International Journal of Teaching and Learning in Higher Education 2019, Volume 31, Number 1, 73-85
http://www.isetl.org/ijtlhe/ ISSN 1812-9129

Science Students' Responses to an Oral Communication Skills Development Initiative: Attitude and Motivation

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Situated within the CID (Communication in the Disciplines) theoretical framework that promotes the focus of communication instruction on the oral genre standards of effectiveness, and employing a transdisciplinary approach, the current study explores science students' attitudes and motivation concerning an oral skills development (OSD) intervention. The cross-disciplinary based intervention involved the delivery of an oral skills development module over a ten-week period to thirty-four chemistry students in which staff from the English language section partnered with lecturers in chemistry to enhance these students' oral presentation of chemistry-based content. The performance of students participating in the module was compared with that of non-OSD chemistry students to verify whether there was a significant difference in performance. Surveys were also undertaken on OSD Chemistry students to see whether or not there was a significant change in attitude after the intervention. Results revealed a significant difference between OSD and non OSD students on a similar oral presentation task with OSD students attaining a higher level of performance. OSD students also demonstrated a positive, significant change in attitude post intervention. Implications of the findings, as well as possible areas for further research, are discussed.

Effective oral communication skills play a critical role in the personal, academic, and professional success of students, as not only do these skills enhance self - confidence, but they also aid in the formulation, structuring, and presentation of effective arguments. Furthermore, the importance of these skills in the world of work has been underscored by reports from the US Department of Labor, which in 1995 reported that communication skills will be in demand across occupations well into the next century, and more recently [2007], that effective oral, written, and listening communication skills are essential to decision making and resolving issues at the workplace.

This is entirely consistent with the worldwide consensus of universities that communication skills are essential to enhancing the employability of students (Mercer-Mapstone & Matthews, 2016). This sentiment finds support in the fact that effective communication skills are being considered as an expected learning outcome for both undergraduate and graduate science degrees, for example, in Australia, Canada, and the USA.

More specifically, oral communication skills are increasingly being viewed as indispensable tools in technical disciplines such as biology, chemistry, and mathematics where traditionally there had been focus on solely technical knowledge (Beaufait, 1991; Bjorklund & Colbeck, 2001; Denton, 1998; Yu & Liaw, 1998). As such, proficiency in communication is being regarded increasingly as equally important in achievement in the sciences as is technical knowledge.

The importance of oral communication skills to work performance of scientists is further supported by researchers such as Felder, Woods, Stice, and Rugarcia (2000), who found that engineering leaders ranked communication skills as being more important than technical skills. Darling and Dannels (2003) have also asserted that the types of communication that engineers considered most important included messages regarding construction skills, teamwork, negotiation, and general question and answer exchanges.

Furthermore, the American Association for the Advancement of Science (AAAS) (2009) contends that the ability of biologists to collaborate and communicate with other disciplines is critical to addressing large and complex biological issues, given the increased interdisciplinarity of the area and the need to fully engage with "collaborators, multiple perspectives, and skills" (p. 15). For this reason, they recommend that all students gain experience in communicating "biological concepts and interpretations" (p. 15) through a variety of formal and informal written, visual, and oral methods and also that students graduating with an undergraduate biology degree be offered instruction, practice, and assessments in broader communicative abilities.

These recommendations have been welcomed by many science educators. For instance, Brownell, Pryce and Steinman (2013), Cleveland and Reinsvold (2017), and Greenwood and Riordan (2001) have expressed concern that teaching in the sciences tends to privilege delivery and assessment of students' knowledge of terminology over focus on enhancing their proficiency in communicating scientific-related information to non-scientists.

Indeed, according to Darling and Dannels (2003), although evidence suggests that communication skills are critical to engineering practices, other studies report that these skills are being inadequately developed in engineering courses and curricula nationwide (Black, 1994; Evans, Beakley, Crouch & Yamaguchi, 1993; Goldberg, 1996; Lumsdaine & Lumsdaine, 1995; Rogers, Stratton, & King, 1999; Sageev, Prieto, & Smaczniak, 1992).

This increased awareness of the importance of enhancing the communicative skills of scientists to enable competence in transmitting information to non-scientists has led to practitioners such as Brownell, Pryce, and Steinmann (2013) arguing for the integration of formal communication training into graduate and undergraduate curricula, as well as others such as Besley, Dudo, and Storksdieck (2015) and Dudo (2013) calling for communication training generally to enhance scientists' ability to engage the public.

At the same time, Treise and Weigold (2002) have reported a variety of efforts and outcomes for training in science communication on the part of scientists who for either professional or personal reasons actively seek support from a variety of resources to boost competence in this area. In fact, science communication has not only become embedded in the curricula of an increasing number of academic institutions (Rajput, 2017), but also has increasingly become an area of focus at academic conferences, in professional development workshops at academic institutions, in discussion fora, and in the media (Cooke et al., 2017).

This enhancement of science communication at all levels has implications for the infusion of communication skills into the science education curriculum which is entirely consistent with transdisciplinarity, a concept attributed to Piaget (1972) who, in highlighting the nexus between the disciplines, referred to transdisciplinary as a "higher stage succeeding interdisciplinary relationships which would not only cover interactions or reciprocities between specialised research projects, but would place these relationships within a total system without any firm boundaries between disciplines" (p. 138) (as cited in Bernstein, 2015, p. 2).

In seeking to clarify this concept Lawrence (2004, p. 489) purports that transdisciplinarity "is a way of achieving innovative goals, enriched understanding, and a synergy of new methods." Further, transdisciplinarity suggests an integration of disciplinary knowledges which includes complexity and multidimensionality and seeks to produce spaces where new languages, logics, and concepts can give rise to generative dialogue (McClam & Flores-Scott, 2012, p. 232).

Additionally, experts worldwide (Althaus 2005; Carolan, 2004; Klein , 2004; Landers 2009) involved in a wide range of disciplines from sociology to engineering have asserted that trans- or cross-disciplinary approaches to teaching, learning, and research are key to confronting and finding solutions to current issues of sustainability. Indeed, these experts contend that traditional discipline-based strategies are inadequate for grasping the "complexity and multidimensionality of sustainability as a socio-ecological crisis and for providing new integrated or synthesized approaches to addressing this crisis" (McClam & Flores -Scott, 2012, p. 231-232).

This position finds support in the contentions of Gibbons et al. (1994) whose theory of the production of knowledge in higher education purports that "the world needs both people capable of operating with both disciplinary knowledge (Mode 1) and with transdisciplinary knowledge (Mode 2)" (as cited in Aneas, 2015, p. 1716). This theory further asserts that higher education is constructed around Mode 1 "scientific" or disciplinary knowledge, while Mode 2, on the other hand, refers to the knowledge generated within interdisciplinary, social, and economic context, or what Marsick and Watkins (1997) and Cseh, Watkins, and Marsick (2000) describe as the ability to apply the varying facets of knowledge in order to address issues by finding solutions.

Transdisciplinarity, therefore, constitutes an integrated curriculum in which disciplinary boundaries are nullified and teaching and learning become organized around the creation of meaning within the social/global context of actual and relevant issues and themes. In the current study, the issue as indicated is the relevance of competent communication skills to scientists and the infusion of communication skills into the science curriculum to enable the development of these skills.

The Initiative

The Communication Across the Curriculum Initiative undertaken at our University was one which embraced transdisciplinarity, as it involved the infusion of communication skills into science courses which were delivered jointly by lecturers from both the science faculty and the English language section. This joint approach resulted from awareness of shortcomings in the overall communication skills of science students, which had led initially to the implementation of a Writing Across the Curriculum (WAC) initiative.

The outcomes of the first phase of this project highlighted the need for writing proficiency to be a part of the objectives of all courses, and for writing to be fully integrated into learning activities, if proficiency in this area on the part of students were to be achieved. Additionally, it was strongly suggested that competence in writing should be given due weight in the assessment of coursework and examinations.

Added to this was the perceived need for the enhancement of oral communication skills as there were concerns that students in chemistry were "still graduating with weak skills in this area, as evidenced by comments made to us by their internship supervisors and subsequent employers" (Garaway, personal communication, February 2015). In the same vein, life sciences lecturers wanted their graduates to be able to use language clearly and effectively in their presentation of scientific knowledge to their respective audiences in both oral and written forms.

These concepts are embodied in the Massachusetts Institute of Technology's (MIT) Communication Across the Curriculum Program, whose establishment in the 1990s was an outcome of the realization that its graduates needed more instruction and practice in writing and speaking to become successful scientists, engineers, and entrepreneurs. The principles and practices employed in enhancing the communication skills of students include ensuring that communication activities (writing or speaking) are integral to the purpose of the class; feedback given by the technical and writing staff complement each other and contribute to students' success, and effective communication is judged by the specific context, course goals, and disciplinary conventions (Perelman, 2009).

Also worthy of note is the alignment of this approach with the CID (Communication in the Disciplines) theoretical framework that promotes the focus of communication instruction across the curriculum on the oral genre standards of effectiveness, as well as evaluation practices of the target discipline (Dannels, 2001b). This framework also "assumes that students' learning that occurs in general, basic courses can be enhanced in the disciplines with instruction that is situated within practices that are salient to the discipline" (Dannels, 2001a, p.147).

In implementing our CXC (Communication Across the Curriculum) initiative, we began with the Departments of Chemistry and Life Sciences whose members had participated in the previous WAC (Writing Across the Curriculum) project. The CXC implementation process was designed to involve the selection of four courses from each of these departments: two courses at Level 2 (2nd year) and two at Level 3 (3rd/final year). One course at each of these levels for each of these departments was designated as writing intensive and the other as speaking intensive, which meant that writing and speaking modules were integrated into specific courses.

These courses were ones that were currently so positioned within the curriculum that most students were required to take them as this would ensure the exposure of a high number of students in these departments to a writing and speaking intensive course at Levels 2 and 3. In the case of chemistry the courses Chemical Analysis: Laboratory I (Level 2) and Chemical Analysis Laboratory 2 (Level 3) were selected for writing and speaking infusion, respectively. As with the case of MIT Communication Across the Curriculum Program, English language instructors would deliver the communication modules (writing and speaking), and lecturers in the discipline would deliver the content.

This transdisciplinary initiative where staff from the English Language Section partnered with lecturers in the Sciences in the delivery of science courses was viewed as a ground- breaking event for our institution and warranted a structured approach, framed by objectives that would lead to research findings based on outcomes. Two major goals of the speech component of this initiative were to enhance students' motivation and attitude to developing competence in oral skills, as well as to enhance performance in this area.

Results from initial research undertaken on the above areas by Francis and McLaren (2014) were encouraging. The aim of this research had been to ascertain the impact of the intervention on attitude and performance, and findings had indicated a positive and significant change in attitude post intervention ($p<0.05$). Results also indicated a significantly higher level of performance on the part of those who had been exposed to Oral Skills Development (OSD) modules as compared to those who had not.

Focusing the Investigation

The selection of the first goal—that of enhancing attitude and motivation for research purposes—was informed by the awareness that there are implicit factors at work which have an impact on performance and which are also important considerations in the delivery of oral presentation skills. For example, Light (2004) has asserted that students conceptualize their study and learning activities in distinct and different ways, and this has important implications for both teaching and learning. In addition to this, Ho, Watkins, and Kelly (2001) have reported that students' perception of instruction influences teaching strategies, which in turn impacts students' approaches to learning. Also according to Pintrich, Smith, Garcia, and McKeachie (1993), students' views and ideas on learning play a crucial role in performance, and it is essential to take these into account to optimize learning.

Furthermore, Orojlou and Vahedi (2011), who conducted research on the relationship between attitude, motivation, and language learning, found that motivation and attitude play a major role in enhancing proficiency and efficiency of students in language learning. More specifically, in the area of oral communication skills, where much of the research has tended to focus on second language learners, a relationship has been found among attitude, motivation, and learning.

For instance, it has been pointed out by Cohen and Macaro (2007, p. 15) that, "successful and highly motivated learners adopted more strategies, especially those involving planning, evaluation, and monitoring." Poorly motivated students, on the other hand, employed a limited set of strategies and "were less ready to act strategically." In addition to this, a study carried out by Lee (2006) revealed that students displayed higher self-efficacy after being trained in oral communication strategies. And more recently, Toomnan and

Intaraprasert (2015) found that students who displayed a positive attitude to developing competence in oral communication in English also made greater use of taught strategies.

In considering the sciences specifically, Budkaew and Kessomboon (2014) have indicated the importance of a positive attitude to achievement in oral presentation skills. This is evidenced by their finding of a statistically significant correlation between a positive attitude to developing oral presentation skills and performance scores in this area ($p < 0.05$) among sixth year medical students.

Additionally, findings on science students' attitudes generally have been mixed, with little overall improvement in attitude after intervention, in some cases, and increased self-confidence in others. For instance, Mercer-Mapstone and Matthews (2016) reported that although students found both scientific writing and oral communication to be important, the latter was perceived as being less important than the former in terms of perceived improvement, inclusion, confidence, and future use. Similar findings have been reported by Varsavsky, Matthews, and Hodgson (2014), who asserted that students' perceived importance of oral skills was higher at the conclusion of their course, than was their self -reported level of confidence and improvement. In keeping with this trend, Leggett (2004) reported earlier that students perceived their writing skills to be more important than their oral communication skills. On the other hand, Train and Miyamoto (2017) reported a positive increase in students' confidence and perception of their communication abilities both in writing and oral presentations. They further reported that this trend was sustained throughout their senior year.

The purpose of the present research was to verify if the previous positive findings on students' attitude and performance (Francis & McLaren, 2014) would be replicated, in which case a trend concerning the benefits of the OSD initiative would be indicated, which in turn would lead to the commitment of further resources to continue the intervention.

In addition to this, however, further information was being sought on the specific areas of attitude and perception in which changes occurred. These considerations led to the following questions:

1. Is there a significant difference in performance on oral presentations between OSD and non-OSD chemistry students?
2. Is there a significantly more positive attitude on the part of chemistry students pre-and post OSD exposure?
3. If a significant change in attitude and motivation has occurred, in what specific aspects of these variables is this to be found?

Method

The speaking intervention was offered to two groups of chemistry (Chemical Analysis) students over the second semester of the 2016/2017 academic year. The breakdown of the student population was as follows: a group of 34 chemistry students (8 males and 26 females) were sub-divided into three laboratory groups, comprising approximately 11 students each.

The Chemical Analysis course ran for a period of ten weeks. In this ten-week period, the groups were on occasion split into two sub-groups of 16 to 18 each with the same topic being taught for two consecutive weeks. As a result, students got breaks in between OSD sessions and small group sessions. The duration of the OSD intervention for both groups was one hour per week. This hour predominantly entailed the following:

- A review of what was done the week before, which was often done by the students;
- A presentation and discussion of the new topic using examples and illustrations that made reference to one or more area(s) of their studies;
- A speech activity related to the topic at hand in contexts that were relevant to their areas of study; and
- An oral report from the students on what they learnt.

Topics covered included the following:

- Managing anxiety;
- Verbal and non- verbal elements of delivery;
- Analyzing and connecting with the audience;
- Components of a presentation;
- Guidelines for effective presentations;
- Use of visual & audio aids;
- rehearsal of presentations;
- Demonstration of an in-class speaking activity; and
- Impromptu speaking strategies.

The terminal presentations were done by groups, and the rubric was divided into two main sections. The first section focused on the overall design and structure of the presentation, which reflected the group's effort and ability to work as a team. In order to make that determination, four sub-aspects were the points of focus. These included (a) the introduction, (b) the body, (c) the conclusion, and (d) the effective use of supporting material, which also considered creativity. Under the section "body," structure, flow**,** coordination, appropriate use of transitions, and effective use of allotted time were the focal points. The second main

section evaluated the presenters individually. In this section were six sub-sections for consideration: (a) the individual's use of voice, (b) gestures and body movement, (c) eye contact, (d) anxiety management, and (e) use of language. The first section was graded out of 12, and the second out of 18. Together, they totalled 10 sub-sections and a potential earning of 30 marks (see Appendix A).

Many of the students taking Analytical Chemistry also took the course Industrial Chemistry. However, not all Industrial Chemistry students had been exposed to OSD. Therefore, Industrial Chemistry had both OSD and non-OSD students, with the latter group comprising 30 students. The terminal performances of these two sets of students were compared using t-tests in order to determine the response to research Question 1.

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 (see Appendix B) was administered to students prior to the inception of teaching. The questionnaire sought to determine students' perception in a variety of areas which included the importance and usefulness of oral skills (Q.1,2,5 and 8), their autonomy and motivation concerning oral skill development (Q.3, 4,6 and 7), and self-evaluation of their ability and confidence in their oral presentation skills (Q.9 and 10, respectively). Likert scale scores ranged from strongly disagree (1) to strongly agree (5). At the end of the semester, prior to the final exam, the questionnaire was again administered to students. The Cronbach alpha reliability coefficient for the questionnaire was .7085.

The same instrument used for both the pre-test and the post-test aimed at investigating the attitudes of the students toward oral skills development. It consisted of ten (10) questions with demographics requiring student identification number, gender, and age group information. Participants' responses were measured using a Likert Scale and their options were *Strongly Agree*, *Agree*, *Undecided*, *Disagree*, and *Strongly Disagree*. A proposal for the research was submitted to the University's Ethics Committee who approved it.

Results

All of the data collected was coded and entered into the SPSS statistical program. The Likert scale responses were coded from 1 to 5, with 1 being the weakest response degree, (S*trongly Disagree***)** and 5 being the strongest response degree (*Strongly Agree***).** Therefore, in this study the higher figures in result reflect more positive responses.

As previously stated, non-OSD and OSD students' scores on oral presentations were subjected to t-test statistical procedures in order to verify whether there were significant differences in oral presentation skills between those who had been exposed to OSD and those who had not been. As was the case previously, it was found that the OSD Chemistry group displayed a significantly higher level of performance than their non OSD counterparts: OSD group (M=36.91; SD=4.722) and non OSD group (M=35.68; SD=5.042); t (65) =2.405, $p<0.05$).

As previously indicated, Question 2 sought to verify whether there was a significantly more positive attitude on the part of chemistry students post OSD exposure compared to pre-exposure. It was found that students' attitude after intervention was significantly more positive compared to their attitude before intervention: pre-intervention (M 33.29; SD=4.548) and post-intervention ((M=37.64; SD=4.162); t (34) = 2.382, $p<0.01$. Based on the fact that results for Question 2 revealed a significantly more positive attitude to OSD after intervention, Question 3 then sought to verify the specific areas in which significant differences were revealed.

In regard to students' perception of the importance and usefulness of oral skills (Q.1,2,5 and 8), a paired samples t-test revealed a significantly more positive perception post intervention on Questions 1 and 5, with no significant differences being noted for the other questions. In the case of Question 1 ("All students should be exposed to an Oral Skills Development module"), there was a significant and positive difference between the scores for the pre-intervention (M4.10; SD=0.64) and the post-intervention (M=4.60; SD=0.50) [t (34) =2.346; $p<0.05$] responses to the statement.

In the pre-intervention questionnaire the largest percentage of the participants, 71.4%, strongly agreed with the statement. After the intervention, this figure increased to 77.1%**.** The percent of participants who agreed with the statement fell by 5.7% in the post-intervention, from 25.7% to 20%. The percentage Undecided remained unchanged. None of the members of the group disagreed or strongly disagreed. This information is presented in Table 1.

Results for Question 5 ("Good speaking skills are important for all science students"**),** as previously stated, revealed a significantly more positive response

Table 1
All Science Students Should be Exposed to a Speaking Course

	Pre-Intervention	Post Intervention
Undecided	2.9%	2.9%
Agree	25.7%	20.0%
Strongly Agree	71.4%	77.1%

Table 2
Good Speaking Skills are Important for all Science Students

	Pre-Intervention	Post Intervention Scores
Undecided	5.7%	0%
Agree	28.6%	20.7%
Strongly Agree	65.7%	79.3%

Table 3
I Would be Willing to use the Feedback I Receive on my Speech to Improve my Skills in this Area

	Pre-Intervention	Post Intervention Scores
Undecided	10.3%	0%
Agree	30.6%	26.8%
Strongly Agree	50.6%	70.8%
Disagree	8.5%	2.4%

Table 4
In General, I Work on my Presentations so That my Performance Reflects the Best I am Capable of

	Pre-Intervention	Post Intervention Scores
Undecided	5.9%	0%
Agree	26.8%	24.4%
Disagree	12.0%	7.6%
Strongly Agree	55.3%	67.0%

post intervention compared to pre-intervention: (M=3.40; SD=1.139) (M4.10; SD=0.64) and the post-intervention (M=4.11; SD=0.90) [t (34) =1.304; $p<0.05$].

Table 2 reveals a pattern similar to that of Question 2 in that there were no participants who "*disagreed*" or "*strongly disagreed*" with the statement. There was also a decline in the percentage of participants who agreed with the statement, from 28.6% in the pre-intervention to 20.7% in the post intervention, while those participants who strongly agreed with the statement after the intervention increased from 65.7% to 79.3%, "pulling in" those who had previously agreed or were undecided.

Concerning student motivation and autonomy in regard to oral skills development (Q.3, 4,6 and 7), paired samples t-tests revealed a significantly more positive perception post-intervention on Questions 3, 6, and 7.

In the case of Question 3 ("I would be willing to use the feedback I receive on my speech to improve my skills in this area") there was a significant and positive difference between the scores for the pre-intervention (M3.69; SD=0.99) and the post-intervention (M=4.57; SD=0.56) [t (34) =.274; $p<0.05$] responses to the statement.

Table 3 shows participants' willingness to use feedback to improve the skill area. There was a drastic increase (50.6% to 70.8 %) in participants who "*strongly agreed*" with the statement concerning the utility of good speaking skills. Those who were "*undecided*" decreased from 10.3% to 0%, and those who agreed and disagreed also decreased from 30.6% to 26.8% and 8.5% to 2.4%, respectively.

Significant differences were also noted for Questions 6 and 7. In the case of Question 6 ("In general I work on my presentations so that my performance reflects the best I am capable of"), a paired samples t-test yielded the following statistical data: pre (M=4.29; SD=.667), post (M=4.66; SD=.561) and the intervention survey results [t (34) =1.528; $p<0.01$].

Table 4 illustrates the percentage distribution for those who worked to the best of their ability on their presentations. The percentage of those who "*strongly*

agreed" moved from 55.3% to 67.0%, while those who "a*greed"* and "d*isagreed*" fell from 26.8% to 24.4% and 12.0% to 7.6%, respectively. The percentage of those who were "*undecided*" fell to 0% post intervention**.**

Question 7 ("I am willing to undertake whatever work is necessary to improve my oral presentation skills") yielded the following statistical data: pre (M=3.85; SD=0.65) and post (M=4.00; SD=0.66) intervention survey results [t (34) =1.528; p<0.05].

Table 5 illustrates that, unlike previous results which indicated a fall in the percentage of those in the "*Agree*" category**,** the percentage of those agreeing remained the same (28.6%) for Question 7. On the other hand, there was a significant percentage increase from 51.6% to 68.5% for the "*Strongly Agree*" category, as well as a noticeable percentage decrease in the "*Undecided*" category from 18.4% to 2.9%.

Questions 9 and 10, which sought to determine students' level of confidence in their ability to deliver effective oral presentations, yielded significant and positive results post-intervention. In the case of Question 9 ("I have the capacity to deliver effective oral presentations"), responses yielded the following results: pre-intervention (M=3.37; SD=.710) and post intervention (M=3.71; SD=.910); surveys, [t (34) =-2.163; p< 0.05].

Table 6 illustrates results for all five categories of the Likert scale, with a percentage fall in the "*Strongly Disagree***"** category from 2.9% to 0%, and a fall of 12.3% to 8.0% in the "*Disagree*" category. A fall in percentage was also noted for the "*Undecided*" category (26.4% to 10.1%), while a percentage increase was noted for both the "*Agree*" and "*Strongly Agree*" (44.7% to 58.4% and 13.7% to 23.5%) respectively.

For Question 10 ("I am confident in my ability to deliver effective oral presentations") the following results emerged: pre-intervention (M=3.09; SD=.639) and post (M=3.29; SD=.622) (t (34) = -1.961; p<0.05).

Table 7 reveals a percentage fall in the "*Strongly Disagree*" and "*Disagree*" categories from 2.9% to 0% and 8.6% to 5.7% respectively. A percentage decline was also noted for the "*Strongly Agree*" category where there was a slight fall from 68.6% to 65.9%, while conversely, percentage rose in the "*Agree*" category from 20.0% to 28.6%. There was no "*Undecided*" category for this question.

Trends noted for the above findings include the consistent reduction in percentage of the "*Undecided*" responses, in most cases to 0%, in keeping with the equally consistent increase in the percentage "*Agree*" and "*Strongly Agree*" responses. This strongly suggests that those who were undecided concerning the value of oral communication skills, their autonomy and motivation in developing these skills, and their ability and confidence in presentation skills unanimously adopted a more positive stance. This is strongly supported by the repeated reduction in the percentage of "*Disagree*" and "*Strongly Disagree*" responses, when indicated via responses.

Table 5
I am Willing to Undertake Whatever Work is Necessary to Improve my Speaking Skills

	Pre-Intervention	Post Intervention Scores
Undecided	18.4%	2.9%
Agree	28.6%	28.6%
Strongly Agree	51.6%	68.5%

Table 6
I Have the Capacity to Deliver Effective Oral Presentations

	Pre-Intervention	Post Intervention Scores
Strongly Disagree	2.9%	0%
Disagree	12.3%	8.0%
Undecided	26.4%	10.1%
Agree	44.7%	58.4%
Strongly Agree	13.7%	23.5%

Table 7
Which of the Following Best Describes Your Level of Confidence in Your Ability to Deliver Oral Presentations

	Pre-Intervention	Post Intervention Scores
Strongly Disagree	2.9%	0%
Disagree	8.6%	5.7%
Strongly Agree	68.6%	65.9%
Agree	20.0%	28.6%

Discussion

Results from the study are consistent with previous findings (Francis & McLaren, 2014), which had indicated a significantly higher level of attainment on the part of students who had been exposed to the OSD module, as well as a significantly more positive attitude after exposure. This trend has demonstrated the value of this intervention and has gone a far way in persuading our university's administration to commit the necessary resources for continuing this initiative.

A similarity between these and other findings outside of our context is also noted, as is seen in the case of the previously mentioned results of Lee's (2006) investigation which had indicated that students displayed a higher level of self-efficacy after training in oral communication strategies. The findings of Varsavsky, Matthews, and Hodgson (2014), as well as Train and Miyamoto (2017), which were also previously mentioned, are also consistent with those of the current study, as is evidenced in their report on the enhanced perception of the importance of oral skills and self-confidence on the part of students at the conclusion of their course.

What is particularly gratifying, however, is the significant and positive change in student perception in all areas of attitude and perception being measured: the value of oral skills development, motivation to improve performance and autonomy in this area, and increased confidence in oral presentation skills. This clearly signals a global attitudinal change which augurs well for the overall development of other students participating in this intervention.

Conclusion

We believe that the positive outcomes of our intervention are due in great part to the transdisciplinary approach which involved the infusion of OSD instruction into the chemistry course, as opposed to offering this as a "stand -alone" course, as this enabled students to see its relevance to their area of study. For instance, all practice presentations were related to the content of the course, and the final presentation, which was graded, was a course related project undertaken in groups. Students were thus also able to see immediate results related to the effort and work they had put into their presentations.

Further, we believe that transdisciplinary-based interventions of this type should be applied more widely in higher education to enhance the capacities of students and, in so doing, better equip them to function in an increasingly more complex and multidimensional environment, as previously suggested by Gibbons et al. (1994) and more recently by Aneas (2015).

For instance, science education, given its wide application and relevance in the current global environment (e.g., climate change, sustainability, alternative sources of energy, nuclear threat) could very well provide a starting point for the move toward transdisciplinarity with areas in addition to communication being incorporated. Such areas could include critical thinking, ethics/philosophy, history, etc. This is consistent with the previously mentioned position of experts involved in a wide range of disciplines (Althous, 2005; Belsky, 2002; Carolan, 2004; Fry, 2001; Gough, 2002; Klein, 2004; Landers, 2009) who call for cross-disciplinary approaches to teaching, learning, and research in order to tackle and address issues relating to sustainability.

We also believe that attempts should be made to verify if results similar to those from this study would be obtained for students in other transdisciplinary initiatives, such as the social sciences, involved in a similar OSD. Additionally, a qualitative component could be introduced in further research whereby students are interviewed after the emergence of findings in order to gain further insight and to explain why a positive change in attitude or performance in specific areas occurred or did not occur.

This study has also offered evidence in support of the positive outcomes and benefits to be gained by providing oral skills development sessions to a particular group of students. Although science students were the focus of the study, it is believed that a similar intervention for students from other disciplines would yield the same results.

Finally, it is important to note that the significantly positive results have also provided renewed impetus for members of our university's administration to continue providing the necessary resources for the exposure of chemistry and life sciences students to this intervention. Further, it has laid the foundation for making a case for affording other science students in sub-disciplines such as physics, mathematics, and engineering—as well as, by extension, students from other disciplines—the same opportunity to enhance their oral presentation skills.

In fact, given the essential role of oral presentations skills in students' academic and professional performance and development, academic institutions must ensure that all students are exposed to this area of learning.

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Acknowledgements

I would like to acknowledge the support of my Research Assistant, Elaine Fenelus, who assisted in researching and documenting the information relevant to this study.

Appendix A
Oral Evaluation Rubric

ORAL PRESENTATION COMPETENCY INSTRUMENT
Student's Name _____ Evaluator's Name _____
Circle one of the numbers after each question based on your analysis of the task: (3) agree, (2) average or (1) disagree

	GROUP	
I. INTRO.	**The Structure of the Introduction is effective** - use of attention getter - clear purpose - preview of main points - motivation	**3 2 1**
II. BODY	**Pattern of Organization is clear and appropriate** --structure, flow --coordination -- appropriate use of transitions to develop points --effective use of allotted time	**3 2 1**
III	**Effective Use of Supporting Material** --visuals -- other creative means	**3 2 1**
IV CONCLUSION	**The Structure of the Conclusion is effective** --transition signal --review of main points ---strong closing	**3 2 1**
	INDIVIDUAL	
	1.Appropriate use of voice re: -pace/speed -volume/projection --no distracting vocal mannerisms	**3 2 1**
	2. Use of appropriate gestures and body movement -smooth, controlled, natural - no distracting physical mannerisms	**3 2 1**
	3. Effective diction -clear and distinct enunciation -correct pronunciation	**3 2 1**
	4. Maintains eye contact	**3 2 1**
	5. Manages anxiety	**3 2 1**
	6. Language Use -appropriate level of formality - reflects awareness of audience - clarity, conciseness/correctness	**3 2 1**

Appendix B

Speaking Across the Curriculum Survey

ID: ……. Gender: Male Female

Age: Under 18; 18-20; 21-24; 25 and over

SECTION A

The following cover a possible range of approaches to writing at university. Please indicate your response to each statement by CIRCLING the rating that best describes your approach.

SA = Strongly Agree; A= Agree; U=Undecided; D= Disagree; SD=Strongly Disagree. Please respond to ALL statements.

All science students should be exposed to an oral development course	**SA**	**A**	**U**	**D**	**SD**
Good presentation skills will enhance my performance in my future career	**SA**	**A**	**U**	**D**	**SD**
I am willing to use feedback I receive on my presentations to improve my skills in this area	**SA**	**A**	**U**	**D**	**SD**
I am willing to spend extra time practicing to ensure effective delivery of my presentation	**SA**	**A**	**U**	**D**	**SD**
5.Effective presentation skills are important for all science students.	**SA**	**A**	**U**	**D**	**SD**
6. In general, I work on my presentations so that my performance reflects the best that I am capable of.	**SA**	**A**	**U**	**D**	**SD**
I am willing to undertake whatever additional work is necessary to improve my oral presentation skills.	**SA**	**A**	**U**	**D**	**SD**
Learning to speak well will enhance my personal development.	**SA**	**A**	**U**	**D**	**SD**
I have the capacity to deliver effective oral presentations.	SA	A	**U**	**D**	**SD**
I am confident in my ability to deliver effective oral presentations.	SA	A	**U**	**D**	**SD**

SECTION B

The following statements seek to determine your prior experiences with writing as well as your perception of your writing ability. Please indicate your response to each statement by circling the rating or descriptor which relates most closely to your perception or experience.

11. Which of the following best describes your level of confidence When writing assignments for your courses?

Very High High Medium Low Very Low

12. Which of the following best describes your writing skills?

Excellent Good Satisfactory Fair Poor

END OF QUESTIONNAIRE

THANK YOU