Writing Science: Integrated content and language learning in practice

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Agenda

1. Context

2. Interdisciplinary cooperation
   • Challenges and solutions

3. Language support activities

4. Assessment and corrective feedback: lab reports

5. Evaluation of outcomes
   • Quantitative analysis of error reduction
   • Survey data

6. Future directions

What we do; how and why we do it

Was it successful and would we do it again the same way?
1. Context

• Vantage One
  • Pathway program to support transition from high school to year 2 university
  • Four streams: Arts, Management, Science, Applied Science

• Academic English Program
  ➢ Foundational academic English courses: trans-disciplinary texts
  ➢ English for specific academic purposes: discipline-specific texts
    • Systemic Functional Linguistics
    • Content & language integrated learning (CLIL)
      • Language as both a medium and an objective of learning

➢ Interdisciplinary cooperation
  • Sustained language support for linked content courses: needs-based curricula
    = VANT 140 + APSC 182/3
2. APSC 182/3: Matter & Energy I/II

• First year physical chemistry courses for engineers, introducing properties of matter, thermodynamics, and chemical reactions
  • Calculation-based and conceptual assignments, midterm, and final exam

• Lab experiments
  • In each term, students complete 5 lab experiments, and write reports

• For many engineering students, writing isn’t science or math, and therefore not necessary to their training

• Poor communication skills is the most common complaint from industrial employers regarding engineering graduates
2. Interdisciplinary cooperation: challenges and solutions

- Unfamiliar disciplinary discourses
- Working relationship
  - Time and space for cooperation
- Signalling *integration* of physical chemistry course and language support to students

- Solutions:
  - Class and lecture presence: content course participant
  - Share text from content course - lecture notes, textbooks etc. - for analysis
  - Register analysis of key text: lab reports
Register analysis of key text: lab reports
Perform lab experiment

Practical demonstrations
3. Language support activities

• Lab report: genre and register analysis
• Genre = ‘staged, goal-oriented social process’ (Martin, 1992)
• Genre realized through register choices:
  • Participants (nouns), processes (verbs), and circumstances (prepositional phrases)
  • Interpersonal positioning (modality and evaluation)
  • Organization and cohesion
• Class activities to support assessment of lab reports
  • Reading and language analysis of report samples
  • Identify potential errors in reports
  • Error correction practice: synthetic -> authentic
3. Lab report: genre & register features

<table>
<thead>
<tr>
<th>Title page</th>
<th>Abstract</th>
<th>Materials &amp; Methods</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>• Descriptive recount = past tense</td>
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<td>• <em>Participants</em> = lab equipment, product(s) of experiment (complex noun groups)</td>
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<td>• <em>Material processes</em>: action verbs; passive voice</td>
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<td>• General-specific organization</td>
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<table>
<thead>
<tr>
<th>Results &amp; Discussion</th>
<th>Conclusion</th>
<th>References</th>
<th>Appendices</th>
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<tr>
<td>Results &amp; Discussion</td>
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<td>• Results (figure) presented as data commentary – descriptive -&gt; explanatory organisation</td>
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<tr>
<td>• Explain results and account for error = language features associated with <em>factorial</em> explanation (verbs, nouns)</td>
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<td>• Carefully hedge claims about accuracy and sources of error (modal verbs, adverbs, adjectives)</td>
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</table>
3. Participants and processes in Materials & Methods section – classroom activity

The equipment and procedure used in the experiment closely follow those described in the Airflow Lab handout [1]. To summarize, the experiment was performed in a 7.62 cm diameter vertical pipe. On one end of the pipe there was a blower and a dampener, which allowed for the air flow rate to be varied. At the other end of the pipe, air was discharged into the laboratory. Inside the pipe was an orifice meter and a Pitot tube, which could be moved along the pipe’s diameter to determine the local velocities by measuring the difference between the stagnation and bulk pressure across the Pitot tube.
“Various sources of error were discovered after the experiment that *most likely contributed* to the 5% differences between the experimental activation energy and theoretical activation energy. The *most significant error* is the leakage of gas. When the KI solution was added, the flask containing the H2O solution was immersed in the water. *This meant that* there *might* be a small amount of O2 produced, but when the KI solution was added, the stopper was removed and the produced O2 escaped from the flask. *This will also reduce* the measured pressure and *result* in a lower rate constant and activation energy. Another *possible* error is ...”
Learning to control ‘a judicious balance of tentativeness and assertion, and the expression of a suitable relationship to one’s data, arguments and audience’ (Hyland, 2013)
4. Assessment practices: lab reports

• Double submission
  • Graded separately for APSC 182/3 and VANT 140
• APSC 182/183 focuses on technical merit, with a very low grading weight attached to communication skills
• VANT 140 = Graded for language
• Revision and resubmission required (for VANT 140 only)
• TA support
• Corrective feedback ...
• Was this successful?
4. Lab Report grade improvement

Lab report average grades

First draft
Revision
4. Corrective feedback

• Annotation with error codes
  • 2-3 letter abbreviations; error is highlighted

• Indirect corrective feedback
  • Alerts student to location and type of error only; no suggestions for correction

• Why use a coding system?
  • ca. 42 lab reports $\times 11 = 462$ texts to grade and give feedback
  • Relatively easy for TA to use
4. Indirect corrective feedback

- Indirect corrective feedback may be more cognitively engaging, fosters greater reflection on the learning process, and promotes problem-solving skills (Ferris, 2011)

- From a sociocultural perspective:
  ‘development can be seen as a function of the frequency and quality of the assistance required and the learner’s responsiveness to the assistance given ... greater ability to self-correct, and to even question or reject the feedback given by others implies a gradual movement from other-regulation to self-regulation’ (Bitchener & Storch, 2016)
4. Lab Report grade improvement

Lab report average grades

- First draft
- Revision
4. Indirect corrective feedback: error coding system

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**1. ORGANIZATION**
- TS / SS / CS – topic sentence / supporting sentences / closing sentence
- Th/N – Theme/New patterning
- T – transition
- CON – conjunction

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**2. CONTENT**

<table>
<thead>
<tr>
<th>VOCABULARY</th>
<th>VERB USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>WW – wrong word</td>
<td>VF – verb for</td>
</tr>
<tr>
<td>WM – word missing</td>
<td>VT – verb to</td>
</tr>
<tr>
<td>WF – word form</td>
<td>AP – active</td>
</tr>
<tr>
<td>ACC – low accuracy</td>
<td>voice</td>
</tr>
</tbody>
</table>

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Both showed 54 mL. By density of 4800 kg/m\(^3\) and
As a result, the first metal is
m\(^3\) which is close to a Magnesium, and this is
the metals’ density is not
use that the metals are alloys Magnesium but also contain
5. Evaluation of outcomes

• Quantitative error data
  • Choice of errors for analysis
    • Verb tense; verb form; active/ passive voice; self-mention; articles
  • Limitations of data
    • Six students chosen at random; errors counted across all six first drafts
    • Collaborative writing: pairs or threes

• Qualitative survey responses
  • 70 respondents out of 89 students in cohort
  • End of Term 1
  • Anonymous, online
5. Error reduction

Verb form, verb tense, active/passive voice

Total Errors

Lab 1 Lab 2 Lab 3 Lab 4 Lab 5 Lab 6

VT AP VF
5. Error reduction

Strength of claim, self-mention

Total Errors

Lab 1  Lab 2  Lab 3  Lab 4  Lab 5  Lab 6

SF  CL

22
5. Error reduction

[Chart showing the total errors for Lab 1 to Lab 6 with ART as a label]
<table>
<thead>
<tr>
<th>Original text</th>
<th>Error codes</th>
<th>Register problem</th>
<th>Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the first part, our objective is to measure the linear expansion coefficient of copper, brass and aluminum.</td>
<td>SF, VT</td>
<td><em>Agency (‘our’) is less important than ‘objective’; reduces objectivity.</em> <em>Inappropriate tense for positioning this stage as recount.</em></td>
<td>In the first part, the objective was to measure the linear expansion coefficient of copper, brass and aluminum.</td>
</tr>
<tr>
<td>The final thermistor temperatures of the three materials all surpass 100 Celsius. This is probably because we made a mistake when calibrating the thermistor. We should wait until the signal stabilized and click “set”.</td>
<td>VT, SF, AP, SF, VF</td>
<td><em>Inappropriate tense.</em> <em>Active voice disrupts information flow; subject of the clause is not the agent.</em> <em>Final clause: suggests that these writers will do this experiment again, rather than framing this as timeless procedure.</em></td>
<td>The final thermistor temperatures of the three materials all surpassed 100 Celsius. This is probably because a mistake was made when calibrating the thermistor. Waiting until the signal stabilized and click “set” is necessary.</td>
</tr>
<tr>
<td>In general, experiment is reasonable, but some other factor affected the accuracy.</td>
<td>ART, CL, PL</td>
<td><em>Lack of second-mention definite article disrupts cohesion; claim is too strong.</em> <em>Singular is inaccurate.</em></td>
<td>In general, the experiment is mostly reasonable, but some other factors affected the accuracy.</td>
</tr>
<tr>
<td>To calculate the coefficient of linear expansion, we measured the change angular displacement of copper, brass and aluminum using Rotary Motion Sensor.</td>
<td>SF, AP, PREP, ART</td>
<td><em>Active voice disrupts information flow; subject of the clause is not the agent.</em> <em>Lack of preposition affects accuracy</em></td>
<td>To calculate the coefficient of linear expansion, the change in angular displacement of copper, brass and aluminum was measured by using a Rotary Motion Sensor.</td>
</tr>
</tbody>
</table>
Developing English-language communication abilities (written and oral) is important for engineers

5. Survey responses
5. Survey responses

Provides valuable feedback on different features of my academic writing

- 1 - Strongly Disagree: 3%
- 2 - Disagree: 6%
- 3 - Neutral: 13%
- 4 - Agree: 47%
- 5 - Strongly Agree: 31%

Revising a lab report based on instructor feedback helps to improve my writing

- 1 - Strongly Disagree: 0%
- 2 - Disagree: 7%
- 3 - Neutral: 14%
- 4 - Agree: 36%
- 5 - Strongly Agree: 43%
5. Survey responses

[The error code and revision process] helps me improve my ...
5. Survey responses

Helps me better understand the technical content of labs in APSC 182

- **1. Strongly Disagree**: 6%
- **2. Disagree**: 9%
- **3. Neutral**: 30%
- **4. Agree**: 34%
- **5. Strongly Agree**: 21%
5. Survey responses

VANT 140 is useful

- Strongly Disagree: 4%
- Disagree: 6%
- Neutral: 11%
- Agree: 37%
- Strongly Agree: 42%

VANT 140 is interesting

- Strongly Disagree: 11%
- Disagree: 13%
- Neutral: 37%
- Agree: 23%
- Strongly Agree: 16%
5. Survey responses

Which VANT 140 activities did you find most useful?

- Practice in correcting errors in lab reports
- Learning about lab report structure
- Language instruction; for example, articles, interpersonal positioning, theme/new, etc.
- Close reading of sample lab reports
- Learning about how to present and discuss figures
- Asking the instructor for help with revising lab reports
- Learning about how to write an abstract

Frequency

0 10 20 30 40 50 60
5. ‘If you think VANT 140 is useful, why is it useful?’

1. The language and structure correction is essential for improvement.
2. It is useful because it helps me revise a lot of mistakes while writing lab reports.
3. I appreciate annotations on lab reports and highly value them. However, it would be so much more helpful if we could have sample lab reports to read as a standard.
4. Because the knowledge would be very useful when write not only lab report but also other kinds of reports.
5. [T]he instructor is like a smiling tiger, who usually smiles at you and say "good job" but gives very low mark.
6. Future directions

• Continue analysis of error frequency
  • Use to inform revisions to curriculum e.g. persistent verb form and article errors may need expanded class time

• Automate process of error counting and tracking
  • Valuable feedback on progress for both instructors and students

• Investigate significant minority who see no value in language support

• Make VANT 140 more ‘interesting’
References


Thank you

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Slides will be available on bcteal2018.sched.com