The Role of Information Literacy Competence and Higher Order Thinking Skills to Develop Academic Writing in Science and Engineering Students

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Abstract: This article discusses a study organized to develop academic writing skills in undergraduate students pursuing engineering courses. The target group consisted of 30 students pursuing a Bachelor of Technology in their third year. The classroom observations regarding teaching writing revealed that writing proficiency for most of the students was at a very low level. Followed by this, an intervention program was organized in one college, where the researcher taught academic writing to the students. Units comprising tasks that focused on raising awareness of the academic texts and involving the students in the cognitive processes of writing were designed. The study focused on raising student awareness regarding the nature and characteristics of academic texts in order to develop academic writing skills. The study also emphasized that involving the students in the cognitive processes of writing (e.g., defining the rhetorical problem, identifying the rhetorical situation, determining the audience, setting goals for writing, planning for the text by generating, and organizing ideas) is necessary. The study further suggests that discussions between students and teachers regarding the construction of a text and the way language works in various text types facilitates better writing.

Keywords: information literacy competence, academic writing, higher order thinking, engineering students, science students

Introduction

The English syllabus for students pursuing engineering courses includes learning writing as one of the objectives. Students who enroll in these courses are not equipped with the general writing skills that they should have mastered at the entry level. In this context, a study was organized to develop academic writing skills in the undergraduate students who are pursuing engineering courses. The study focused on raising student awareness regarding the nature and characteristics of academic texts in order to develop academic writing skills. The study also emphasized that involving the students in the cognitive processes of writing (e.g., defining the rhetorical problem, identifying the rhetorical situation, determining the audience, setting goals for writing, planning for the text by generating, and organizing ideas) is necessary. The study further suggests that discussions between students and teachers regarding the construction of a text and the way language works in various text types facilitates better writing.

The Study

The study was based in engineering colleges. The target group for the study consisted of 30 students pursuing a Bachelor of Technology in their third year. The classroom observations regarding teaching writing revealed that writing proficiency for most of the students

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was at a very low level. Followed by this, the intervention program was organized in one college, where the researcher taught academic writing to the students. Units comprising tasks that focused on raising awareness of the academic texts and involving the students in the cognitive processes of writing were designed. Therefore, each unit consisted of lead-in tasks, which focused on raising awareness of the nature and characteristics of academic texts, and a final writing task, where the students were expected to write a text.

Three units were designed: *Nominalizations*, *Making Generalizations: Boosting and Hedging*, and *Writing a Research Paper/Project Report*. The lead-in tasks, which focused on raising awareness of the nature and characteristics of academic texts, included reading passages based on the content of the engineering courses. Proficiency in information literacy skills and higher order thinking skills was required for the students to become successful in these tasks. The students were expected to comprehend the passages and recognize, evaluate, and use the information relevant to work on these tasks. In addition, students were expected to employ the skills of evaluating, analyzing, creating, reasoning, and applying while working on the lead-in tasks. These tasks gave impetus to the students to work on the final writing task. In continuation with the intervention program, a project was assigned in order to examine its effectiveness.

The criteria for the selection of tasks are based on research done by Prabhu (1987), Nunan (1989), and Ellis (2003). The factors considered in the construction of a study task are that it (a) is a work plan, (b) involves primary focus on meaning, (c) can involve four language skills (listening, speaking, reading, writing), (d) engages cognitive processes, and (e) has a clearly defined communicative outcome. The tasks adopted for the intervention programme involved these prerequisites. The students were engaged in cognitive processes to raise awareness of the nature and characteristics of academic texts. In addition, the tasks engaged them in the cognitive processes of writing in order to enable them to produce written texts.

Kumaravadivelu (1991) said that tasks indicate content, but the teacher and learner decide on the language to be negotiated in the classroom. Such a task design gives room for the use of a specific linguistic form. Moreover, Ellis, Basturkmen, and Loewen (2001) argued that the teacher's role as an instructor and interlocutor, which is a requisite for a task, can be achieved by focusing on form episodes. Therefore, the tasks designed and adopted for the study focused on the vocabulary, grammar, and sentence structures required to produce written texts and also on communication of meaning through the texts.

Prabhu (1987) suggested that complexity depends on the amount and type of information to be handled in the task. The number of cognitive operations such as deduction, inference, or calculation decides the complexity of the task. Besides, the precision that a task requires and working with concepts also determine the complexity of the task. Complexity also involves cognitive demands on the students' ability to understand the language used in the tasks. In addition, complexity of a task refers to students' ability to go beyond the information of the text and hypothesize, infer, and make judgments about the meaning and purposes of the texts (Candlin and Nunan, 1987).

Analysis of the Data

The data was analyzed at two levels. Firstly, the analysis of the lead-in tasks of the units is presented in relation to the students' ability to employ information literacy skills and higher order thinking skills, which form a requisite to raise awareness of the way academic texts are constructed. Therefore, a detailed discussion of the lead-in tasks and how these tasks facilitated

in helping students to produce written texts is presented. The discussion focuses on the way the students employed information literacy skills and higher order thinking skills while working in these tasks. Secondly, the final writing tasks were analyzed with help of the descriptors developed for the purpose. The skills taught as part of the academic writing course are categorized as recurrent skills and discrete skills. Recurrent skills are those that were taught across the units to write a clear and well-defined topic sentence, whereas discrete skills are the ones specific to the particular unit taught. The written texts of the students were examined in order to find out the way information literacy skills and higher order thinking skills employed by the students while working on the lead-in tasks facilitated in writing effective texts.

The performance of the written texts was described based on the levels of achievement (Levels 1, 2, and 3). Categorization of students according to the levels of achievement was documented. The rationale for placing the students at a particular level was based on the skills displayed by them in the written texts. A detailed discussion on the role of information literacy skills and higher order thinking skills in raising awareness of the academic texts—which, in turn, led to the development of academic writing skills—is presented. The following sections detail the findings of the analysis of the units taught as part of the academic writing course.

Unit 1: Nominalizations

The focus of the unit was to raise student awareness of the importance of using nominalizations in academic texts. Furthermore, emphasis was on enabling students to write a text using nominalizations. The unit contained five tasks. Task 1 focused on helping students transform verbs into noun forms. Tasks 2 and 3 trained the students to form sentences using nominalizations. Task 4 was a preparatory task with a focus on developing ideas to write a text using nominalizations in Task 5. As part of Task 5, students wrote a text using nominalized forms. The researcher monitored the students as they worked on the tasks and provided assistance to the students for tasks, which were cognitively challenging. Individual assistance was given to those who needed help. As mentioned earlier, students were required to use information literacy skills and higher order thinking skills to work on the lead-in tasks, which was expected to lead to the production of effective written texts. The following is the description from the response of Learner 1, who was not proficient in these skills and was therefore placed at Level 3.

The analysis of the lead-in tasks showed that the learner was able to understand the use of nominalizations in the academic texts given in the tasks. Learner 1 was successful in framing sentences using the noun forms. However, the learner failed to employ the skills of evaluating and analyzing the reading passages, which is reflected in the written response of Task 5. Task 4 focused on enabling the students to generate information related to the topic of the text. However, he could not add more points to the given hints. The written text of the learner showed that he was not able to present adequate information in the text. The text reflects lack of control over sentence structures. Moreover, there was negligible use of discourse features and the text was poorly written.

The analysis of the written texts in the nominalization unit proved that students who were able to analyze the information given in the lead tasks (Tasks 1–4) were successful in the writing task (Task 5). Besides, students who were not able to utilize these skills were not successful.

Unit 2: Making Generalizations: Hedging and Boosting

There were seven tasks in Unit 2, which focused on raising students' awareness about the importance of making generalizations in academic texts. The objective was to help students make generalizations in a written a text by hedging and boosting. Task 1 exposed students to the use of generalizations in a passage. Tasks 2, 3, and 4 raised awareness on the purpose of using hedges and boosters in academic texts. Tasks 5 and 6 were lead-in tasks that focused on pooling up ideas in order to produce a text in Task 7. Some of the students found the writing task quite challenging, especially in the use of appropriate hedges in context. Hedging and boosting was a new concept for them; however, they were enthusiastic to work on the tasks. The following is the description of the text of Learner 2 who was placed at Level 3.

By and large, students who were placed at Level 3 found it difficult to work on most of the tasks. They relied on peers and the researcher for most of the tasks. Learner 2 also had difficulties in understanding how generalizations were used in the texts. Tasks 5 and 6 were lead-in tasks that focused on helping students generate ideas by interpreting the information given in the graph in order to write the text as part of Task 7. It was observed that the learner was not able to interpret the information given in the graph.

The written text in Task 7 showed that the use of hedges and boosters was limited. In addition, the use of hedges and boosters was inappropriate, leading to the distortion of information given in the graphs. The analysis of the response of the learner for the unit showed that the learner had difficulties in analyzing the information given in the graphs of the lead-in tasks.

Unit 3: Research Paper/Project Report

This unit was divided into eight lessons: research proposal, the introduction section, the literature review section, the methods section, the results section, the discussion section, the abstract, and bibliography. It focused on helping students to understand how various sections of a research paper/project report are presented. Furthermore, the organization of the sections and their elements were discussed with the students. The researcher discussed the necessity of producing coherent texts using appropriate cohesive devices and transition signals in the written texts. The style and use of impersonal register specific to academic texts were also discussed. Therefore, the students were expected to produce the written texts inclusive of the characteristics of academic texts that were discussed in the beginning of the unit. In addition, the researcher provided assistance to the students while they worked on the individual lessons of the unit. A point to be mentioned is that the writing tasks incorporated in the lessons focused on enabling the students to write short texts related to the lesson. For instance, the writing task in Lesson 1 limits the students to writing the introduction section based only on the notes given to write the section and not beyond the given notes.

Lesson 1: Research Proposal

This lesson, containing three tasks, focused on enabling students to write a research proposal. Task 1 raised awareness in the students regarding the purpose, the sections, and the elements that include a research proposal. As part of Task 2, students were shown how these elements were presented in research article. Awareness about the elements of a research proposal was raised by asking the students to match the elements with the excerpts taken from a research proposal. Students were expected to write a research proposal as part of Task 3.

The following is the description of the text of Learner 3, who was placed at Level 1. The text of learner shows that the learner included the relevant sections of a research proposal and

the related elements. The elements of each section are mentioned in the beginning of the paragraph and circled by the learner. The discussion presents the sections and the elements included by the learner with examples.

General area: *Embedded system is a combination of software and hardware….*

Importance of the topic: *Embedded systems are important in giving protection to the related information by giving security…*

Theoretical approach: *This project is important and implemented on KEIL vision…*

Aims and objectives: *The main purpose of using this is for security reasons. As this security plays a major role….*

Duration: *This project is implemented for 3 months…*

Contribution of research to the field: *The project is useful in implementing in hotels, hostels and household, offices …..*

Methods: *The system is fixed at the entrance of the door.*

Reason for choosing the method: *Microcontroller accepts data as it manipulates the information and interfaces data with various devices….*

Results: *The main advantage is user don't have to carry keys along with him…*

The excerpt given above proves that the learner made a conscious attempt to include the elements that comprise a research proposal. The elements are circled for emphasis. The analysis of the tasks showed that the learner was successful in analyzing the reading passages given in the lead-in tasks and creating a written text in the final task of the unit.

Lesson 2: Introduction

The focus of Lesson 2 was on enabling students to write an introduction section of a research paper. Its two tasks raised awareness in the students regarding the purpose and elements of an introduction section. In Task 1, students were asked to examine and analyze excerpts taken from an introduction section of two research papers. They had to notice the way the elements were presented in these research articles and were expected to write an introduction section as part of Task 2. The following is the description of the text of Learner 4, who was placed at Level 1.

General area: *Nowadays smart phones are extensively used by students. The potential application includes Bluetooth and Wifi along with other wireless technologies….*

Key term definitions: *Terms that are worthwhile to be known are tracking servers…*

Problem: *Unfortunately, students find a limitation to locate and access essential information…*

Gaps in previous studies: *In previous experiments information was addressed only to classroom...*

Aim of the study: *In order to have a context-aware university it is essential to overcome the difficulties of acquiring information…*

Methods: *One of the possible ways is to form a request string to tracking server which is to be forwarded to content server…*

This excerpt of Learner 4's response to Task 2 reveals that the learner was able to include the elements of an introduction section. The students were expected to mention the elements and circle them so that they would not digress and present a focused text.

Lesson 3: Literature Review

Lesson 3, containing two tasks, focused on raising awareness of the way a literature review section is presented. In addition, students were trained to write a literature review section based on the given notes. The tasks raised awareness in the students regarding the organization and features of a literature review section of a research paper/project report by asking the students to arrange the excerpts taken from a research article in order as part of Task 1. Students were expected to write a literature review section as part of Task 2. Therefore, it can be summarized that the lesson focused on helping students understand the features of the literature section of a research paper/project report. In addition, students were trained to write a part of a literature review section of a research paper based on the given notes. The following is the description of the text of Learner 5, who was placed at Level 1.

Task 1 focused on helping students understand the features of a literature review section and the in text referencing patterns used to cite information. The learner was able to match the given excerpts from the contents page of a project report with the features of a literature review section. However, in-text referencing was difficult for the learner. She took the researcher's help to work on the task (Task 1d). The learner was able to develop and organize the notes given to write the literature review section for Task 1e.

Lesson 4: Methods

The focus of the Lesson 4 was to enable students to write a text on the methods section of a project report. Awareness was raised regarding the purpose and the related elements that comprised a methods section. The students were asked to examine the excerpts taken from the methods section of a project report/research paper. The lesson consisted of two tasks. The students were also equipped with the words that are generally used in a methods section (Task 1a). They were further trained to write methods section of a project report as part of Task 2.

The students were expected to write a methods section based on the hints given for Task 2. The excerpt given below of Learner 6 confirms that the learner included the sections that comprise a methods section of a project report:

Description of the sample: *The sample* Annona cherimola *belongs to* Annonaceae *family.*

Description of material used for data collection: *The plant materials are identified at Thirumala forests in Chittoor district located in A.P.*

Description of data collection procedures: *The extract was formulated by utilization of 500 g of powdered leaves of* Annona cherimola.

Description of data analysis procedures: *In vitro screening and in vivo screening were conducted on the rats and the chemicals required are characterized…*

Lesson 5: Results

Lesson 5, with two tasks, focused on enabling students to write a results section. Task 1 centered on raising awareness in the students of the purpose and elements of a results section by asking them to examine the extracts taken from the results sections of research articles. Students were expected to write the results section as part of Task 2. The students were trained to write a paragraph on the results based on the given information.

In response to Task 1, Learner 6 was able to match the purposes of a results section to the excerpts given from that results section. Task 2 focused on using the vocabulary required to describe variations represented in the graph. The learner attempted to use the vocabulary to describe the variations verbally in the text. The learner organized the details given in the graph in order to write results paragraph based on the graph given in Task 2. These sections are mentioned and underlined in the excerpt. The text shows that the learner included the content relevant to the appropriate sections. However, it also shows that the learner used longer sentences, which resulted in lack of clarity. Otherwise, the skills taught in the lesson are effectively presented by the learner.

Lesson 6: Discussion

Lesson 6 focused on enabling students to write a discussion section. The lesson contained two tasks. Awareness was raised in Task 1 by asking the students to examine extracts taken from a research article. They were required to analyze the excerpts and match them with the given purposes of a discussion section and were expected to write a discussion section based on the given notes as part of Task 2. The excerpt from the response of Learner 7, shown below, highlights that the learner presented an effective discussion section. The results were reported accurately. The use of appropriate verb forms to present the discussion is the strong point of the written text.

Report a result: *Examination of* Annona cherimola *predicts that methanolic and hexane extracts possess anti-inflammatory and antioxidant properties…*

Suggestions for further research: *Further studies recommended are tracing of active principle responsible and its related mechanism…*

Limitation of the study: *There is a demand for clarification on realization principle…*

Lesson 7: Abstract

The focus of the Lesson 7 was on enabling students to write an abstract. Awareness was raised in the students regarding the elements that comprise an abstract through completion of four tasks. Tasks 1 through 3 were awareness-raising tasks, while students were expected to write an abstract as part of Task 4. The words and sentence stems that are generally used in an abstract were highlighted. Awareness was raised by asking the students to examine the excerpts taken from the research articles of an abstract in terms of the presentation of the elements such as introduction, purpose, methods, results, and conclusion.

The excerpt from the response of Learner 7, given below, highlights the inclusion of abstract elements.

Introduction to the topic: *The project "BLUversity a ubiquitious" enables the implementation for localizing the information within a university campus…*

Purpose: *To minimize the difficulty close attention is paid here…*

Methods: *The innovative approach was to build a university which makes a powerful and practical utilization of gadgets like mobiles, PDAs….*

Results: *The results showed that deployed BIU made an attempt which can track the information through…*

Conclusion: *This paper thus successfully overcomes the hurdles faced by students…*

Lesson 8: Bibliography

Lesson 8 focused on enabling students to cite references, from various sources, in a bibliography. The number of tasks that comprised the lesson was 1. Awareness was raised in the students by showing them the referencing patterns of books, book chapters, and journal articles. Students were expected to use referencing patterns to make references from the given notes as part of Task 1.

Project

As mentioned earlier, a project was assigned to the third-year students in order to evaluate the effectiveness of the teaching sessions of the intervention program. The students were expected to visit an organization of their choice and report the details of the organization in the form of a project report. Input was given to the students regarding the procedures to be adopted to collect data. However, the focus was on evaluating the ability of the students to present the data in the form of a project report that includes appropriate sections and elements that are due in a project report and not on evaluating skills of data collecting and analyzing procedures. The response from the excerpt of a learner shows the way the student reflected the learning of the various sections and elements of a research paper/project report. The title of the project was "Department of Archaeology and Its Performance." The student presented the objectives of the department, obstacles faced, and the measures to be taken by the department in the project report. The analysis of the projects revealed that most of the students were able to present the project report with the appropriate sections and elements. However, a few of them could not.

Conclusion

The study focused on academic writing characteristics in various forms of prose and did not include other academic genres such as letters, statements of purpose, curricula vitae, faxes, and e-mails. Therefore, further research may include studies related to a variety of academic genres to develop academic writing skills. Furthermore, the study may have conjoined quantitative data analysis procedures to analyze the data in order to achieve accurateness of learner performance on academic writing skills. However, the study attempted to show that explicit instruction to develop academic writing that includes raising learner awareness of

academic texts and giving opportunities to the students to improve their writing by involving them in the cognitive processes of writing makes them more confident and facilitates better academic writing skills. Organizing collaborative writing sessions in which students reflect on their own writing practices and reflect on their peers' written texts helps them understand the ways written texts are constructed. Teacher reflection on the students' written texts during and after writing enables them to revise their drafts efficiently. Furthermore, qualitative discussions by the teacher on the nature and characteristics of academic writing in order to enable the students to understand the way academic written texts are constructed fosters academic writing.

References

Candlin, C. N., & Nunan, D. (1987). *Revised syllabus specification for the Omani School English Language Curriculum*. Muscat, Oman: Ministry of Education and Youth.

Ellis, R. (2003). *Task-based language learning and teaching.* Oxford, United Kingdom: Oxford University Press.

Ellis, R., Basturkmen, H., & Loewen, S. (2001). Learner uptake in communicative ESL lessons. *Language Learning, 51*, 281–318.

Kumaravadivelu, B. (1991). Language-learning tasks: Teacher intention and learner interpretation. *ELT journal*, *45*(2), 98-107.

Nunan, D. (1989). *Designing tasks for the communicative classroom.* Cambridge, United Kingdom: Cambridge University Press.

Prabhu, N. S. (1987). *Second language pedagogy.* Oxford, United Kingdom: Oxford University Press.