effect of text simplification on perceived, and actual, difficulty of academic texts. For instance, in their study, Leroy et al (2013) concluded that coherence enhancement improved actual text difficulty and resulted in their participants' better performance in a reading test, while lexical simplification had either no impact (in the case of MC items) or had a negative impact (with the Cloze). As shown above, the responses of participants to questions 2 and 3 of the exit questionnaire regarding which part(s) of the text they found most difficult to understand (Q2)/engage with (Q3) have also shown that the participants' perceived text difficulty was also higher for part 3 in comparison to all other parts.

RQ3. How do the participants perceive the effect of the three readability features investigated in this study on their comprehension of the text and how do they perceive the inclusion of reading questions for academic reading materials?

Regarding participants' perception of the effect of the readability features investigated in this study (i.e., cohesion, syntactic complexity and lexical complexity), the results showed that the participants considered syntactic complexity and cohesion as contributing factors to the readability of the text more than the lexical complexity. As shown in Figure 4 above, the analysis of responses to question 4 in the exit questionnaire (*If you found (a) part(s) of the article difficult to understand, which of the following factors would you relate it to?)* showed that participants attributed syntactic complexity and cohesion of the text as factors contributing the most to the difficulty of the text. Similarly, and as shown earlier in Figure 3, when asked which parts they found more difficult to read and engage with, more than half of the participants (62%) referred to parts 3 and 4 as the most difficult and least engaging parts. As seen above, part 3 was lexically modified, while part 4 was not modified at all. These findings correspond to earlier results that, while cohesion and syntactic complexity can directly affect the participants' comprehension of the text, lexical complexity does not necessarily have such an effect.

As for the participants' reflection on the experiment and their attitudes towards the inclusion of reading comprehension questions with reading materials, the text-based analysis of the qualitative data to the last two questions of the exit questionnaire revealed the following results. Twenty-nine (29) out of 40 participants responded to these last questions and 23 (79.3%) considered the inclusion of reading comprehension questions as facilitative (the other 6 responses were neutral about the inclusion of reading comprehension questions). They referred to several reasons *why* they found the inclusion of reading comprehension questions useful in comprehending the text. These included: helping them to concentrate and focus on reading; helping them to look for the main information; and having to re-read parts of the text which, they believed, helped to improve their comprehension. Table 6 provides a summary of all the reasons the participants mentioned in their responses.

Table 6: *Reasons explaining why the participants found inclusion of reading comprehension facilitating their comprehension of the text*

Reason	Sample response	Participants (N=23)
Made me focus	*Focused my mind and made me relate to the text, otherwise I'd have drifted and stopped reading.*	7
Looking for main information	*It helped to focus in on thinking about the main ideas and made it easier to process what had been read.*	4
Re-reading which improved comprehension	*It meant that I could go over the text repeatedly until I found a satisfactory answer which helped me understand the text better.*	3
Writing answers helped with internalising the information	*As it required writing it helped internalising info as we were writing down the answer; similar to note-taking but a guided one.*	3
Created a sense of curiosity and interest/ engagement	*Because you were searching for answers therefore you had to engage more questions; to some extent aided the understanding of the text as it broke down what the article was saying into sections, so was able to pick up some of the key ideas.*	2
Satisfaction and an indication of understanding when found answers	*Led to me re-reading to pick out the answer; I'd feel satisfied with my understanding once I could answer the Qs.*	2
Structured understanding of the text	*It helped me structure my understanding of the context.*	2

As for the final survey question regarding the participants' reflection on the experiment and their perception of their reading performance and comprehension, some interesting insights emerged. The first point made in their comments was related to the effect of text layout on their engagement with the text (willingness to read the text). As one student stated, *presentation and layout of the articles contribute greatly to my comprehension of structure and the 'flow' of the authors narrative*. [*In this experiment] part 1 was presented nicely and I was more willing to finish reading this part in comparison to other parts.* Another participant added*, part 1 had a better presentation with table and bullet points than other parts which made it more readable to me*. Similarly another one mentioned that, *font size and word spacing plays a massive role in readability. It can be daunting to have a block of text in your face*.

Such findings resonate those of other studies (e.g., Hear et al, 1996) where dense texts were perceived as factors determining perceived readability. As it can be seen from these comments, perceived readability can be attributed to text layout and presentation. Another factor referred to was the style of writing and how different styles can be engaging or off-putting. One participant commented that, *I find that it is hard to understand the text in many academic articles and books as the reading level is too high for me to understand. This has put me off reading books from the library/academic papers online when I wish to understand/research a topic. Therefore, I tend to use websites that have been written by teachers or people more on my level, as I find it easier to understand. However, this means I get marked down for using too many websites and not enough published papers in my lab report*. Another student also added, *I think, in general, many students avoid reading academic texts including those recommended for the course as we are a lot more exposed to much clearer explanation of topics. For example YouTube videos or web pages with easy-to-understand language.*

As seen in the comments above, two factors seem to contribute to the perceived readability of academic texts from students perspective. The first one is the presentation of texts and their layout which seems to improve reading engagement. The second one is the writing style and how familiarity with certain styles of presentation of knowledge (e.g., dense academic written texts vs simplified audio-visual texts) can engage or disengage student with academic reading.

7. IMPLICATIONS AND CONCLUSIONS

This research project aimed to provide insights into how the choice of language can impact on student engagement with their degree course reading materials and consequently their learning more broadly. The project gathered and analyzed empirical data on issues directly impacting upon both student engagement and widening participation.

The findings of the study suggest that the readability level of materials (here measured by Lexile and Coh-metrix readability measures) – particularly those targeted at novice undergraduate students who may not have the required level of discipline-specific genre literacy of engineering subjects as well as non-traditional company-based and mature students who have not been involved with HE before or for many years – can contribute to the engagement of learners with such resources. As such, the findings showed that among textual features of academic journal articles, organization (cohesion) and syntactic complexity of these texts can significantly affect the accessibility of such texts.

Academic articles can be classified as expository texts: those texts that intend to educate the reader about a topic. A distinctive feature of these texts is including unfamiliar words (less frequent words) and few connectives (low deep cohesion). However, these texts tend to have high referential cohesion given repeated reference to the point being taught (McNamara et al., 2012). On the other hand, academic articles which do not have high referential cohesion, do not seem to be suitable choices for reading materials especially for students with less background knowledge of the subject.

In the case of this study, the results suggest that improving cohesion of a part of the article used in this experiment seemed to improve participants' comprehension of this part. Such findings are in line with suggestions made in the literature regarding the use of high cohesion texts for instructional purposes (Nelson, Perfetti, Liben & Liben, 2010).

The implications of such findings for academics, particularly those who select reading materials for degree courses (e.g., module/course leaders) are that first, when selecting reading materials, it is important to consider readability measures of text (this can be done using measures such as Lexile) for different cohorts of students at different levels. For instance, in the case of novice undergraduate students and/or non-traditional students, texts in the lower college and career ready Lexile range (1185L to 1385L) should be used (i.e., grade 11 & 12). Such measures can be obtained through readability measure programmes such as Lexile which are mostly available for educators at no cost. (See Lexile free text analyzer: https://lexile.com/educators/tools-to-support-reading-at-school/tools-to-determine-a-books-complexity/the-lexile-analyzer/)

It is also important to consider textual features of texts selected for reading at different stages of a programme in order to encourage more engagement with reading materials at different stages of students' learning. For instance, journal articles with high cohesion may be more suitable for pre-lecture reading materials as they allow for more scaffolding to support students in the initial exploration of materials. Such scaffolding can gradually fade by introducing less cohesive texts, for instance in post-lecture reading materials or later in a module, when students move away from the entry level to more advanced levels of analysis, synthesis and evaluation.

In addition, academics can also consider including reading comprehension questions for lower undergraduate students and non-traditional postgraduate students, especially in pre-lecture activities, as well as follow-up tasks (e.g., online forum discussion) for post-lecture reading materials as this can assist them with engaging with more complex texts in a more supportive and collaborative learning environment. Moreover, as the results of this study suggest, including reading comprehension questions provides a sense of purpose for students to read the text and guides them in locating main and important ideas in the text. As a student in this study said, *It helped to focus on thinking about the main ideas and made it easier to process what had been read*. Furthermore, responding to reading comprehension questions can be a guided note-taking practice explaining to students where to find specific information and what pieces of information to take note of. Given that note-taking is a fundamental academic study skill, providing some scaffolding on that to novice undergraduate students and non-traditional students who have been away from the study environment and therefore might lack such skills is essential.

7.1 Limitations and suggestions for future studies

As a small-scale case study, while this project provides useful insights to academic staff regarding the selection of reading materials for programmes with diverse student cohorts, there are limitations to it that should be considered when making any interpretation of its findings. First, despite all attempts made to make the tests of the four sections of the text comparable (e.g., using the same item types and the same number of items testing both local and global comprehension in each part as well as including a balance of difficult, moderate and easy items in all four parts of the test) there may yet be some intrinsic differences between these sections which would have contributed to the difference observed in participants' performance in each part of the test.

One way to address this limitation could be to include a control group to compare their performance to that of the experimental group; this was the original design intended for this study. However, unexpected delays in the collection of the main data occurred due to new university ethical approval procedures and compliance with the General Data Protection Regulation (GDPR) enforcement during the research period. As a result, it became necessary to conduct the analysis for this study with a significantly reduced data-set and insufficient time to include a control group. Alternatively, a pre- and post-experimental design could be employed where the same test was used once before and once after the modification. Further studies are, therefore, needed to investigate this phenomenon through using these alternative research designs.

In addition, although measures were taken in this study to control other extraneous variables such as fatigue effect by providing a short break between each part of the test, future research can consider using other techniques such as counterbalancing whenever using a series of different texts (e.g., using more than one journal article). Furthermore, since this case study mainly focused on particular groups of students (described as 'novice' and 'non-traditional') in STEM subjects, further case studies are needed to investigate this phenomenon in other subject divisions and/or in relation to other differentiation factors among students (e.g., non-background English users at different English proficiency levels).

This project sought to increase understanding of factors perceived to have a major influence on the engagement with academic texts especially among students who are usually considered 'novice' students and 'non-traditional' learners in engineering subjects. Developing a deeper understanding of these factors will facilitate academics' approaches to inclusive teaching and alignment of their practices with that of higher education in terms of learning for all students and widening participation agendas. This study, therefore, intended to help develop, among academics, an enhanced understanding of factors influencing the accessibility of academic writing especially for those early-stage or non-traditional learners who may lack initial confidence when encountering academic writing for the first time.

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APPENDIX A: EXPERIMENTAL READING TEST ITEMS & COMPREHENSION TYPE ASSESSED IN THEM

	Part 1 (9 items)	
No.	**Question stem**	**Comprehension level assessed**
1–3	Read the section related to high activities listed below and briefly explain their responsibility: 1. Design product and process 2. Perform strategic planning 3. Manage resources	Global × 3
4	In this paper, why have the authors classified business processes into the three groups given in the text?	Global
5	How is VE constrained?	Global
6–9	Which of the three categories proposed by the authors does each process listed below match? Write the name of the category next to each process: 6. Identify and fill need for depreciable nonhuman resources: 7. Identify and fill need for non-depreciable nonhuman resources: 8. Identify and fill need for human resources: 9. Develop and translate strategic plans to tactical plans:	Local × 4
Part 2 (9 items)		
10–12	According to the article, what are the three approaches attributed to BPR? 10: Approach 1: 11: Approach 2: 12: Approach 3:	Local × 3
13	According to the authors, what is the main issue concerning work-flow systems?	Local
14	How do the authors compare BPR and EE?	Global
15	How does EE view an enterprise?	Global
16	What are the two main criticisms towards a single-model architecture?	Global
17	What essential features must any model have in order to be capable of supporting change management models?	Global
18	How does mapping additional views (e.g. information and organization) on each create a more comprehensive architecture for an enterprise?	Global
Part 3 (9 items)		
19	What is a process or activity considered as in OO approach?	Global
20	According to the writers, why the Object-oriented BP can effectively meet the process modelling needs of organizations?	Global
21	How do ‘black boxes’ manage their responsibilities?	Local
22	How does a VE ontology compensate for single-use models?	Local
23	According to OO model, how phenomena are grouped?	Local
24	What is the most important property of an agent in relation to describing enterprise entities?	Local
25–27	Read paragraphs E to G and briefly note down the main idea of each paragraph. 25. Paragraph E : 26. Paragraph F : 27. Paragraph G :	Global × 3
Part 4 (9 items)		
28	What attributes of all other views does the Business rule view specify?	Local
29	How do the features of the IDEF0 modelling help the integration of activities while protecting the confidentiality of individual enterprises in a VE?	Local
30	According to the authors, under what conditions can the value of performance characteristics be recognized in a resource view?	Local
31	How does business process differ from the activity view?	Local
32–36	Read the section related to each view listed below and write down the function of each view: 32. Business rule view: 33. Activity view: 34. Resource view: 35. Business process view: 36. Organization view:	Global × 5

APPENDIX B: EXIT QUESTIONNAIRE QUESTIONS

<table>
<tr><td>1</td><td>How would you rate the readability (difficulty) level of the whole text from 1 to 7 with 1 indicating very easy and 7 very difficult?

Very easy Very difficult
1 2 3 4 5 6 7</td></tr>
<tr><td>2</td><td>Were there any parts in the text that you found particularly difficult to understand? (You can choose more than one option)
<table><tr><td>Part 1</td><td>Part 2</td><td>Part 3</td><td>Part 4</td><td>None</td></tr></table></td></tr>
<tr><td>3</td><td>1. Were there any parts in the text that you found particularly difficult to engage with? (You can choose more than one option)
<table><tr><td>Part 1</td><td>Part 2</td><td>Part 3</td><td>Part 4</td><td>None</td></tr></table></td></tr>
<tr><td>4</td><td>2. If you found (a) part(s) of the article difficult to understand, which of the following factors would you relate it to? (You can choose more than one option)

a. It was difficult to understand due to complex sentence structures (e.g. long sentences)
b. It was difficult to understand due to the word choice (e.g. use of technical terminology or less frequent words)
c. It was difficult to understand due to lack of cohesion between ideas and sentences (e.g. there was not enough usage of cohesive devices such as ‘in addition’, ‘therefore’, ‘on the other hand’ linking ideas between sentences and/or different parts of the text)
d. It was difficult to understand/engage with due to lack of familiarity with the topic
e. Other reasons:</td></tr>
<tr><td>5</td><td>Do you think being given reading questions helped you to read the text?
Yes
No
If Yes, how did that help you?</td></tr>
<tr><td>6</td><td>Please write any other comments you wish to add about this experiment and/or readability levels (reading ease) of texts in your degree reading lists and how that has impacted your engagement with these texts.</td></tr>
</table>

Research into Reading Grants

AN INVESTIGATION INTO HOW VARIOUS TEXTUAL FEATURES OF ACADEMIC JOURNALS CAN INTERACT WITH STUDENTS' ENGAGEMENT WITH THESE TEXTS: A CASE OF NOVICE AND NON-TRADITIONAL LEARNERS IN STEM SUBJECTS

RESEARCH IN EFL READING AND READING ASSESSMENT
Report 3, 2022

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