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Keywords : *writing to learn, attitude, science teaching, learning outcomes, writing across the curriculum.*

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The Use of Select Writing across the Curriculum Strategies and Their Impact on Science Students' Attitude to Writing: A Comparison of Outcomes for Two Undergraduate Biology Courses

Selected WAC Strategies and Writing Attitudes

Ingrid Mclaren [α] & Dale Webber [σ]

Abstract - This study describes the differences in students' attitudes to writing before and after the use of writing to learn [WTL] and learning to write [LTW] strategies in the delivery of their respective courses. Results reveal that students who had been exposed to LTW strategies display a significantly less favourable attitude to writing than those who had engaged in WTL activities. Further, both LTW and WTL groups are significantly less favourably disposed to writing after engaging in their respective strategies. The impact which the lack of congruence between writing activities, course assessment and outcomes may possibly have on these results is discussed. Recommendations are made as to how to improve student attitude to writing through greater alignment with assessment and objectives. Future directions for research are discussed.

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I. Introduction

Writing is undoubtedly a critical component of learning and assessment in all disciplines in higher education. In fact Bean (2001) has contended that good writing enhances students' learning and develops both their critical thinking and active problem-solving abilities, and others, (Forsyth, 2004; Stowers & Barker, 2003), have attested to good communication skills being a critical component to success in one's personal and professional life. However, there continues to be a growing concern amongst academics, (Lillis & Turner, 2001; Ganobcsik-Williams, 2006; Byrne, 2007), and science educators (Jerde & Taper, 2004; Moore, 1994; Samsa & Oddone, 1994) in particular, about the writing competencies of students. The latter group contends that generally, undergraduate students have not learnt to write effectively in scientific formats and that the majority of scientific writing problems observed are related to the Documents' organization, tone, clarity and concision For this reason they have promoted a closer integration of writing with education in all disciplines, not only to improve writing skills but also to facilitate better understanding of subject matter (Banger-Drowns, Hurley & Wilkinson, 2004).

This challenge has been met to a large extent by the Writing across the Curriculum (WAC) initiative which enables students' exposure to a variety of writing styles in multiple content fields (Cornell & Closter, 1990) while giving them the tools to synthesize, analyse, and apply course content in meaningful ways (Wiley, Gleason, & Withered Phelps, 1996).

WAC according to Hirsch and Collins (1988), there are three essential dimensions which constitute the development of academic writing skills. The first This approach comprises two main elements ---- 'writing to learn' and 'learning to write'-- and although the distinction between them is often blurred, English et al. (1999) in attempting to provide clearer lines of demarcation, have suggested that the former is located within the domain of 'subject knowledge'/'knowledge domain' and the latter within the context of 'skills of literacy'. Further to this, the articulation between the two approaches has been described by Hirsch & Collins (1988) on the one hand, as enhancing learning of content [WTL] and on the other----how to write about content [LTW].

This two-pronged approach to writing ('writing to learn' [WTL] and 'learning to write' [LTW]) is viewed as particularly beneficial and relevant in the teaching of science courses. In the first instance, WAC strategies are considered to be instrumental in facilitating students' thinking and domain-centred learning in the sciences (Tynjala *et al.*, 2001). In further support, Bocolo & Mason (2001) have determined that writing activities, particularly in the sciences, can be a useful aid in conceptual comprehension and retention as well as in promoting reflection on such information especially if

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there is a forum for feedback/discussion. As a result, students are stimulated to view writing as enhancing the learning process through more appropriate assimilation of information and communicating it more effectively. Writing in the sciences is, therefore, elevated above the basic role of merely the recording of information to an appreciation of its role in the construction and transfer of knowledge in the mind of the learner.

In the second instance, learning to write strategies enable students to move beyond the confines of a "myopic focus on technical terms toward the broader aim of science, which is that of being able to communicate scientific knowledge to a diverse community" (Boyd et al., 2008 p,219). In fact Hand, Prain & Yore (2001) have determined that writing activities improved students' ability to communicate more effectively, because they consistently scored better on subsequent tests and displayed superior performance on higher- order questions compared to their counterparts in the control group whose writing tasks were not directed.

Still, although many investigations have attributed WAC strategies to improved student learning and performance, fewer studies have focused on the impact that these strategies might have on student attitude to writing. This has been noted by Prain and Hand (1999) who contend that student perceptions, other than in terms of assessing the effectiveness of different tasks for promoting learning, have been largely overlooked in the research on student writing for learning. Additionally, Rivard (1994) has contended that research into students' perception of their own learning from writing has largely been ignored in favour of testing the learning outcomes of different writing tasks and instructions against one.

At the same time, researchers who have investigated the relationship between the use of writing strategies and student perception of writing have reported generally positive outcomes. For instance Harvard researchers have asserted that the relationship between the amount of writing for a course and students' level of engagement-whether engagement is measured by time spent on the course, or the intellectual challenge it presents, or students' self-reported level of interest in it-is stronger than any relationship found between student engagement and any other course characteristic (Light, 1991).

In the same vein, Dobie and Poirrier (1996) found that intense incorporation of writing-to-learn strategies in a required introductory nursing course helped students who began with negative attitudes about writing to become more positive. They also found that using writing strategies strengthened student-teacher communication, and helped to lower attrition rates.

Furthermore, Reaves et al. (1993) reported that although there was no overall difference in the attitudes toward writing for students who had been taught by 'writing to learn' activities, a significant increase in students' confidence in writing was noted at the end of intervention. Partial support is found in Anderson's (2008) results where a significant improvement in students' perception of their writing ability and problem solving skills after a 'writing to learn' intervention was reported.

However, although providing some support for the role of writing and in changing attitude to /perception of writing, none of these studies sought to compare the impact which writing to learn as opposed to learning to write activities might have on student perception of writing.

Against this background, the present study sought to answer the following:

1. Do students who are exposed to writing to learn and learning to write activities become more positively disposed toward writing?
2. Which if any of these strategies has a greater impact on student attitude to writing?

This study was situated within the context of a WAC Programme implemented within the Faculty of Pure and Applied Sciences in November 2006 by the English Language Section of the Faculty of Humanities and Education. Our attempts to incorporate writing to learn/learning to write strategies to enhance writing skills and learning in the sciences constituted the major part of this project.

The project was implemented because of concerns on the part of both Science and English Language teachers that students, who had completed English Language Foundation courses in their first year, were not applying the writing principles learned in these foundation courses to their discipline. This resulted in writing which, in most cases, failed to adequately demonstrate knowledge of concepts being taught and to effectively communicate scientific information.

The aims of this project were therefore to enhance science students' communication skills and their attitude to writing and also to better enable the science teaching staff to assume responsibility for students' writing by ensuring that students learnt and practiced the discourse conventions appropriate for their discipline.

The WAC programme was initially introduced through a series of workshops with members of the Faculty of Pure and Applied Sciences. The sessions were "aimed at sensitizing Faculty to WAC pedagogy, approaches and activities for improving students' critical thinking and communication skills", particularly among those in Level 2 & 3 courses.

Subsequent to this, the Lecturer for a Level 2 Ecology course and a Level 3 course in Coastal Management, with the assistance of the WAC Coordinator decided to incorporate WAC strategies into

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these courses. The decision as to what type of strategies would be used was based on the perceived deficiencies and needs of students and the objectives of the courses.

The actual choice of activities was further informed by guidelines provided by Hesse (2007, p. 3) who sought to clarify the difference in focus and purpose between 'writing to learn'(WTL) and 'learning to write' (LTW) activities. He proposed, for instance, that whereas WTL emphasizes course content through having students actively engage information and ideas, LTW emphasizes student development of writing skills and strategies. Further, while "Getting better" as a writer is an indirect benefit of WTL, "Getting better" as a writer is a direct and primary goal of LTW. Related to this is the fact that for WTL, [instructor]response tends to focus on quality and accuracy of student thought and engagement as opposed to LTW where response tends to focus on both quality and accuracy of student thought and engagement and on matters of presentation (rhetorical effectiveness, adherence to conventions, etc.)

It was thus anticipated that deeper immersion in LTW writing activities would result in students having a significantly more positive attitude to writing than their WTL counterparts whose engagement with writing would be less intense.

II. Method

a) Classroom

There were 40 students enrolled in the Ecology course and 20 enrolled in the Coastal Management course.The Ecology course is delivered via 24 hours of lectures, 6 hours of tutorials, 36 hours of field and laboratory work including a weekend field trip. Performance in this course is determined by course work which includes a 2 hour practical test (20%), a multiple choice test (10%) and laboratory and field reports (10%) and a Final Examination- a 2 hour theory paper (60%). This theory paper required the writing of three essays which would measure the acquisition of knowledge as well as the ability to apply this knowledge to a variety of contexts, and as indicated by the weighting, constituted the primary measure of student performance in the course.

It is important to note that the weighting for writing competence, referred to as 'Quality of Writing', for the final examination as well as for the course work (where applicable) was 10 as opposed to 90 for content. No changes were made to the proportion of marks allocated to writing for the proposed intervention.

'Learning to write' strategies were thought to be more suitable for the Ecology course as students were frequently found to be deficient in communicating information via laboratory reports on the design and execution of basic sampling techniques relating to the population or community of organisms. They were also found to have difficulty in clearly describing concepts of community productivity, succession, nutrient cycling and energy transformation.

Since writing skills were a major concern, the Lecturer decided that students should focus on writing and rewriting drafts of essays and laboratory reports with guidance and feedback on each draft provided by the lecturer, his support team, and in some instances the students themselves.

From the outset, the lecturer gave students information about the writing strategies that he would be integrating into the course. There was initial resistance to additional writing activities, but this abated somewhat when the lecturer highlighted the potential benefits of these activities which included the possibility of higher grades.

All students were required throughout the course to produce drafts of laboratory reports on experiments carried out and to revise these reports based on feedback given by the lecturer, a teaching assistant and laboratory demonstrators who were provided with guidelines by the lecturer. No grades were assigned to these reports and the feedback given was to be viewed as constructive criticism.

In addition to this, students were randomly divided into two groups: Group A -the forest group- would sample, identify, and evaluate specified communities of organisms in forests and Group B–the marine group-- would participate in the same activity in coastal areas. Members of each group were required to write the methodology component of a lab report and exchange their reports with members of the other group (i.e. Group A to give reports to Group B group and vice versa). Each group would then attempt to replicate the experiment of the other group. Important to note is the fact that neither group of students was told that they would be replicating the experiment in addition to reading it. A Sample response to this exercise, before and after feedback is illustrated in Table 1.

Another type of strategy involved responding to essay exam questions toward the end of the semester. The procedure undertaken by the lecturer was as follows:

- Discussion of strategies for answering essay exam questions in tutorials
- Highlighting the need for preparing outlines in preparation for writing.
- Engagement in essay planning exercises during tutorials.

Incorporation of the draft/redraft strategy by (a) handing out essay questions (b) suggesting to students that they attempt some of these, submit them to him for feedback (c) using this feedback to attempt another draft which would also be assessed by him.

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The Coastal Management course, similar to the Ecology course, consists of 24 hours of lecture, 6 hours of tutorials, and 36 hours of field and laboratory exercises to illustrate the principles of coastal management. Performance in this course is also determined by course work which constitutes a 2-hour practical test (20%), laboratory and field reports (10%) and a research paper presented via an oral presentation (10%) and a final 3-hour theory paper (60%). As with the Ecology, course the ratio of weighting for Content and Quality of Writing remained at 90:10 respectively.

Although students pursuing this course were also viewed as needing to enhance their communications skills, the lecturer decided that they would benefit more from writing to learn activities. These activities would focus, through writing, on engagement with course content, and thus hone students' skills in applying and evaluating information related to resource management practices, legislation and enforcement of marine parks and conservation areas and the kinds of pollution affecting coastal resources. WTL activities were also viewed as being particularly beneficial to students in this course as these would better prepare them for the oral presentation required as part of the coursework. Some feedback would also be given, but his would be more general and would not require redrafting exercises. Students were apprised at the beginning of the course about the strategies to be incorporated into class activities, and the possibility of higher grades was again used here as an incentive for their involvement.
The WTL strategies applied to this course were:

- Admission and exit slips
- Summary Writing and Discussion
- Tutorial questions
- Practice Essay
- Lensing: Change roles

b) Admission and Exit Slips

Students were asked at the beginning of the course to state what their expectations of the course were and also what was their potential contribution. They were then asked at the end of the course what they had learnt, what was most beneficial and whether their expectations had been met.

Additionally, at the start of each new topic a slip with questions was administered and students given 10 minutes to write what they knew, understood and expected of the topic. At the end of the topic a similar slip was administered and the answers compared.
This was done throughout the semester.

c) Summary

At the end of some topics the class was divided in two and each half presented with a topic related question and given 10 minutes to summarise and then share the summary with the other half and vice versa. Finally, an essay topic was given for all students to plan individually for each of the two topics.

d) Tutorial Questions

At the beginning of the course, an essay topic was given as practice for all students to plan individually for at least two of the topics.

e) Practice Essay

Each student was asked to select an essay topic, write it, and re write it based on feedback.

f) Lensing: Changing Roles

The entire class was presented with an environmental assessment for a coastal construction development which had merit (especially social) as well as problems (usually environmental). Two teams were formed. One represented the government regulators (to give or not to give permission and under what conditions) and the other played the developer/owner. Arguments were written and presented by each in support of their case.

The roles were then reversed and the arguments just presented were returned to the respective sides and they were then required to write arguments representing the opposite view. They were not told that they would be changing roles.

III. Instrumentation

The development of questionnaires to gauge student attitude to writing took into account McLeod's (1991, p.98) assertion that rather than being considered as merely affective responses such as grief, anger and joy, attitudes should be viewed as "psychological states acquired over a period of time as a result of our experiences; these attitudes influence us to act in certain ways". Musgrove (1999, p.3) has interpreted this to mean that "an attitude is a learned state of readiness rather than the act or response itself. Synonyms would include tendency and predisposition".

As such the 10 item (pre-test) questionnaire (Table 2) which was administered to students prior to the inception of teaching, sought to determine students' perception of the importance and usefulness of writing (Q.1, 2, 5 and 8), their autonomy and motivation concerning writing (Q.3, 4, 6 and 7) and self-evaluation of their writing ability and confidence in their writing skills (Q.9 and 10). Likert scale scores ranged from strongly disagree (1) to strongly agree (5). At the end of the semester, prior to the final exam, a related questionnaire (post-test) which was almost identical to the pre-test (Table 1) was given to students. The Cronbach alpha coefficient for the pre and post questionnaire was .7085 and .7186, respectively. Data from the pre/post-test analysis provided evidence as to whether students' attitudes changed while using WTL/LTW strategies.

a) Analysis

Responses from the pre and post-test questionnaires for both groups, were analysed via - paired samples *t- test* procedures to determine the

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significance of difference in (i)) overall change in attitude for the LTW and WTL groups and (ii) changes in attitudes for LTW and WTL groups regarding writing at the beginning of the course and at the end. A comparison of the significance of difference in attitude change between groups was undertaken using a one sample *t- test* procedure.

Table 1 : Sample of Students Description of Method before and after Revision

Student First Attempt
1) Groups were divided into two and shown their datum point. 2) Each group then measured a 4 m^2 area on opposite sides of the transect line in which they would conduct sampling, creating on alternating pattern. 3) Each group then proceeded to sample their area recording the following: 1. Height of plant 2. Percentage coverage of plants 3. DBH of plants taller than 2 m 4. Distance from datum point 5. Height and number of epiphytes or orchids and trees on which they were located 6. No. of animals and species. **The following data was provided by demonstrators:** 1. Soil temperature (^{0}C) 2. Wind speed 3. Light lux 4. Dry Temperature (^{0}C) 5. Moisture temperature (^{0}C) 6. The reading for the above were taken every 5 m.
Student Attempt After Feedback A line transect, 100 m long was tagged at every meter and extended through the dry limestone present from road to sea. Group 7 was assigned to a 10.00 m length of the transect line. The 1 m^2 quadrat provided to sample each meter of the transect, was placed on alternating sides of the line. The plant species in the quadrat were identified. Wherever the species cannot be identified a small section was removed and labelled and returned to the lab to be identified with aid of the herbarium sheets. The number of individuals were counted and recorded. For each plant species, the distance from the starting point of transect, the diameter of each at breast height, the height and the percentage cover of each plant was determined. Height and number of epiphytes or orchids and trees on which they were located was noted. A shovel was used to dig amongst soil and leaf litter present in the quadrat area and animals found recorded. The Abiotic factors at selected points were recorded (relative humidity, light, soil moisture, soil temperature and wind speed).Notes on various plants and animals observed were made. All information observed were recorded.

Table 2 : Survey Instrument Used in class to evaluate student attitudes on writing

The following statements cover a range of attitudes to writing at university. Please indicate your response to each statement by CIRCLING the rating which best describes your attitude. 5 = Strongly Agree 4 = Agree 3 = Undecided 2 =Disagree 1 = Strongly Disagree
PART I 1. Writing enhances learning 2. Good writing skills will enhance my performance in my future career . 3. I usually plan my time so I can draft and revise papers prior to submission 4. I am willing to use feedback on I receive on my papers to improve my writing. 5. Writing in the Sciences is just as important as writing in important as writing in the Humanities. 6. My papers reflect the best writing I am capable of 7. I am willing to do additional work to improve my writing. 8. Writing skills should be taken into account when test, assignments and examinations are being graded
PART II Please evaluate your writing skills and level of confidence in your writing by encircling the descriptor that best describes each. 9. Which of the following best describes your level of confidence when writing for your courses? Very High High Medium Low Very Low 10. Which of the following best describes your writing skills Excellent Good Satisfactory Fair Poor

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IV. Results

LTW students had been required to identify, and evaluate specified communities in forests or coastal areas, and to exchange the methodology component of their lab reports with that of their peers who would then seek to replicate the experiment. Many students on reading the reports of the members of the other group, Claimed at first to understand the content. However when they were told that they should now carry out the experiment described in the report, they were forced to admit that the writer had omitted crucial details and information which would hinder the undertaking of the task. Thus, the original writers were forced to review their work, and based on comments, revise what they had written. This revision exercise on the part of students led to lab reports with more detailed descriptions, clearer communication of the sequencing of activities as well as more appropriate word choice. Students were thus better able to replicate experiment of the other group. Table 1 provides a sample of the original and revised drafts.

A similar procedure was undertaken for other lab reports where students were required to re write their first draft after feedback.

Only 20% of students complied in a consistent manner in the draft/redraft of essays which involved responding to practice essay exam questions.

The WTL group was quite positive regarding the course outcomes as evidenced by their responses on Exit Slips. However, no student addressed the use or effectiveness writing activities. Some students did however mention enhanced ability to deliver oral presentations. One student stated: "[The course] it has exceeded my expectations and I have come to regard it as the best course of my degree". According to students, positive aspects of the course included "critical thinking", "gaining skills in EIAs", "project management skills", "environmental awareness" "made me read more and more confident in oral ability".

The negative aspects as put forth by the students included: "not enough time to grasp concepts of lectures and labs", "group work difficult", "class work too intense".

Regarding the Summary Writing activity, the lecturer commented that although students provided constructive criticism on each group's draft, they were less able to clearly communicate their points in writing the related essay. In fact, he was amazed at how poorly students communicated concepts they understood and how difficult it was for them to transfer their understanding of these concepts from thought to paper.

In the case of Tutorial Essays and Practice Essays for which each student was required to select and write an essay which would be marked by the lecturer and then rewritten by the student, only 15% of the students wrote another draft after receiving feedback on the first one.

In the case of the "Lansing: Changing Roles" activity, after students' initial surprise that they would have to reverse roles, that is, write and present a case against the one they had previously defended, they were forced to critically evaluate the merit of each argument. In doing so, they enhanced their understanding of the role and perspective of government agencies and developers in real life scenarios.

Statistical analyses reveal that students in the Learning to Write [LTW] group and the Writing to Learn [WTL] group displayed a significantly less favorable attitude to writing after engaging in their respective activities. Table 3 illustrates a significant reduction (<0.01) in the pre test mean for the LTW group from 39.64 to a post test mean of 33.29. The same obtained for the WTL group whose pre test mean was 37.80 compared to a post test mean of 35.35 (<0.05). Further, the LTW group who had initially been significantly more favorably disposed toward writing compared to their WTL counterparts, displayed a significantly less positive attitude(<0.01) to writing after intervention (Table 4).

Table 3 : Attitude Change for Learning to Write (LTW) and Writing to Learn (WTL) Groups

	N	Pre test Mean	SD	Post test Mean	SD	Paired sample t test p
LTW	36	39.64	4.162	33.29	4.548	<0.01
WTL	20	37.80	4.188	35.35	3.843	<0.05

Table 4 : Comparison of Attitude Change between Learning to Write (LTW) and Writing to Learn (WTL) Groups

	N	Pre test Mean	SD	Post test Mean	SD	Paired sample t test p
LTW	36	39.64	4.162	33.29	4.548	<0.01
WTL	20	37.80	4.188	35.35	3.843	<0.05

A comparison of the pre and post-test responses for the LTW group (Table 5) reveal details of the downward trend in students' attitude during the semester. Based on the negative change in responses for nine of the ten items, six of which were significant, it is clear that students were less positive about the benefits of writing, less motivated and willing to undertake additional work to improve their writing, and became even less confident in their writing ability after intervention.

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Table 5 : Likert Test Question Response Values Showing Changes in Attitudes for LTW Group Regarding Writing at the Beginning of the Course (pre) and at the End (post). Questions are shown in Table 2

Question	N	Pre Test Mean	SD	Post test Mean	SD	Paired Samples t test p
1	35	4.57	0.56	3.69	0.99	<0.01
2	35	4.60	0.50	4.10	0.64	<0.05
3	35	3.67	0.96	3.97	0.82	0.19
4	35	4.63	0.54	4.46	0.13	0.30
5	35	4.40	0.77	4.40	0.98	0.13
6	35	3.77	1.03	2.51	0.88	<0.01
7	35	4.11	0.90	3.40	1.19	<0.05
8	35	3.03	1.31	3.69	0.83	<0.05
9	34	3.38	0.65	1.76	0.89	<0.01
10	34	3.68	0.80	1.71	0.93	<0.01

The only positive and significant change in attitude was noted regarding the matter of lecturers taking students' writing into account when grading tests and assignments (Q.8).

Members of the WTL group also displayed a general downward trend in attitude with six of the ten items revealing a negative change in response, and four of these being significant. However unlike the LTW group there were more exceptions as students demonstrated a significant and positive change regarding their willingness to plan and revise work before submission (Q.3) and were more willing , though not significantly so, to use feedback to improve their writing (Q. 4). Additionally, they displayed a slightly more positive attitude concerning the importance of writing (Q.5) and, similar to the LTW group, were significantly more favourable to lecturers taking writing skills into account when grading tests and assignments (Q.8). Table 6 illustrates these results.

Table 6 : Likert Test Question Response Values Showing Changes in Attitudes for WTL Group Regarding Writing at the Beginning of the Course (pre) and at the End (post). Questions are shown in Table 2

Question	N	Pre Test Mean	SD	Post test Mean	SD	Paired Samples t test p
1	20	4.45	0.60	4.05	0.60	<0.05
2	20	4.60	0.50	4.30	0.57	0.08
3	20	3.0	1.05	4.00	0.56	<0.01
4	20	4.40	0.75	4.50	0.51	0.73
5	20	4.00	1.12	4.20	0.70	0.40
6	20	3.45	1.05	2.80	0.99	<0.05
7	20	4.00	0.65	3.85	0.81	0.40
8	20	3.15	0.98	3.75	0.85	<0.05
9	20	3.32	0.47	2.11	0.81	<0.01
10	20	3.40	0.50	1.95	0.75	<0.01

V. Discussion

Contrary to expectations, and previous findings, students who had been more intensely engaged in writing, were less positively disposed toward writing than were their counterparts who engaged in writing geared primarily towards the learning of course content. Moreover, instead of an improved attitude to writing both groups, after intervention, displayed a significantly less positive attitude.

We suggest that this negative attitude change may well be attributable to factors outside the realm of the type of learning strategies employed and their effectiveness. In the case of the LTW group, students may have become discouraged when the flaws in their writing were highlighted and they became aware of exactly how onerous and demanding was the task of improving writing skills. More important, these students could have become even more discouraged by the fact In spite of the extra effort expended in writing and redrafting their work, there was no additional weighting given to writing in course evaluation (90: Content; 10: Quality of Writing) nor to the final exam, worth 60%, which required extensive essay writing. In other words, there was no tangible reward/compensation for their efforts to improve their writing skills or any perceived

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congruence between these activities and assessment measures.

This was possibly exacerbated by the fact that students when completing the post questionnaire had not yet taken the final exam and so would not have been able to determine whether or not the in course writing strategies had enhanced their essay writing skills.

The significantly positive change reported for attitude as it related to lecturers taking writing skills into account when grading papers supports our view that students' perception of writing was influenced by the lack of congruence between the increased focus on writing and course assessment. In a similar vein, researchers such as Biggs (1999) and Robertson (2004) have highlighted the important role played by congruence between teaching, learning activities and assessment measures in student achievement. Entirely consistent with this is the assertion of Keys *et al.* (1999) that learning activities must be perceived by students as being meaningful and authentic and should match the conceptual structure of a topic and broader curricular goals.

The perceived lack of congruence between learning activities and assessment may have also contributed to the WTL group's significantly less positive approach to writing as they, similar to the LTW group, displayed a significant upward trend in attitude on the matter of writing skills being taken into account in the grading of papers. Additionally, although these students were exposed to strategies which were geared toward enhancing their knowledge domain, they apparently did not view writing proficiency as integral to their success. This conclusion is consistent with that of Boyd et al. (2008 p. 232) who when confronted with similar findings attributed these to the fact that "having successfully completed the first in course test and half a semester of lab reports without having to engage in serious writing tasks", [student] perception appears to be that writing is not significant in learning and, by extension, is not required for passing the course". Related to this is the fact that, similar to the LTW students, these students had not yet engaged in extended essay writing in the final exam when their attitudes were evaluated at the end of the course.

At the same time, WTL students' comparatively less drastic downturn in attitude to writing may be attributed to, their lack of exposure to the rigours of writing, feedback and redrafting. Admittedly, follow up interviews with students would have served to clarify and confirm our findings and provided additional information.

VI. Conclusion

Based on our findings, we conclude that the use of writing strategies per se or any other type of learning activity for that matter is not sufficient to bring about a change in student attitude, particularly when such activities are viewed as 'add on' and not integral to the course. Rather, activities need to be incorporated within the course in alignment with assessment measurements and learning outcomes. As Houghton (2004) points out "students will inevitably tend to look at the assessment and structure their learning activities, as far as they are able, to optimise their assessment performance". This position is further strengthened by Boud's (1998) assertion that methods of assessment and related requirements probably have a greater impact on student learning than any other single factor.

We therefore suggest that a positive perception of writing on the part of students may be encouraged if there is sustained writing and evaluation throughout the course and assessment measures take writing proficiency more seriously into account. In other words, the message must be sent to students that not only is writing competence *per se* important but also that it is valued by lecturers and integral to success in courses.

To this end, we recommend that select courses in the sciences be designated as Writing Intensive (WI) which would serve the two fold purpose of enhancing students' writing competence as well as their attitude to writing.

We also recommend that other studies of this type be undertaken at our institution, particularly with students in WI courses, (if indeed these become a reality) in order to determine whether a more substantial alignment with learning/ writing activities, assessment measures and outcomes results in an enhanced attitude to writing. Such studies should however include a qualitative component comprising follow up interviews with students and extended personal responses in writing.

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