Form and Content in a Science Writing Curriculum

Tom GALLY

The separation of form from content—that is, the abstraction of consistent patterns, rules, and principles from a seeming diversity of empirical entities—is a fundamental component of human mental activity and essential to intellectual and social progress. Whether they are mathematical patterns observed in physical phenomena, principles of social organization derived through experience with cooperation and conflict, or grammatical rules inferred from a corpus of texts, abstract forms that have been distilled and separated from concrete realities enable those realities to be better understood, manipulated, and predicted. But this process of abstraction, however necessary it may be to mental comprehension and practical applications, often comes with a cost: the neglect of individual variations which, in their diversity or complexity, interfere with the formation of generalizations but which nevertheless are real and often turn out to be significant in ways not immediately apparent. This paper, after discussing briefly a few instances of this conflict between form and content in other realms, focuses on an area of particular interest to readers of this journal—the teaching of academic writing in English to speakers of other languages—and presents an example of an academic writing curriculum for which it has been possible for content to be effectively integrated with form.

Form and Content in Mathematics, Politics, and Language

From the early observation that the eyes in a person's head, the wings on a bird, and a pair of stones on the ground all shared a similar property—the property of being two in number—and that this property was similar to properties of other groups of things—the quantities three, four, five, etc.—and that these properties themselves could be understood and manipulated independently of those eyes, wings, or stones, the science of arithmetic was born. As this abstract notion of number was observed to have properties similar to other abstract notions, such as shape and order, higher and higher levels of abstraction arose and further fields of study such as algebra, real analysis, and computational theory emerged, forming eventually today's grand edifice of mathematics. So vast are both the practical and the aesthetic benefits of mathematics that it may be difficult to imagine what the negative aspects of this multiple abstraction might be, but a cost does exist in the context of education. Although most children are able to learn numbers and counting at an early age and soon become able to think of a concept like "seven" without imagining "seven apples" or "seven people," as they progress through their mathematical education, with arithmetic being abstracted into algebra and shapes into geometry, many, eventually most, children and teenagers lose interest in mathematics. Part of the reason for this loss of interest is, of course, higher mathematics' inherent complexity and difficulty, but an equally large factor, as least to judge from the comments of people who say they do not like mathematics, is the widening separation, as one advances through the curriculum, between the abstract forms of mathematics and the tangible content of everyday experience. Mathematics educators are aware of this problem, of course, and have devised many ingenious pedagogical methods for guiding and motivating students, such as by having young children use blocks and counters to learn the concepts of number, addition, and subtraction or having older learners use algebra to solve real-world problems. Nevertheless, as the gulf between the abstract concepts and the concrete reality widens and there no longer seems to be an observable entity that intuitively corresponds to a concept such as a complex function or an infinite-dimensional vector space, such teaching techniques become increasingly difficult to devise. For people whose lives are rooted in the messily tactile and visible, invisible mathematical concepts, despite—or because of—their pristine clarity, become impossible to grasp.

In the realm of politics and social organization, the cost of abstraction can be even higher. The principles and practices of democratic government, for example, depend on the superordination of abstract principles to the specific personalities, needs, and desires of individual human beings—thus John Adams' description of a republic as "a government of laws, and not of men" (1775/1819, p. 84). While democracy arose out of the greater failings of other forms of government, particularly those of feudalism and inherited monarchy, in which the whims and desires of individual lords and monarchs took priority over abstract notions such as private property or legal procedure, democratic government bears a converse cost, in which the needs and wants of the individual human being are subsumed to abstract laws and procedures. Much effort has been made to bridge this conflict between the flesh-and-blood individual and the ideals of democracy and the rule of law, such as through restrictions on the government's ability to imprison individuals or to seize private property, but no observer of today's democratic governments would say that those conflicts have been completely resolved. The shift to higher levels of abstraction, however well-intentioned, inevitably leads to inadequate consideration of the concrete.

The same applies to the study of language, in which the distinct utterances of many individual speakers over time are classified into neat, abstract entities such as phonemes, words, and grammatical structures. It is indeed the use of such concepts that makes it possible to discuss, teach, and learn languages efficiently. However, as this writer has argued elsewhere, that process inevitably obscures the actual variation in language production: what is regarded as a single sound is in fact, in articulation and acoustics, different each time it is uttered (Gally, 2010a, pp. 12–14), and the "same" word can have a different meaning every time it is used (Gally, 2010b, pp. 88–95). It would be impossible in practice to discuss language without abstracting a layer of conceptual structure to transcend the multitude of individual variations, but that process of abstraction also obscures the organic, idiosyncratic way in which human beings actually use language.

The Slant Toward Form in the Teaching of Academic Writing

The impetus for the above discursion on the problems posed by formalist approaches was a re-examination of several textbooks on English academic writing for speakers of other languages. One of those texts was the widely used *Academic Writing for Graduate Students: Essential Tasks and Skills* by John M. Swales and Christine B. Feak of the University of Michigan (2nd edition, 2004), a well-organized book that contains much useful information about how to write academic papers and theses in English. Its first unit, "An Approach to Academic Writing," begins with a clear exposition with useful examples of some considerations that should go into any academic writing project: "audience, purpose, organization, style, flow, and presentation" (p. 7). Later units cover matters such as the organization of different types of texts, including those that proceed from general topics to specific examples or those that describe problems and solutions, and the writing of summaries or critiques. Scattered throughout the book are many lessons on language use, including how to write definitions of various types, where to put adverbs in sentences, and what expressions to use to strengthen or weaken a claim. With varying degrees of emphasis, other academic writing textbooks (such as Oshima & Hogue, 1999; Rossiter & Department of English, 2004; Kluge & Taylor, 2007; Gally, 2008; Cargill & O'Conner, 2009; Tajino, Stewart, & Dalksy, 2010) focus on similar matters—in other words, on matters of form. If content—that is, the actual information, arguments, and conclusions contained in an academic paper—is discussed, it is only in passing, such as in sample texts or in Swales and Feak's very brief discussion of "creating a research space" (pp. 243–244). As so many textbooks give much greater emphasis to form over content, it seems likely that most academic writing classes in universities have a similar emphasis.

There are practical reasons for this content-independent approach. One is that it is much easier to teach and learn a few general principles, such as types of paragraph structures or useful words for indicating transitions, if they have been abstracted and separated from the vast multitude of possible content. This principle, of course, applies similarly to other types of abstraction for pedagogical purposes as well. But academic writing possesses another characteristic that drives the separation of form from content even more strongly: the high degree of specialization in academic fields and the difficulty textbook readers or writing-class students would have trying to read and discuss genuine academic research in a variety of fields. Swales and Feak state in passing (p. 4) that while "it is often believed that disciplinary courses are 'better' or 'more efficient,' " they prefer classes in which students come from a variety of disciplines. One reason they cite is the camaraderie that develops among students from different departments at a university, students who would normally have little opportunity to meet and interact. More significantly, for the purposes of this study, they argue that a multidisciplinary class is superior because it "turns attention away from whether the information or content in a text is 'correct' toward questions of rhetoric and language" (p. 4). Ignoring for the moment the revealing scare quotes around the word "correct," one wonders in which disciplines and at what institutions it would be possible to assemble enough graduate students who understand the content of each other's research papers well enough to evaluate the correctness of their content. Even in a relatively well-defined field such as economics or chemistry, researchers working at the cutting edge are rarely able to fully understand, let alone assess the validity of, other papers in their field unless their subspecializations match nearly precisely. Swales and Feak's arguments for the superiority of their multidisciplinary approach to academic writing seem less convincing than the practical barriers to a monodisciplinary approach.

But whatever the reason for separation of form from content in the teaching of academic writing, this separation has serious implications. The most important is that the primary purpose of academic research is to acquire or develop new knowledge about specific real or mental entities, whether the process of a chemical reaction, the cognitive behavior of human infants, or the implications of an economic theory. Researchers write about their research in order to convey that knowledge to others and to convince their readers of its importance and—despite Swales and Feak's apparent disdain—of its correctness. While the tools offered by academic writing textbooks—information about how to organize a paper into sections, how to structure paragraphs, or how to indicate transitions between sentences—are useful to those ends, scholars do not write papers in order demonstrate their ability to compose topic sentences, write discussion sections, or select sentential adverbs, and they do not read others' research writing in order to enjoy those papers' organization or sentence structure. It is the content of the research, and that content's validity, that drives both scholarship and writing about scholarship, and teaching of academic writing that downplays content inevitably runs the risk of emphasizing the peripheral at the expense of the central.[1]

This issue is particularly crucial for students early in their academic careers. While doctoral students, for example, have been immersed for some years in the methodologies and argumentation of their specializations and thus should be learning to evaluate for themselves whether the content of their writing is correct within the framework of those fields, students at an earlier stage of academic study, such as those targeted by Rossiter & Department of English (2004) and Gally (2008), have only just begun to be exposed to academic modes of information collection, analysis, and argumentation. A typical first-year undergraduate generally has not yet learned how to evaluate the validity of data or reasoning in any particular academic field. While textbooks and teachers can give general advice in such regard, it must often be limited to common sense, which is insufficient for most fields, or to arguments for authority, such as Tajino, Stewart, & Dalksy's blanket prohibition on the use of Wikipedia as a source (2010, p. 96). The modes of argumentation that are regarded as valid in specific academic fields are particularly resistant to treatment in mixed-major writing classes, as writing teachers are unlikely to be familiar enough with argumentation techniques in any fields outside their own to offer useful guidance to their students. But it is primarily in its argumentation where academic research succeeds or fails, and the reduction of argumentation in academic writing classes to superficial elements such as paragraph structure or transition words leaves students with a dangerously incomplete introduction to what scholars are actually trying to do when they write academic texts.

Form and Content in the ALESS Program

When the Active Learning of English for Science Students (ALESS) classes began in the College of Arts and Sciences at the University of Tokyo in April 2008, the initial curriculum, which had been prepared by Paul Rossiter and this writer, was largely based on form.[2] The first-year undergraduates were guided through a discovery of the basic components of scientific papers, particularly the papers' Introduction, Methods, Results, and Discussion (IMRaD) structure, and they worked through exercises on language-focused topics such as types of paragraphs (enumerative, sequential, and contrastive), topic sentences, information flow in sentences, and the use of pronouns in scientific writing. The writing process was also emphasized, particularly rewriting and peer review, and some attention was paid to rhetoric in a unit on hedging and boosting (that is, expressions indicating various degrees of strength in the assertions made by the writer). Even when the actual content and arguments of scientific papers were considered, such as in the reading of short research papers taken from the journal *Nature,* the focus was not on the scientific validity and implications of the papers' assertions but on the structure of their texts.

For example, in the sixth week of the course, students were shown the following paragraph, which was adapted from the introductory paragraph (which also served as the abstract) of a research paper from *Nature* titled "Avoidance of disease by social lobsters" (Behringer, Butler, & Shields, 2006):

> Transmissible pathogens are a serious problem for social animals, so they have evolved behaviors to decrease the probability of infection. There is no record, however, of social animals avoiding diseased individuals of their own species in the wild. Here we show how healthy, normally gregarious Caribbean spiny lobsters (*Panulirus argus*) avoid conspecifics that are infected with a lethal virus. Early detection and avoidance of infected, though not yet infectious, individuals by healthy lobsters confers a selective advantage and highlights the importance of host behaviour in disease transmission among natural populations.[3]

After reading the paragraph, the students were asked to identify the function of each sentence, choosing from among the following:

a) An explanation of the significance of the results of the research.

b) A claim about what is missing from previous research on this topic.
c) A summary of the results of the research done by the authors.
d) A description of the issue which is the general topic of the research.

This question, while requiring an understanding of the paragraph's content, focuses not on the content itself but on the paragraph's structure, that is, the order of sentences within that paragraph.

The next question in that exercise, however, did delve somewhat more into the content:

> Now that you have read the introduction, think about what extra background information you might need before you read about the methods and results of the actual research. Choose among the following (and you can add something extra on the last line if you like).
>
> a) A definition of the term "social animal".
> b) More information about the part of the ocean where the spiny lobsters live.
> c) What kind of virus affected the lobsters in the study.
> d) How the virus is transmitted.
> e) More information about the social habits of spiny lobsters.
> f) Previous knowledge about healthy lobsters perhaps avoiding infected lobsters.
> g) ______________________________(*something else*)

The purpose of this exercise was to raise the students' awareness of the kinds of background information that must be provided to readers in order to make the arguments of scientific papers comprehensible, thus making the students better able to write the introduction sections of their own papers. The homework assignment that week was as follows:

> Think about the topic of your research, the method you will use to investigate your topic, and your expectations about what the results will be, and ask yourself: What background

> information would it be helpful for my reader to have before I start describing my methods and results? Then write one paragraph (or two, if absolutely necessary) clearly explaining this background information and describing the problem.

Thus the original curriculum for the ALESS classes, as introduced in April 2008, did not ignore the content of scientific communication, but, in keeping with the tradition of second-language academic writing pedagogy, its overall emphasis was on form. The key exception to this formalist slant was the element of the curriculum that was perhaps the most original but also the most controversial: the original scientific experiments that the students devised, conducted, and wrote up as IMRaD papers.

Student Experiments

An original experiment was made the centerpiece of the ALESS curriculum for practical reasons. Even in an academic writing course emphasizing form, students need to write about *something*. In the humanities or social sciences it is possible for students to write academic papers based on library or Internet research, but scientific papers are generally about phenomena observed in or inferred from the physical world, often through the use of highly specialized equipment and methodologies. As first-year undergraduates, however, ALESS students are still acquiring basic knowledge about scientific and mathematical principles; few are conducting experiments, devising conceptual models, or doing other research that can be reasonably written up in IMRaD form. To provide realistic content for their class papers, therefore, it was decided to ask the students to design and implement simple scientific experiments using readily-available materials.[4] During the first few weeks of the semester, while also examining scientific papers in English for the first time, the students would think of topics for experiments they would like to conduct. They would then present proposals for their experiments to their teachers and fellow students in writing or orally (or both), and the practicality and scientific validity of those proposals would be discussed.

To help students learn how to evaluate the possible experiments, they might be asked, for example, to read the following three proposals and respond to the questions below.

Proposal 1
Because of the increased burning of high-sulfur coal in China, the acidity of rainwater falling in Japan is said to have increased. In this study, I will measure the acidity of rainwater in Tokyo over a three-week period and compare the results with the direction of prevailing winds over Japan during the same period. The comparison will show whether or not rainfall acidity in Japan is affected by coal-burning power plants in China.

Proposal 2
In Japan, a person's ABO blood type is popularly believed to correlate to the individual's personality, but few systematic studies have been done. For this project, I will survey 200 male university science majors aged 18 to 20 using a standard psychological test to look for correlations between their personalities and blood types. Because the test group will be fairly homogenous, any correlation found will be more significant than in studies of random populations.

Proposal 3
The Yamanote commuter train line in Tokyo, Japan, forms a two-way loop, so it is possible to reach any station from any other station by boarding a train going in either direction. In this study, I will board the train at each station and measure the amount of time it takes to reach each other station going in either direction. The results will show which train should be boarded at any particular Yamanote Line station in order to reach any other particular station in the shortest time.

1. Evaluate each proposal according to the following criteria:
    - How interesting is the topic scientifically?
    - Is it a scientifically logical experiment?
    - How valid are the study's results likely to be? (Note that negative results, such as the lack of a correlation, are also valid.)
    - Can the project be completed within the amount of time

available?
2. If you find problems with the proposals, discuss how the proposal can be revised. How can the problems be reduced or eliminated?

After the students discuss these questions among themselves and as a class, they review each other's proposals. As a result of this peer review, as well as feedback from their teachers and further consideration on their own, the students revise their experimental plans and then proceed to conduct their experiments. In the following weeks, they write the paper itself, usually beginning with the introduction section about the background of the experiment, with citations to related literature, and then moving on to the description of the experimental methods and results and then a concluding discussion. The students usually compose an abstract for their papers and also include figures, tables, and other illustrative material. Finally, at the end of the semester, the students give five-minute oral presentations to their classes in English about their experiments and results.

While sometimes the experimental topics chosen by students can be rather specialized and require technical vocabulary to explain, most are readily understandable to the other first-year students in the classes as well as to the teachers (many of whom do not have formal scientific backgrounds). As a result, both other students, during in-class peer review, and the teachers are able to consider not only the papers' formal characteristics, such as grammar, rhetoric, and organization, but also their content, including, most importantly, the descriptions of experimental methods and results and the arguments used to support the authors' scientific claims. The opportunity to write papers and give presentations about experiments that they have conducted themselves and to discuss the content of their experiments with their peers and teachers also motivates students and makes the classroom environment more lively.

Internal Controversy

When ALESS began in 2008, however, the experiment was something of an accidental addendum to the form-based curriculum, almost a gimmick used to obtain the minimal content needed to write an IMRaD paper. Little attention was given to scientific argumentation, and the guidance provided to the students as to the scientific interest or validity of their proposed experiments was limited to questions of the sort given above and to any supplemental explanations and examples offered by the individual teachers in class. After the end of that semester, however, when all of the students' final papers had been received and compiled, some of the teachers expressed dissatisfaction with the quality of the science described in the papers. The two most serious objections were that some papers did not seem to tackle problems that had any connection to actual scientific issues and that some papers did not use valid scientific argumentation.

Beginning in the second semester, many teachers therefore began placing greater emphasis on reading previous research and devising experiments that would extend that research in accordance with scientific methods. For example, one worksheet prepared by an ALESS teacher as homework asked the students to find papers by specific authors or with specific topics in the Web of Science online database; later, students would use the skills acquired through that exercise to find other scientific papers on which to base their own experiments. Another worksheet, used in-class, guided students through the various goals of scientific research projects, such as identifying causes of phenomena, generalizing previous results to other materials or phenomena, finding applications for existing knowledge, and identifying flaws in previous research. As the semesters went by and the teachers learned more about what types of student experiments tended to be most interesting, fruitful, and doable under the course's severe time and resource limitations, they also compiled more and better examples of previous research projects that could serve as inspiration to ALESS students, both from the regular scientific literature and from previous student projects in ALESS and elsewhere.

The issue of scientific argumentation was tackled by introducing students to the concepts of independent, dependent, controlled, and uncontrolled variables in scientific experiments. The in-class peer review of research topics was thus enhanced to cover the questions such as the following (taken from a worksheet prepared by teachers after the first semester):

Explain to your partner your research question and the method that you are thinking of using to answer the question. Ask your partner for suggestions and criticisms of your research project.

A few questions to get you started:

What are the independent variables, the dependent variables, the controlled variables, and the uncontrolled variables in this research?

Will the dependent variable be measurable? Will it be possible to collect enough data?

Is the experiment realistic? Is it possible to conduct in three weeks or so?

What is known (the background theory) and what is not known (the answer your research question is aimed at)?

The most productive questions in this exercise—that is, the questions that contributed most to improvement in the content of the students' experiments and papers—were the ones about variables and about the relation between the known and unknown. Unlike in the first semester, when the questions focused only on vaguer issues of "interest" and "logic," the attention now paid to the types of variables in an empirical experiment and the role of the experiment in extending current knowledge has contributed greatly to an improvement in the content of the students' papers. By 2010, the third year of the ALESS program, the faculty now felt confident enough in the quality of the ALESS research papers to compile and publish the first issue of a journal of 20 student papers. The titles and abstracts of some of these papers—with the students' English mostly unedited—appear in the Figure.

Issues with the ALESS Approach

The incorporation of the design and implementation of an original experiment in the curriculum for an introductory class in scientific writing and presentation was not devoid of problems or controversy. One issue, as mentioned previously, was the lack of laboratory space and experimental equipment, thus limiting students to relatively simple experiments that could be conducted at home or on campus using readily obtainable materials. Being simple to conduct does not necessarily mean that an experiment is easy to devise, and many students in the first semesters found the process of designing a new experiment from scratch to be the most difficult part of the course. As mentioned above, the ALESS faculty have responded to these issues not only by obtaining measuring equipment and other devices suitable for simple scientific experiments but also by presenting to students more systematically examples of interesting experiments that can be conducted without elaborate apparatus. The issue of the scientific interest and validity of some of the students' experiments was also tackled through guided introductions to the research literature and to scientific methods of research and argumentation. Since these measures were taken, a steady improvement has been observed in both the seriousness of the students' experiments and the rigor of the scientific arguments in their papers.

The most fundamental issue raised regarding the central role played by the original experiment within the ALESS curriculum is the relevance of such an experiment to the goals of the course. If the class was supposed to be focused on scientific English, some faculty and students said, then the experiment and the time devoted to scientific-reasoning issues were irrelevant distractions and an unnecessary waste of time. The limited time available for the class, they said, should be focused on matters such as language, rhetoric, and logical exposition. These objections were taken very seriously by the ALESS faculty and were debated at great length during faculty meetings and workshops, with some of the teachers feeling that the experiment should be simplified drastically or even dropped and others arguing for its preservation and improvement. To explore other options, several teachers taught pilot classes in which the experiment was modified in order to lessen its time burden.[5] In the end, however, the consensus among the faculty was to keep the experiment exercise largely in its original form but with students given more help in devising, implementing, and interpreting their experiments. The content, it was decided, should not be separated from the form.

Content with Form

The decision to keep the experiment at the center of the ALESS curriculum was not based on any quantitative data on the superiority of that approach. With the ALESS program aimed at improving the communication and reasoning skills of students for their careers years in the future as researchers, it would be difficult—perhaps impossible—to design a quantitative assessment of the course's effect on those future skills in a way that would exclude other factors also affecting the students' development. Instead, it was the qualitative impressions and comments of the teachers and students themselves that led to the experiment's preservation. With the small size of ALESS classes (usually 15 or fewer students), students became familiar with each other's experiment topics through peer review and other in-class activities; this familiarity lent a satisfying unity to the semester's classes and led to more fruitful discussions during the final oral presentations.[6] Teachers reported that it was easier to present formal topics such as the use of pronouns in various sections of IMRaD papers or the rhetoric of hedging and boosting when those topics were linked to the content of experiments that the students had designed and conducted themselves. As the experiment became integrated more meaningfully into the curriculum, criticism of it from students in end-of-semester questionnaires seemed to taper off and more positive comments were received (though many students continued to complain about the course's overall workload, an inevitable consequence of compressing what could be a full-year course into a single semester). While the manner in which the experiment is incorporated in the ALESS course will continue to evolve in the years ahead as teachers gain more experience and as faculty with different perspectives join the program, it seems likely that this component will continue to be central to the course's curriculum.

This incorporation of a simple, student-designed experiment in an introductory course on second-language scientific writing and presentation might not be possible if ALESS students were not first-year undergraduates who have not yet chosen their fields of study. If they were already budding organic chemists, plant physiologists, and semiconductor engineers, then they would naturally want and need to write about content in their respective specializations—content that would be mostly incomprehensible to their fellow students and to their teachers. It is precisely because ALESS students are just embarking on their scientific careers that the course is able to focus not only on the formal aspects of their texts but on their content. Although the context of the ALESS program might be unique, at least in Japan, one hopes that its curriculum might provide inspiration to other academic writing programs that have, perhaps, drifted a bit too far in the direction of formal language use and could be enhanced by increased attention to the actual content of what students write.

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Notes

1. Extreme examples of an emphasis on form over content can be seen in satiric publications such as *Annals of Improbable Research* and *The Journal of Irreproducible Results,* which publish articles that, in language, organization, and format, closely resemble actual scientific research papers but whose assertions are obviously false. The goal of these efforts is, of course, humor, but they serve a more important purpose as well: to show that correct form is not enough to make good scholarship.
2. At the University of Tokyo, undergraduates spend their first two years in a liberal arts program, entering their majors only in their third year. During those first two years, students are divided into six broad categories corresponding roughly to law, economics, humanities, physical sciences, biological sciences, and medicine. Since 2008, all students in the last three categories—about 1850 a year—have been required to take the one-semester ALESS class, during which they write a scientific paper in English based on a simple experiment that they devise and conduct themselves and give a five-minute oral presentation about their paper. Additional information about the ALESS program and curriculum is available in Gally (2009a, 2009b), Allen (2010), and Lee (2010), and at http://aless.ecc.u-tokyo.ac.jp/.

3. The footnoted citations that were included in the original paper and in the version given to students are omitted here.
4. When the ALESS program began, no equipment or laboratory space was available for the students to use in their experiments. In the several years since, we have become able to provide some support for the students' experiments, both in the form of measuring equipment and other devices that can be lent to students for use in their experiments and through one-on-one consultations with graduate students about the design, implementation, and analysis of their experiments. These improvements are still inadequate, however, and students will benefit more when dedicated laboratory space and more expert advice become available.
5. In several pilot classes, students were asked to devise a hypothetical experiment and then write their paper as if they had in fact conducted it, using results that they had invented. While this did seem to reduce the time burden, the students' motivation and the conceptual unity of the class also suffered, and this variation was not adopted more widely. Ethical issues about the use of invented results were also raised. Another possibility would be to present the students with descriptions and results of genuine experiments and ask them to write up those experiments in IMRaD format; this idea has been suggested by faculty both inside and outside the program but has not yet been tried.
6. When the program began, each student devised and conducted the experiment on his or her own. Later, the teachers began to allow students to do the experiments in groups of about three or four. In most classes now, the students are given a choice whether to work in groups or alone. When an experiment is devised and conducted by a group, each member of the group must write a paper independently, explaining the method and results from a different point of view.

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The Relationship between Water Rise and the Composition of Fabrics

Author: Koki Sano

A liquid rises up a piece of fabric against gravity to a particular height. Here we show how the proportion of cotton to polyester in the fabric affects the height to which the liquid rises. When the proportion of cotton was large, the height of capillary rise increased quickly at first, but later it increased more slowly. On the other hand, when the proportion of polyester was large, it increased slowly but steadily. It appears that these results are caused because cotton maintains more moisture than polyester does. These results may seem to have application in producing new textiles.

Influence of Light Color on Plant Growth

Author: Yumiko Tomoe

It is known that plant growth is considerably influenced by light condition, but how plant growth is actually influenced is unknown. In this study, I observed the actual chromatic influence of light. I predicted that under lights with more absorbed colors, auxetic growth, increment of plant weight per a certain length, would be accelerated and that plant pigmentation, leaf color, would be vivid. In addition, I expected that under lights with less absorbed colors, elongation would be accelerated and plant pigmentation would be diluted. In this experiment, I grew radish sprouts in plastic containers covered with colored or achromatic cellophane. A large part of the results is consistent with the hypothesis. However, it is surprising that the elongation under green light was smaller than that of sprouts grown under other light colors and that under blue light, the pigmentation became diluted. The findings from this experiment indicate that the influence of the light color on plant growth is conditioned by the absorption rate of each light color. This study suggests that to make plants taller but not thicker, it is effective to radiate green or yellow light and that to accelerate auxetic growth, it is effective to radiate red or blue light. Further work is needed to determine the range of the light spectrum most effective for regulating the plant growth such as elongation acceleration, and whether the results can be applied to other plant species.

Native Japanese Musicians and Non-Musicians Have Less Lateral Preference in Attentional Capacity than Non-Japanese

Author: Anthony

Neurologically intact adults have the tendency to focus more attention on the left side of space, as documented in line-bisection and "line-and-dot" tests. In the former, participants marked the center of a given horizontal line, while in the later, participants were shown images of vertical lines with a dot marked on either the left or right side of the lines. These lateralization tests were conducted on non-Japanese musicians and non-musicians, and it has been shown that musicians have more balanced attentional lateralization than non-musicians. The aim of this study is to further investigate whether the same result appears in the case of native Japanese participants. Two groups of 15 right-handed Japanese musicians and non-musicians were given mirror image of gradient-coloured horizontal bars, and compared to the control group of non-Japanese, both groups made balanced choices of left and right stimuli. Consistent with previous research, the result indicates that other than musical training, language and nationality background also influence the attentional capacity of adults to a considerable extent.

Figure. Titles and abstracts of three papers written by ALESS students in 2010, taken from *ALESS: A Collection of Student Papers.*