



Broadening the Exposure of Engineering Students to the HOTS

Muna Balfaqeeh, Asli Hassan

Petroleum Institute (United Arab Emirates)

mbalfaqeeh@pi.ac.ae

ahassan@pi.ac.ae

Abstract

Writing in Engineering requires students to write in a concise form that coincides with all aspects of the higher order thinking skills (HOTS). Freshman students begin their studies after having met their language proficiency prerequisites, which makes them linguistically suitable to move towards more abstract, reflective activities. In this pilot research, students produced three in-class writings at 4-5 weeks interval between the writings. After their first writing, students were exposed to Bloom's Taxonomy table in a two- step process. The students' written production was monitored throughout their second writing and final exam. Our hypothesis asserts that Engineering students once exposed to higher thinking order skills will retain and continue to develop these skills in their in-class writing. The aim of this paper is to emphasize the developmental aspect of writing, with the level of transferability of skills such as the higher order thinking skills.

1. Introduction

Engineering students are expected to write in a concise form that corresponds with all the elements of Higher Order Thinking Skills (HOTS). In this pilot research, students produced three in-classes writings at four to five -week interval during the semester. Our hypothesis was based on the belief that students once exposed to higher thinking order skills will retain and continue to develop their skills and the progress will be shown in their in-class writing. After their first writing, students were taught the Bloom's Taxonomy table in a two- step process. The first step introduced the students to a table with the HOTS and LOTS and then asked them to highlight any of the parts of the table that they believed they practiced or used in their writings. The results of the students' perceptions will not be part of this article. This paper mainly focuses on the intervention part in which was divided into two steps and the results of the intervention second step in which Bloom's taxonomy was reintroduced in a seminar format. The students' writings were monitored throughout the semester. The aim of this paper is to emphasize the developmental aspects of writing and the degree of transferability of skills especially the higher order thinking skills that should occur in the course of a semester.

2. Background of Academic Language Functions

The current research substantiates the operational definition of critical thinking and/or higher order thinking skills (i.e. analytical reasoning, synthesis, problem solving or higher mental processes) as a hierarchical one.[1] According to Hummel and Huit "...each higher level subsumes the properties of the lower levels... which... lead(s) to the conclusions that the taxonomy is indeed a hierarchy with the exception that perhaps evaluation and synthesis are misplaced".[1] They also highlight the fact that "convincing educators, including college teachers, to demand precise operational definitions of critical thinking is going to be no easy matter... getting teachers and standardized test developers to assess students at the higher levels of the taxonomy will not be an easy task". They state that although all educational stakeholders would never challenge the importance of teaching critical thinking, they are not providing the necessary support to endorse these activities. A paradigm shift is recommended from revising assessment tools which may not improve the students' higher order thinking skills, to providing more enhancements and continuous professional development workshops that would enable them to "discover/rediscover the value of instructional techniques and incorporate new teaching strategies".[1]

A similar idea was discussed by Nash and Wild in their article, "Writing Student Learning Outcomes with the help of Bloom's Taxonomy", in which they described Bloom's Taxonomy as a taxonomy that covers three intersecting areas: the cognitive, the psychomotor and affective, and the academic language functions can be considered as an extension of the cognitive domain. They added that, "Bloom found that over 95% of the test questions students encounter require them to think only at the lowest possible level- knowledge. [2] In support, Thambyah stated that, "the need for engineers be fluid in their approach to problem solving, spontaneous and being able to 'think on their feet', makes the idea of structure learning outcomes ... a seemingly counter-productive endeavor".[3]



On the assumption we made earlier that the HOTS are embedded in the critical thinking skills, Richard Paul [4] supported in his keynote address in the 27th Annual International Conference on Critical Thinking by establishing a link between HOTS and Culture. He added that “we need to discover the extent to which our thinking is bound by a culture” and whether it limits our understanding of the world around us.[4] The other notion that he discussed is the “barrier of fear”, which might also hold our brains back from exploring new points of view or novel ideas and techniques in an attempt not to divert from their comfort zone or their routine.¹ Some of these issues will be explored in this research. Perhaps, our students need more time to develop academic culture that is supportive of the development and usage of critical thinking skills. Examining the constructivist view that states “there are two main student approaches to writing: a deep versus a superficial one...from this perspective a spontaneous writing in which an individual expresses him/her feelings and thoughts, is considered a superficial”, [5] supports our findings of this pilot project.

3. Methodology

The study followed an action research framework as an appropriate methodology since it attempted to find systematic solutions that would expand the repertoire of students’ writing skills. These steps were as follows:

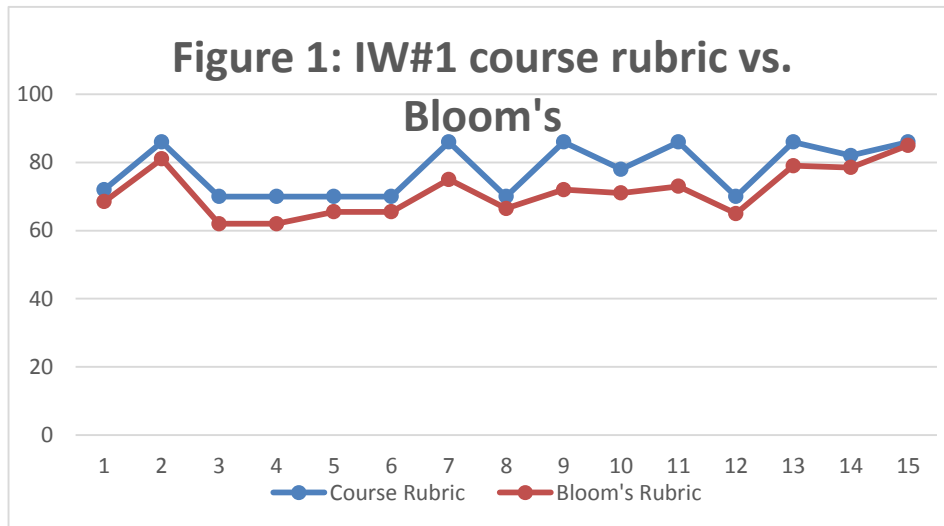
1. Individual Writing 1 (IW#1): In-class writing happened before the intervention and was used as a baseline for the pre-intervention phase 1 to conduct a comparative analysis with the students’ writings in IW#2 and final exam.
2. Intervention : Students were given the ALF table (appendix A) and asked to reflect and recall whether they used any of the academic language functions listed in their individual writing one (IW#1). The teachers delivered a follow up lesson on language functions based on the ALF toolkit by Sarah Clyne[6] in an active teaching lesson, and students were asked to take notes.
3. Individual writing 2 (IW#2): Students produced an in-class writing that became part of the final course grade.
4. Final Exam: Students produced one last piece of writing as a final assessment of the course. The prompt required students to combine different readings in connection to their freshman year experience. This task involved students to use higher order thinking skills in order to successfully fulfill the requirements of the prompt. As part of the study, students’ writings were evaluated based on the Revised Bloom’s Taxonomy Rubric by focusing only on ‘synthesis’ and ‘evaluation’ sections of the rubric in order to compare the validity of the writing assessment based on our course rubric and the revised Bloom’s Taxonomy Rubric (see appendix B & C). The reason behind using the second rubric is the fact that the course rubric does not assess the synthesis and evaluation components clearly and they are not given equal importance compared to the course objectives. The study was interested in measuring the impact of isolating two of the highest and most complex elements of HOTS by comparing the pre & post intervention. To reduce bias and increase validity, the authors decided to use one grader and one class which consisted of 15 Emirati female engineering students in their second semester freshmen level. These students have already passed the TOEFL with a minimum of 500 and/ or IELTS 6 in order to begin their freshman year.

4. Results & Discussion

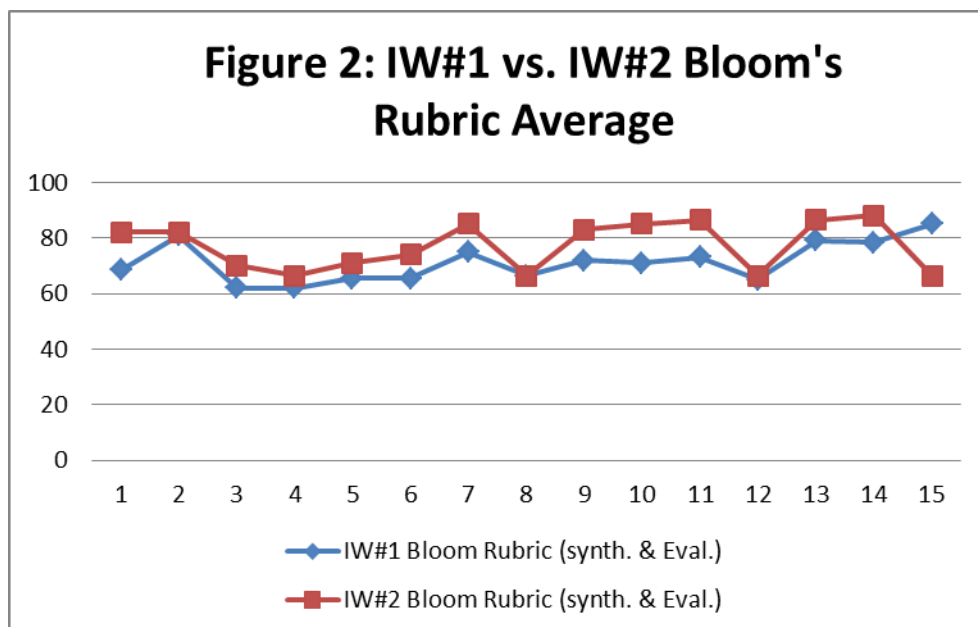
¹ In this research culture encompasses the educational culture of the students and the future work culture as Engineers, considering the university experience as a bridge that completes the gaps between both cultures.



The intervention part of this study was conducted right after individual writing 1(IW#1) and before individual writing 2 (IW#2). In Individual Writing 1 (IW#1) which is considered in this paper as a base line to identify students weaknesses in using the Higher Order Thinking Skills (HOTS). This assessment is used by students to improve individual writing skills and by instructors to identify areas for improvement and tailor the writing component of the course to accommodate the students' needs.



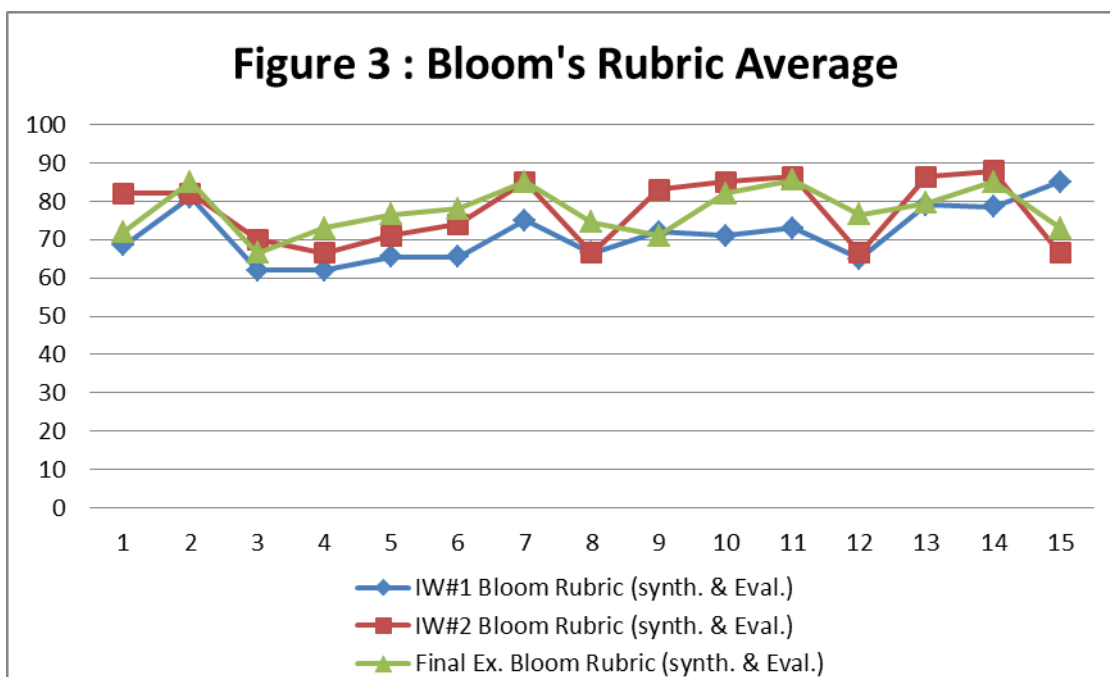
IW#1 was evaluated as per the numeric course rubric as well as the Bloom's revised rubric. (Figure 1) The results indicated some inflation in the course rubric grades compared to the Bloom's revised rubric, especially in the peak points. This supported some of the initial observations made by the researchers. It was also expected, since the aforementioned course rubric evaluated different elements of writing including task completion, organization, content and language. This meant that students who had higher proficiency in language, tended to have higher order thinking skills represented through the synthesis and evaluation.



According to Figure 2, students' results in IW#1 showed a weak performance in synthesis and evaluation. While after the intervention the IW#2 showed a significant improvement in the synthesis and evaluation abilities except in 2 cases where there was no improvement. Majority of the students demonstrated some improvement in both the evaluation and synthesis functions using the Bloom's rubric. This proved that students may have initially lacked the exposure of direct teaching of the HOTS



and learning such functions was not a matter of mental progression from the students' part as much as a skill that can be taught in class and gradually acquired by all students. Whereas the two cases which have not shown any improvement might have found it challenging to make the transition to a more abstract, undefined parameters in an assessment environment.



In Figure 3 students' writings in the final exam dropped in comparison to IW#2, except for very few cases. Some students appeared to sustain some of the improvements acquired after the intervention. However, there was an overall drop of 5-10 points range. Students who did not make any improvement between IW#1 and IW#2 thus not showing any improvement after the intervention, surprisingly showed an improvement in the final exam. Looking closely at all three assessments under Bloom's taxonomy rubric, we found that 7 out of the 15 students enhanced their scores in the Final exam in comparison to IW#2, while 2 maintained the same scores (Figure 3). With respect to these results, the researchers believe that this in-transferability might have been caused by several factors: the intervention did not continue until finals and/or revisions were not provided which led to a minimal effect to the transferability and its acquisition. Another reason might be the context in which these writings were produced, students felt safer to write within the parameters of the task rather than immersing themselves in an abstract framework.

5. Conclusion

"What you measure is what you get".² This statement that can be seen as a starting point in this research, which provoked us to think about all the different possibilities that may have led to this dilemma. Our initial observation was that our students were not capable of identifying or realizing what we meant by providing a piece of writing that entailed the Higher Order thinking skills (HOTS). Consequently, we decided to create a number of "empirical intervention Strategies" that would allow students to realize what was missing in their individual writings. Hummel and Huitt [1] identified critical thinking as "analytical reasoning, synthesis, problem solving, or higher mental abilities"- a definition that makes critical thinking intersects with our subject matter-. According to them "...we need to address the issue of defining and measuring critical thinking", which raises again a number of questions. It is highly possible that the skills learned from the intervention raised some awareness but were not fully mastered. In order for the students to use HOTS quite comfortably, the intervention should be continuous and self-sustained.

² H & H p1



References

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