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Writing Essay as Essential Assessment in Groundwater Contamination Course

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ABSTRACT: An essay was used as an assessment to illustrate a certain way of thinking and attitude of a student. The essay demonstrates the student's utmost degree as an author with a cognitive and affective style. The study aimed to provide a simple description of the essay as an assessment and critical function in the Groundwater Contamination course of the Environmental Engineering Program offered by Curtin University Malaysia. Groundwater Contamination is designed for students of environmental engineering and covers a number of topics, including groundwater characterization, contaminant transport processes in groundwater flow systems, migration and chemical development of contamination plumes, and groundwater remediation. No correlation exists between essay length (word count) and report or presentation grades, while there was a strong relationship between the student mark and essay content ($R^2 = 0.88$), but a moderate relationship to essay format ($R^2 = 0.55$). Overall, the students at Curtin University Malaysia were able to meet the Course Outcome of Groundwater Contamination and the Program Outcome of Environmental Engineering because of the essay they wrote as a test.

KEYWORDS: Groundwater contamination; writing essay; assessment; bloom taxonomy

1. Introduction

Essay evaluations provide information on the outcomes of training conducted under relatively controlled conditions. Typically, achievement exams are used to evaluate final results following the conclusion of a training program, but they can also be used to characterize intermediate stages of training [1,2]. One method of assessing performance difficulties is through the use of free-to-create responses (free response items). In this situation, evaluations occur freely and independently, with participants displaying their knowledge and abilities without regard to their organization or mode of expression. Typically, questions are used in essays to pose a challenge, define a task, or characterize a subject area [2,3]. An essay is a kind of art in which some arguments about a subject are presented in an original manner, using artistic means based on acquired information and skills, as well as personal opinion. The essay is a form of argumentation. In essence, it is a product of evidence-based thinking—any opinion is backed up and justified by arguments. When it comes to argumentation, the associative

principle is the guiding principle—an idea naturally leads to another that is linked in some way. Thus, an essay's thesis statement is defined by a distinctive approach to the problem, the heterogeneity of the arguments, and uniqueness. The essay's impact is determined by the arguments and facts presented, the manner of the presentation, and the essay's power of speech. The following is a thinking exercise. Each essay is composed of free text, diagrams, and preliminary binding models, with the author's ingenuity and imagination taking precedence. The application of essay writing skills in high schools (universities) enables the diagnosis of students' originality and creative attitudes. The essay shows that the student has reached his or her highest level as a writer with a cognitive and emotional style [4,5]. Some advantages of essay evaluation include its capacity to evaluate all levels of learning objectives and its promotion of original and creative thought. Due to the subjective nature of essay assessments, grading is very unreliable even for the same assessor at different times, grading may be influenced by other factors such as handwriting and length of response, extremely time-consuming to answer and correct, and they are not recommended if only low-level learning outcomes are assessed, which can be assessed by multiple-choice or short-answer questions [6-8].

At the university, we use the essay to illustrate a certain way of thinking and attitude, as well as an integral part of the evaluation process for 3rd and 4th courses, such as Groundwater Contamination. Academic essays enable students to both defend and convey their own perspectives on a subject. The author conveys his or her own viewpoint without adhering to common opinion. Utilizing the essay format facilitates the expression of an opposing viewpoint. Because the essay is a genre by itself, it allows for freedom of thought, expression, and viewpoint. Personal experience is vital to the essay's success. The issue is reflected in his singular perspective, which enables him to express his particular opinions more forcefully. The essay's core focus is the introspective and emotional empathy-based approach to thinking. In general, this article seeks to paint a thorough picture of the essay's critical function in the Groundwater Contamination course offered by Curtin University Malaysia's Environmental Engineering Program. In general, this article presents a simple description of the essay as an assessment and critical function in the Groundwater Contamination course of the Environmental Engineering Program offered by Curtin University Malaysia.

2. Course description

Groundwater Contaminantion is a 3rd year course that covers 3 section: (1) groundwater characterization, (2) plume migration in groundwater, and (3) groundwater remediation. The purpose of site characterization is to determine the surface and subsurface conditions pertinent to hazardous waste management. This section also includes a crucial formula for determining the mass distribution of contaminants in the various phases, which is essential for remediation design. The second section explains how to estimate groundwater movement and plume migration rates. The learner is instructed on how to interpret aquifer test results and estimate the age of a groundwater plume. This article focuses on design calculations for commonly used in situ or ex situ groundwater remediation processes, such as bioremediation, air sparging, air stripping, the advanced oxidation process, and activated carbon adsorption. Groundwater Contamination (ENST3005) is a 12.5 credit hour course (Australian University system) that consists of lectures (2 hours per week) and tutorials (1 hour per week). According to the course

outline, all topics are presented orally via powerpoint presentation, then discussed in class, followed by problem solving, and essay writing and final exam as assessments. Curtin University Malaysia requires lecturers to describe the course outline to students during the first week of the academic semester. This includes the learning activities undertaken during the course, the learning resources used, their assessments, and the course's map to the Course Outcome (CO).

Table 1. Mapping of CO for the Groundwater Contamination course.

No	COs	Teaching approach	Assessment
CO1	Explain the basic equations of groundwater flow and transport process (contamination)	Lecture & Tutorial	Examination
CO2	Solve groundwater flow and transport process equations analytically and numerically	Lecture & Tutorial	Examination
CO3	Demonstrate application of mathematical models in predicting contaminant movement and evolution	Project based learning	Essay (Report & Oral presentation)
CO4	Analyse case studies of contaminant transport in various situations and communities	Project based learning	Essay (Report & Oral presentation)

Table 1 summarizes the CO, teaching, and assessment strategy for Groundwater Contamination. Groundwater Contamination has two assessments, the first of which is tied to the CO and the second of which is linked to the program's objective achievement. The following is the assessment structure for students:

- Essay (50%) addresses CO3 an CO4 and evaluate PO3 (Design of Solutions) and PO4 (Investigation).
- Final examination (50%) addresses CO1, CO2, CO3 and evaluate PO1 (Engineering Knowledge), PO2 (Problem Analysis), and PO3 (Design of Solutions).

PO1 (Engineering Knowledge) refers to the integration of mathematics, sciences, and environmental engineering subdiscipline knowledge to design and analyze complex environmental engineering challenges. PO2 (Problem Analysis) refers to analyze and develop solutions for complicated environmental engineering issues. Design of solution (PO3) integrates learning with client requirements to produce feasible, practical, and environmentally sustainable solutions for complex environmental engineering problems, whereas Investigation (PO4) employs research-based knowledge and methods to investigate and synthesize information in order to formulate solutions for complex environmental engineering problems.

3. Method.

3.1. Sample.

We extracted 15 essays from a collection of Groundwater Contamination course assignments from 2020-2021. The essays were extracted from "Blackboard" after they were examined using Turnitin, an online plagiarism detection program. Students' essays must have a similarity score of less than 20% on Turnitin. All essays were collected for this data set at the end of the first semester of the Environmental Engineering program.

3.2. Essay instruction.

During writing an essay, students were supposed to highlight main trends in a particular area of groundwater contamination, to elaborate on many significant solutions to past issues, and to identify future big challenges. Additionally, students were expected to conduct a critical analysis of current ideas, methods, and approaches and to recommend prospective areas for future research. The following criteria should be incorporated within the essay:

- The major challenge(s) faced in this area of research and/or practice.
- The occurrence, distribution, and contaminant movement.
- Application of mathematical model in groundwater system.
- The status of the field and description of the challenges for future research and health impact to the community.
- Discussion of pros and cons of remediation technologies.

Essay component of the Groundwater Contamination contributes to 50% of the total assessment and the rubric of this project is summarized in Table 2. The Bloom Taxonomy has been connected to all of the essay report and presentation criteria. The Bloom's taxonomy is a set of three hierarchical classification frameworks for educational learning objectives based on their complexity and specificity. The three lists cover domains of learning such as cognitive, emotional, and psychomotor. The six-level cognitive domain hierarchy has been the primary focus of most traditional education and is frequently used to structure curriculum learning objectives, assessments, and concepts such as knowledge, comprehension, application, analysis, synthesis, and evaluation, while psychomotor domain skills refer to the ability to manipulate a tool or instrument physically. Psychomotor objectives are often directed toward the development of behavior and/or skills, such as perception, set, guided reaction, mechanism, complicated overt response, adaptability, and origination.

Table 2. Criteria of essay evaluation in the Groundwater Contamination.

No	Criteria	Percentage	Bloom taxonomy	
			Learning domain	Level
Report				
1	Overview, occurrence, distribution and contaminant movement	25%	Cognitive	Level 4: Analyze
2	Mathematical model in groundwater system	20%	Cognitive	Level 4: Analyze
3	Description of the challenges for future research and health impact to the community	20%	Cognitive	Level 4: Analyze
4	Explanation of remediation technologies: discuss pros and cons for each technology	25%	Cognitive	Level 4: Analyze
5	Mechanic, formatting, graph/table, grammar and Reference	10%	Cognitive	Level 3: Apply
Presentation				
1	Content, organization of material, and methodology	40%	Cognitive	Level 6: Evaluation
3	Spoken delivery	20%	Psychomotor	Level 2: Set
4	Quality of visuals	20%	Cognitive	Level 5: Synthesis
5	Answering and timing	20%	Psychomotor	Level 2: Set

4. Result and Discussion

4.1.Essay Length and Quality

Figure 1 illustrates the length of an essay written by a student in the Groundwater Contamination course. The essay with the highest percentage (38%) was written in 4000-4999 words, while the essay with the lowest percentage (3%) was written in 3999 words (31%). However, no correlation exists between essay length (word count) and report or presentation grades, as both have R^2 values less than 0.1 (Figure 2). This indicates that, as a result of the constraints imposed by inadequate language proficiency, more proficient students tended to write shorter essays. Additionally, writing in a foreign language may be hampered by the necessity of concentrating on the language rather than the subject.

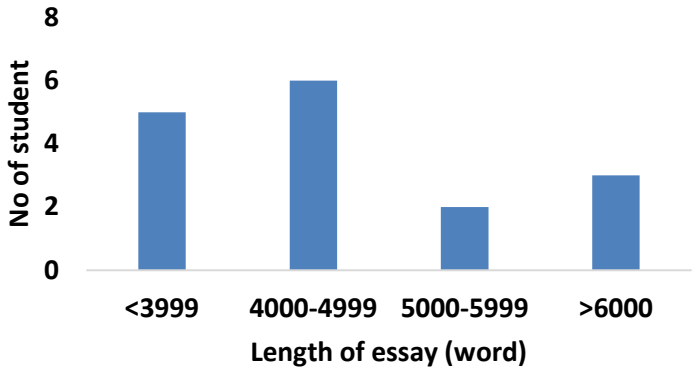

Figure 1. Number of student and their essay length.

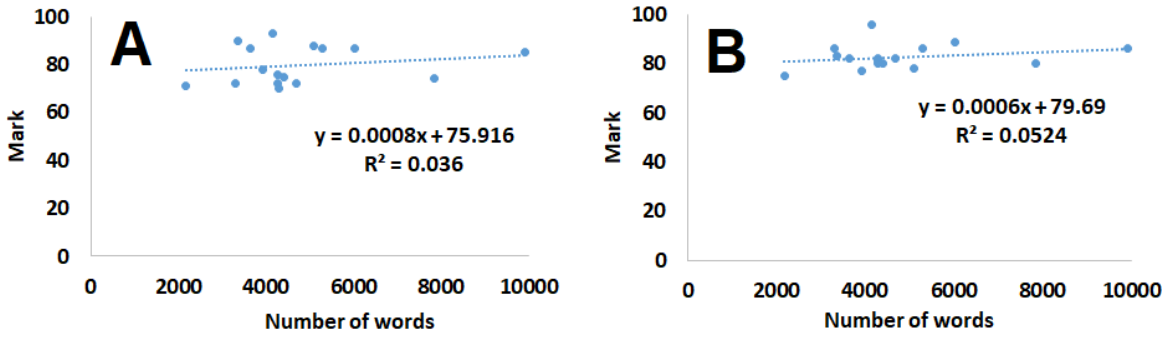

Figure 2. Relationship between length of essay with mark of report (A) and presentation.

On the other hand, the relationship between the quality of the essay topic and the quality of the essay format is examined. There were a strong relationship between the student mark and essay content ($R^2 = 0.88$), but moderate relationship to essay formating ($R^2 = 0.55$). In this context, it is feasible to view the ability to compose longer texts as indicative of increased skill in a foreign language, making the length of the text a relevant factor of assessment. This is because students assume that concentrating on the essay's content is more important than concentrating on the essay's format.

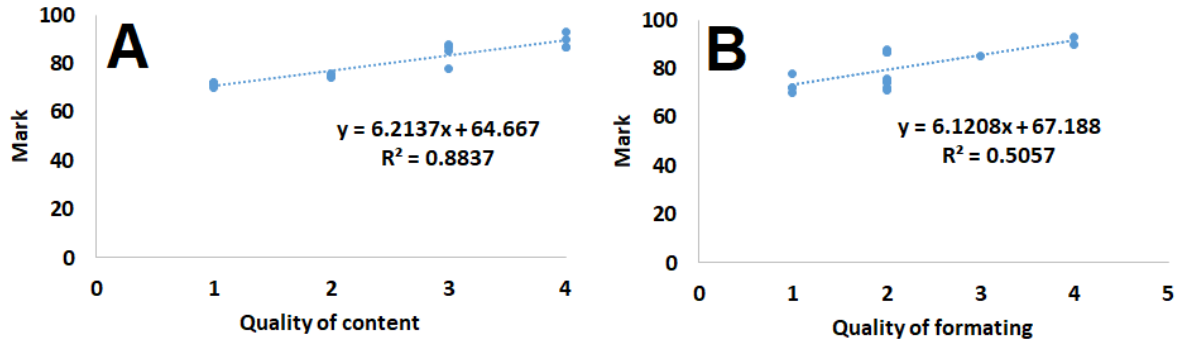

Figure 3. Relationship between quality of essay content (A) and essay formatting and with essay mark.

4.2.Course Outcome and Program Outcome (PO) Attainment

When determining a student's attainment of the PO, the percentage of students achieving 50% or higher is used. After that, the CO attainment is determined using the weighted average of the assessment attainment. Finally, program-level PO attainment can be calculated by averaging the PO attainment of the cohort's students. As illustrated in Fig. 4, a sample of CO achievement for the Groundwater Contamination course during the academic session 2020-21. CO1 was connected with PO 1 (Engineering Knowledge) in the groundwater pollution unit, where it exceeded the stipulated limit (50%) in 2020 (95%) and 2021 (87%). CO2 is associated with PO2 (Problem Analysis), where it is 82% for 2020 (82%) and 100% for 2021), CO3 is correlated with PO3 (Design Solution), where it is 90% for 2020 and 87% for 2021, and CO4 is correlated with PO 3 (Investigation), where it is 100% for 2020 and 2021. Because the essay contributes to CO3 and CO4, we may assume that all students are capable of successfully completing this task.

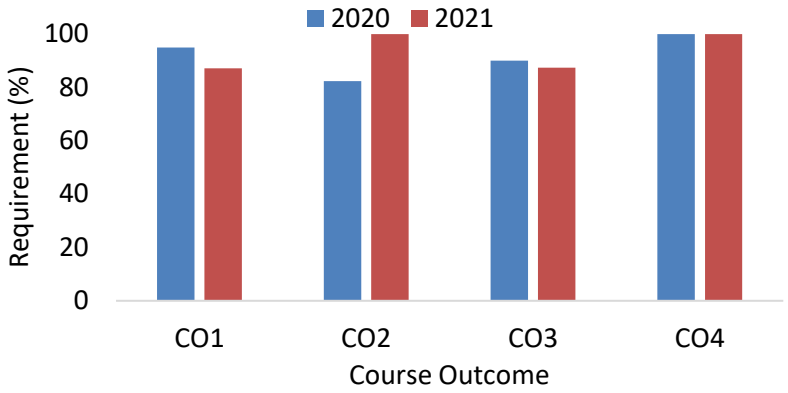

Figure 4. Course Outcome attainment.

4.3.Student evaluation

Students' evaluations and suggestions regarding the delivery of the course are key components of the course's future advancement. Students are asked to respond to eleven questions on the teaching and learning process at the end of the semester that relate to the course outcomes. The evaluation of the Groundwater Contamination course for semester 1, 2018 is summarized in Table 3. Students unanimously believe that the learning experience, learning materials, assessment activities, workload, and quality instructor all contribute to students reaching the

learning outcome in this course. By and large, student reactions and comments suggested that they are highly motivated, comfortable with the course format, and satisfied with the teaching approaches. Final evaluations indicated that learners' performance and recall of content had improved.

Table 3. The evaluation of course summary report of Groundwater Contamination.

eValuate Unit Summary Report

Evaluation period: 2020-2021
Reponse rate 66.5%

No	eVALUate quantitative items	Agreement (%)	Disagreement (%)	Unable to judge (%)
1	The learning outcome in this unit are clearly identified	80	10	10
2	The learning experiences in this unit help me to achieve the learning outcomes	70	30	0
3	The learning resource in this unit help me to achieve the learning outcomes	70	30	0
4	The assessment tasks in this unit evaluate my achievement of the learning outcomes	90	0	10
5	Feedback on my work in this unit help me to achieve the learning outcomes	70	20	10
6	The workload in this unit is appropriate to achievement of the learning outcomes	90	0	10
7	The quality of teachings in this unit help me to achieve the learning outcomes	70	30	0
8	I am motivated to achieve the learning outcomes in this unit	70	30	0
9	I make best use of the learning experiences in this unit	80	20	0
10	I think about how I can learn more effectively in this unit	80	20	0
11	Overall, I am satisfied with this unit	80	20	0

4.4.Pros and cons

Assessment can be classified as formative or summative, their definitions have become muddled in recent years, particularly formative assessment. This can cause confusion in the classroom and inhibit student advancement if not used correctly. Professionals from outside the school, such as educational inspectors, may be asked to assess student learning. In order to deliver a balanced assessment, they may not always know or appreciate the school and life contexts. With the recent introduction of league tables, there is a substantial risk of incorrectly assessing instructors, pupils, and educational facilities. Less time spent on summative performance assessments may lead to a spiral of “teach to test” practices where students' lives and those involved in their education increasingly revolve on testing. Teachers educate to the test, and school officials and the broader public become score-obsessed [9,10].

During a lesson, unit, or course, teachers assess students' comprehension, learning needs, and academic progress using a variety of formative assessment strategies. Formative assessment collects evidence about learning to change teaching and prepare next educational steps. Evidence of learning is vital since it shows if a student's learning process has changed. Based on this research, teachers can set targets/goals and provide feedback to students on their progress, signaling to students not just what they need to learn, but also how best to learn it, thus contributing to student reflection on their own learning [11]. Recent research on assessment and learning shows that formative assessment can be utilized to improve academic levels and standards. Previous studies also showed that using self-assessment to motivate learning in pupils could result in significant gains in overall performance. Assessment is widely

acknowledged as one of the most successful instructional techniques [12,13]. The purpose of formative assessment is to guide students' learning processes and improve their learning outcomes. On the basis of its potential to improve student learning, formative assessment has become a "key educational policy pillar."

4. Conclusions

The essay is a kind of art in which some arguments about a subject are presented in an original manner. Academic essays enable students to both defend and convey their own perspectives on a subject. No correlation exists between essay length (word count) and report or presentation grades. This is because students assume that concentrating on the essay's content is more important than the essay format. The percentage of students achieving 50% or higher is used. CO1 was connected with PO 1 (Engineering Knowledge) in the groundwater pollution unit. CO2 is associated with PO2 (Problem Analysis), where it is 82% for 2020 (82%) and 100% for 2021. Overall, the essay as an assessment had enable the students to achieve the CO and PO as outlined in the Environmental Engineering undergraduate programmes offered at the Curtin University Malaysia.

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Competing Interest

All authors declared no competing interest.

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