Collaborative Writing: Too Much of a Good Thing? Exploring Engineering Students' Perceptions Using the Repertory Grid

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Abstract: Students' perceptions of technology-supported collaborative writing (CW) and peer reviewing are important because these perceptions affect adoption decisions, initial engagement, and continued reliance on collaboration/peer feedback as a learning resource. This paper describes and demonstrates the utility of the Repertory Grid Technique to probe such perceptions. Combining interviews and written surveys, this study uncovered constructs that engineering students' use to think about CW/peer-reviewing, and interesting patterns of relations among those constructs. For instance, while students perceived activities that involve the construction of personal arguments (such as CW) to be exciting and effective for learning, they also judged such activities to be time-consuming and stressful. This study also found interesting differences in the construct systems of high- and low-performing students.

Introduction

The potential of writing as a learning activity has long been recognized (e.g., Emig, 1977). From a cognitive perspective, writing has the potential to foster deep understanding of the subject matter. This is because writing involves the construction of, and interplay between, conceptual problems (what to say) and rhetorical problems (how to say it) (Bereiter & Scardamalia, 1987). From a socio-cultural perspective, and more specifically through the lens of genre theories, writing assignments provide a context in which students can acquire and practice rhetorical skills and strategies useful to integrate into a discipline-specific discourse community (Gee, 2004).

The importance of writing in higher education is well recognized. Recent nationally commissioned reports from the US and UK, for instance, highlight the central role of writing in graduates' ability to participate effectively in the knowledge economy (Davies, Swinburne, & Williams, 2006; National Commission on Writing in American Schools and Colleges, 2003). Looking at engineering education more specifically, writing is also recognised as a key graduate attribute. And because much of writing in professional practice is done collaboratively (e.g., Ede & Lunsford, 1992 show that 85% of the documents produced in offices and universities have at least two authors), there is a clear need for developing students' collaborative writing skills.

Although there is plenty of evidence for writing as a potent learning activity, there is no guarantee that students will enact their writing assignments productively. One way to enhance the probability that students will use writing activities for deep learning is to embed writing in a social context. A rudimentary, but frequently used form of writing consists of individual or collaborative writing (CW) combined with peer reviewing (Topping, 2005). A major advantage of CW and peer review is that they can be conducted with large numbers of students. Indeed, CW and peer reviewing can be seen as an answer to the specific pedagogical challenge that arises when employing writing in settings with a large number of students, e.g. for undergraduate education: How can guidance (scaffolding) and (formative) feedback on writing be provided, given the teacher:student ratio? This necessitates looking for alternative resources, in the form of self-guided learning, peer feedback, and guidance/feedback that can be provided by computational means.

Our research team have begun to develop an online writing environment with components specifically designed to support the peer review process (Calvo, O'Rourke, Jones, Yacef, & Reimann, 2010), reflection on writing products (Villalon, Kearney, Calvo, & Reimann, 2008), and reflection on writing process (Southavilay, Yacef, & Calvo, 2010). Our inquiry into CW and peer reviewing currently follows two lines. First, we are interested in understanding how students write by examining process data. Second, we are also interested in students' perceptions and subjective experiences of CW and peer reviewing. The study reported here is part of this second line of inquiry. The study aimed to explore engineering students' perceptions of CW and peer reviewing. In addition, the study also examined the utility of a variant of the Repertory Grid Method as an approach to assess the structure of students' perceptions.

The paper begins with a brief summary of prior studies on students' perceptions of writing, along with the theoretical perspective informing those studies. Next, the repertory grid approach to capture students' perceptions is described, followed by the study's data collection methods, analysis, and main findings. We close by discussing the implications for the design and integration of computer supported CW pedagogy and technology into undergraduate engineering education.

Students' Perceptions/Conceptions of Writing

We are interested in students' perceptions of CW and peer reviewing, and in their perceptions of the technologies made available to them, because these perceptions may affect not only how and to what extent students engage with the pedagogy and the technology initially, but also be an important factor affecting the self-guided employment of writing and of peer support as tools for continuous professional development.

One research tradition that provides a theoretical framework that links students' perceptions, learning behavior, and subsequent outcomes is phenomenography (Marton & Booth, 1997). Phenomenography's key insight is that learning is relational: a learning activity is always the product of the relation between the student and the task. Students who see a task differently will enact it in different ways. Phenomenographic studies have identified two basic ways of conceiving a learning task: *cohesive* (as orienting towards transforming personal understanding) and *fragmented* (as orienting towards collecting information or memorizing). Students adopting a cohesive conception typically engage at deeper cognitive levels than those adopting a fragmented conception (Marton & Saljo, 2005).

Several phenomenographic studies have investigated students' views of writing. For instance, based on interviews with history and psychology students, Hounsell (1984) identified different conceptions of essay writing. Some students talked about essays as a presentation of a personal argument or perspective; other talked about essay writing as presenting a string of ideas and facts/data, without an overall organizing argument or perspective. A study by Prosser and Webb (1994) found that students' adopting the more cohesive conception (i.e. essay are argument) also adopted a deeper approach (e.g. making decisions on what needs to be included in the essay based on the overall argument) and produced better quality essays. These associations have also been demonstrated by more recent, larger scale studies (Ellis, Taylor, & Drury, 2007).

While phenomenography has proved to be a useful framework, studies informed by phenomenography have almost exclusively conceptualized experience in terms of the cohesive-fragmented and deep-surface distinctions. We suspect that students' perceptions and experiences of CW and peer reviewing may include other dimensions that are also important to explore. Hence, we need a method to capture students' perceptions without relying too much on a priori or pre-determined dimensions. To this end, we see the Repertory Grid Technique (RGT) as a promising approach. The RGT was developed mainly in psychology based on George Kelly's Personal Construct Theory (Kelly, 1991). Kelly's theory is compatible with phenomenography: both agree that what matters most is not reality as such, but how people see or experience it. Kelly proposed that differences in people's perceptions the world are due to (not necessarily explicit) theories that people hold about respective aspects of the world, and that these theories affect perception through *constructs*, defined as "...a way in which some things are construed as being alike and yet different from others" (Kelly, 1991, p. 74). Constructs develop and change over time as a function of experience, but are relatively stable compared to the speed with which situation and context change. Furthermore, Kelly suggested that each individual possesses a finite number of constructs at any point in time, and that these constructs are related to each other to form a system. The next section describes RGT in more detail.

The Repertory Grid Method

One of our aims in this study is to identify a method that can help capture students' perceptions with the goal of improving upon the design of pedagogy and technology, as well as gauging the effects of differences in perceptions on learning outcomes. This requires a method that works with a small number of students, delivering rich data necessary for informing design decisions, as well as with larger number of students, necessary for generalizing findings. The method we employed to satisfy these demands is based on Repertory Grid Technique (RGT, Fransella, Bell, & Bannister, 2004).

RGT has a long and productive history in social psychology and clinical psychology, but also in areas such as marketing research and information systems research (see Curtis, Wells, Lowry, & Higbee, 2008; Tan & Hunter, 2004 for reviews of applications in the information systems area). A major advantage compared to survey methods is that RGT does not only elicit peoples' ratings but also the dimensions along which these ratings are made. In its canonical format, RGT proceeds by presenting participants with a set of *elements* (the objects of perception, such as social partners, car models, or in our case: teaching/learning methods and technologies) and then eliciting from participants in a systematic manner the constructs they use to distinguish and to group the elements. Importantly, the constructs, or dimensions for comparison, are not given to the participants, but generated by them during grid elicitation.

A typical method to elicit constructs would be an interview where the interviewer presents the participant with sets of three elements (e.g., three learning technologies) and then asks the participant to select two elements that are similar, and distinct from the third, and then to label the dimension that forms the basis for this triangulation (e.g., interactivity with the poles Low and High). Repeating this triangulation for all combinations of elements yields a multidimensional space in which each element occupies a position. Over this data representation, one can for instance calculate similarity measures that can be further subjected to qualitative analysis, cluster analysis, or dimension reduction methods (e.g., principal component analysis; multi-

dimensional scaling). Such data can be analyzed on the individual level as well as pooled over participants. For more descriptions of the various elicitation and analysis methods, as well as software tools, the reader is referred to tutorials such as Fransella et al. (2004).

A major practical drawback of RGT is the time it takes to conduct the construct elicitation, in particular if the elicitation is done by interview. Since (engineering) students have little time, and we did not have the means to pay our research participants, we employed a combination of RGT and standard survey methodology. A small number of volunteering students were interviewed with the goal to elicit their construct system, and the main constructs were then used as the basis for a survey that was distributed amongst a larger number of students. While this has the disadvantage of potentially glossing over interesting individual construct systems, it has the advantages of being much more rapidly applied and of reducing interviewer bias.

Research Questions and Methods

This study addressed two main questions: How do engineering students' perceive CW and peer reviewing? And are there any relations between students' perceptions and their writing performance?

Participants and Course Context

Participants in this study were 3rd-year engineering students enrolled in a course titled E-Business Analyses and Design in Semester 1, 2010. Nine students (4 males, age 20 to 23) from the course volunteered to participate in the interviews. Thirty-nine students (31 male) volunteered to participate in the survey. (This sample represented 73.6% of the whole class.) The course focused on "aspects of analysis, project specification, design, and prototype that lead up to the actual build of a website or application."

Of particular interest for this study was the writing assignment, which required students to work in pairs and write an e-business proposal. While this was a group task, there was a section of the proposal that each student had to write individually to obtain individual marks. After the submission of the proposal, each student had to read and write a review of another group's proposal (the peer review was also graded). Students were then asked to revise their submitted proposal based on the peer review and tutor feedback. The CW and peer reviewing were performed in an online environment (iWrite).

Online Writing Environment

Our on-line writing environment ('iWrite') provides students with tutorials on writing for different disciplines, assignment information, and tools for writing, improving their writing, reviewing and submitting their assignments (Calvo, O'Rourke, Jones, Yacef, & Reimann, 2011). To instructors, it provides a complete solution for scaffolding the write-review-feedback cycle of a writing activity. Specialist writing instruction content is built into the technology, and management tasks which would be highly time-consuming for large classes are handled automatically. In the course investigated here, iWrite was used to support an assignment that combines CW and peer reviewing.

Data Collection

Six interviews were conducted to elicit the constructs students used to think about learning activities. Three of the six interviews were conducted with pairs of students. Each interview took 20-30 minutes. In the interviews, students were shown triads of learning activities and were asked: "Here are three learning activities. Choose two among these three, and think about how they are similar to each other, but different from third." This procedure was first demonstrated using an example triad: taxi/private car/public bus. The learning activity triads were: (a) reading textbooks/reading articles/attending lectures, (b) Peer reviewing/individual oral presentations/group oral presentations, (c) attending lectures/tutorials/peer reviewing, (d) writing individually/writing collaboratively/reading textbooks. For each triad, the interviewer wrote a phrase or word to represent the student's answer as his/her construct and asked whether the student agreed with the phrase/word.

Each of the interviews produced 5 to 11 constructs (median: 7). While some constructs were commonly present in 2 or 3 of the interviews, no constructs appeared in all 6 interviews. More in-depth analysis can be done on the interview data to explore the interviewees' individual construct system. This paper, however, focuses on the pattern of perception across the whole class sample. For the purpose of this paper, we report that the interviews elicited a total of 31 constructs. Because a pilot study indicated that we could only include approx. 10 constructs (given the time constraints), we had to select from the pool of 31 constructs. We did so by first examining whether the 31 constructs could be grouped based on their similarity in meaning. This resulted in 15 groups of constructs. From this, for the survey, we selected 11 constructs that were mentioned by more than 1 student. These 11 constructs are listed in Table 1 in the next section, and the 4 excluded were: "interactive/non-interactive", "provides clues about important materials/not", "requires communication skills/not", and "depends on one's own motivation/supervised".

The survey was distributed on paper and online. The questionnaire asked students to rate five learning activities which they experienced in the course, plus what students' consider to be an "ideal" learning activity, on a scale from 1 to 5 in terms of the 11 constructs elicited from the interviews.

Findings

Interrelations between the Constructs

To explore the interrelations between constructs students used in thinking about learning activities, we first performed an exploratory factor analysis (Oblimin rotation with Kaiser Normalization was used). The factor analysis suggested a 4-factor solution which accounts for 67.26% of the total variance. Sampling adequacy (KMO) was measured at 0.644, which is acceptable, while Bartlett's sphericity test was significant (chi-square=587.8, $p < .0001$). The factor analysis results are shown in Table 1.

Table 1: Factor analysis results (loadings of less than .3 are not shown).

#	Constructs	Factor loadings			
		1	2	3	4
1	Requires construction of own argument (1) vs. does not (5)	.789			
2	Requires independent research (1) vs. does not (5)	.763			
3	Involves peer discussion (1) vs. no peer discussion (5)	.578		.409	
4	Boring (1) vs. exiting (5)	-.547	.510		-.388
5	Effortful (1) vs. effortless (5)		.782		
6	Time consuming (1) vs. not time consuming (5)		.754		
7	Stressful (1) vs. relaxing (5)		.738		-.391
8	Can be done anywhere (1) vs. only in certain places (5)			-.887	
9	Can be done anytime (1) vs. only in certain times (5)			-.869	
10	Structured (1) vs. unstructured (5)				.807
11	Effective (1) vs. not effective (5)	.318	-.355		.726

The first factor may be interpreted as "Student-centeredness", with more student-centered learning activities requiring students to perform their own research, construct their own argument, and involve peer collaboration. The second factor may be interpreted as "Demand", with more demanding activities being effortful, time consuming, stressful, and boring. The third factor was interpreted as "Flexibility", with more flexible activities being constrained by neither time nor location. The fourth factor is more difficult to interpret, as it is composed of "Structuredness" and "Effectiveness for Learning". This implies that that students tend to perceive structured activities as being more effective than unstructured ones.

The cross-loading of the "Boring/exiting" construct is worth noting. On the one hand, this construct loads with the "Student-centeredness" factor, indicating that students tend to perceive student-centered activities as exiting. "Boring/exiting" also loads with the "Structure and Effectiveness" factor, showing that activities perceived to be structured are also perceived to be boring. On the other hand, "Boring/exiting" loads with the "Demand" factor, implying that activities perceived as demanding are also perceived as boring. This pattern highlights the challenge of engaging engineering students: to be perceived as exiting, a learning activity needs to be unstructured and student-centered, but at the same time relaxing and requiring little effort and time.

The cross-loading of the "Effectiveness" construct is also interesting to note, in particular because it follows the opposite pattern to the "Boring/exiting" construct. While "Effectiveness" loads most strongly with "Structuredness", it also loads with the "Student-centeredness" and "Demand" factors. The directions of these loadings indicate that activities which are more student-centered and demanding (time/effort) were also seen to be more effective for learning.

Students' Perceptions of Collaborative Writing and Peer Reviewing

How do engineering students perceive CW and peer reviewing, *vis a vis* other learning activities? In addressing this question, we used the factor analysis results above to simplify the 11 original constructs by combining those which loads strongly (above .7) and exclusively onto a single factor. This resulted in the 7 constructs: (1) *Student-centeredness* (combination of "independent research" and "construction of argument"), (2) *Effectiveness*, (3) *Structuredness*, (4) *Demand* (combination of "time", "effort", and "stress"), (5) *Flexibility* (combination of "anywhere" and "anytime"), (6) *Excitingness*, and (7) *Peer discussion*. (Note: to further aid interpretation, some of the scores have been reversed such that higher scores reflect stronger perception in that construct; possible score ranges from 1 to 5 for all constructs).
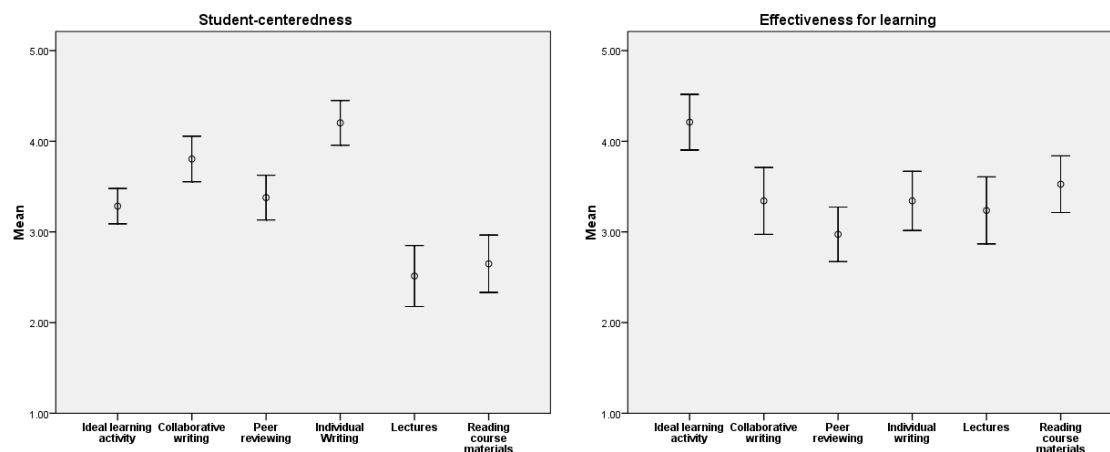
Figure 1. Perceived Student-Centeredness and Effectiveness; Error Bars Represent 95% Confidence Intervals.

As Figure 1 (left panel) shows, CW was seen to be the second most student-centered activity (after individual writing), while attending lectures and reading course materials the least. Interestingly, both collaborative and individual writing were seen as more student-centered than an ideal learning activity. In other words, writing was seen to involve *too much* construction of personal argument and independent research. Peer reviewing, on the other hand, was considered to be ideal in terms of student-centeredness.

In terms of learning benefits (Fig. 1, right panel), CW, individual writing, and peer reviewing were all seen as no more effective than attending lectures. All learning activities fell short of students' expectations in this regard. Peer reviewing, in particular, was seen to have the least benefit for the students' learning; it is seen as slightly less effective than CW (Wilcoxon $z = -2$, $p = .045$), individual writing (Wilcoxon $z = -1.72$, $p = .085$), and reading (Wilcoxon $z = -2.331$, $p = .02$).

There seems to be relatively little variation in the perceived level of structure across the five learning activities (Figure 2, left panel). CW and peer reviewing were seen to be the least structured activities, although only slightly less structured than ideal (the difference between ideal and peer reviewing was statistically significant, $z = -2.242$, $p = .025$).
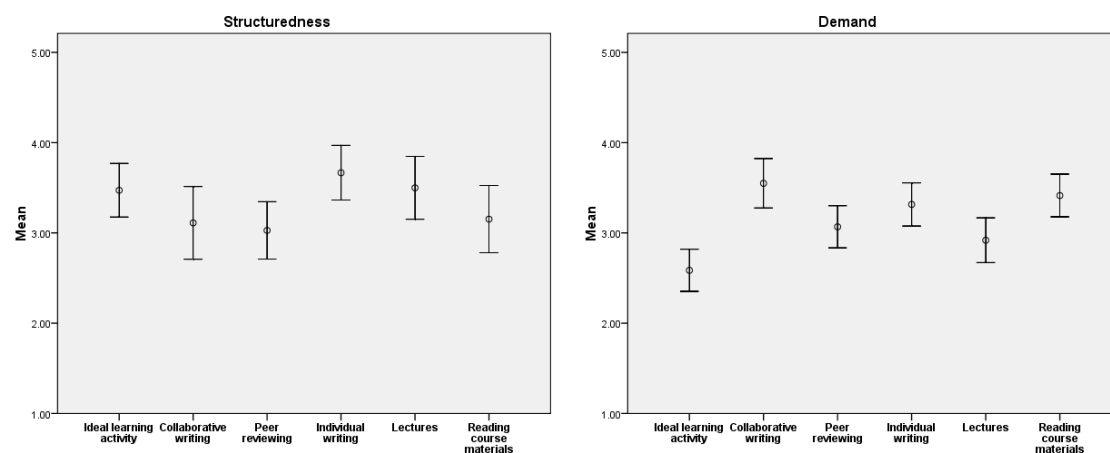

Figure 2. Perceived Structuredness and Demandingness; Error Bars Represent 95% Confidence Intervals.

In terms of perceived demand (Figure 2, right panel), individual writing, peer reviewing, and (in particular) CW were all judged to demand more time/effort and more stressful than an ideal learning activity. Peer reviewing seems to pose slightly less demand than CW. While it is quite easy to see why the writing-related activities were seen as demanding, it is worth noting that the lectures and particularly reading materials were also deemed too demanding. Hence, designing a learning activity that meets students' expectations in this regard may be difficult.
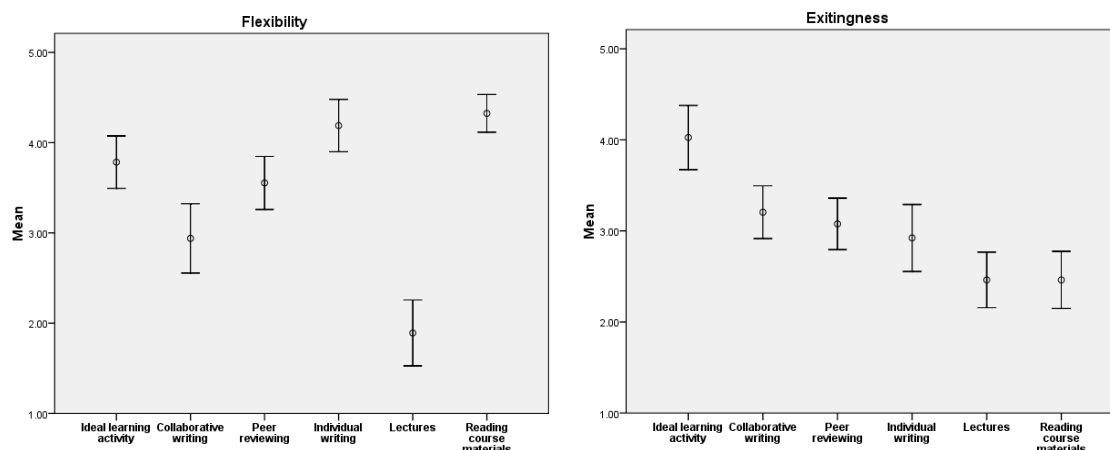
Figure 3. Perceived Flexibility and Excitingness; Error Bars Represent 95% Confidence Intervals.

With regards to flexibility (Figure 3, left panel), attending lectures was seen to be the least flexible, while individual writing and reading were the most. Interestingly, CW was considered to be less flexible than ideal (although still more flexible than attending lectures), despite the availability of the online writing environment. Peer reviewing was seen to be more flexible than CW, but still slightly less flexible than ideal. With regards to level of excitement (Figure 3, right panel), none of the five learning activities met students' expectations. However, CW, peer reviewing, and individual writing were all perceived to be more exciting than attending lectures and reading course materials. CW was unsurprisingly seen to involve the most peer discussion. This, however, was more than what students would have liked. On the other hand, peer reviewing and individual writing, along with the other learning activities, were all seen to involve too little peer discussion.

Relations between Students' Perceptions and Writing Performance

Do students' perceptions of CW and peer reviewing predict their writing marks? Simple non-parametric correlation tests were performed to examine this question. Results indicated that students who obtained better writing marks also tended to perceive: CW to be more effective for learning ($r = .348$; $p= .032$) and more exciting ($r = .298$, $p = .065$); and peer reviewing to be less structured ($r = - .342$, $p = .036$), involve less peer discussion ($r = - .376$, $p = .02$), and more exciting ($r = .287$, $p = .07$). These significant correlations are mostly in line with expectations: students who see CW and peer reviewing as exciting and/or beneficial for learning would likely adopt more productive approaches in their writing. The other two correlations (between higher marks with perceptions of less structure and peer discussion in peer reviewing) are less obvious and need further exploring.

In addition to the correlation analysis, we also compared the construct system of high and low performing students. This analysis utilizes the unique structure of repertory grid data, which allows the application of principle components analysis on the constructs to produce a 2-dimensional map whose axes represent the first two extracted factors, onto which each learning activity can be plotted. This kind of analysis has the advantage of depicting the structure of students' whole construct system, as opposed to looking at single constructs separately. For this analysis, the high performing group comprised of six students who scored 8 or more (out of 10), while the low performing group comprised of five students who scored 4 or less in their CW assignment. The average construct ratings were calculated as a basis of the principle components analysis, which was performed using Chris Evans' program (http://www.psyctc.org/grids/). The results (Figure 5) showed some striking differences between high and low performing students.

In the construct system of high performers (Figure 5, left panel), CW is placed quite close to the ideal learning activity. More specifically, CW is considered to be exiting, effective, student-centered, involves a lot of peer discussion, unstructured, and simultaneously posing low demand. In contrast, in the construct system of low performers (Figure 5, right panel), CW is placed far from the ideal learning activity and is perceived to be ineffective, unstructured, not exiting, and not student-centered.

Another difference between high and low performers is related to the construct of "structuredness": in the high-performers' construct system, "structuredness" is associated with level of demand, but not necessarily with student-centeredness, effectiveness, nor excitingness. The opposite is true in the construct system of low performers: "structuredness" is strongly associated with student-centeredness, effectiveness, and excitingness. In other words, low performers (but not for high performers) seem to expect more structure to be able to see the learning and motivational value of an activity.
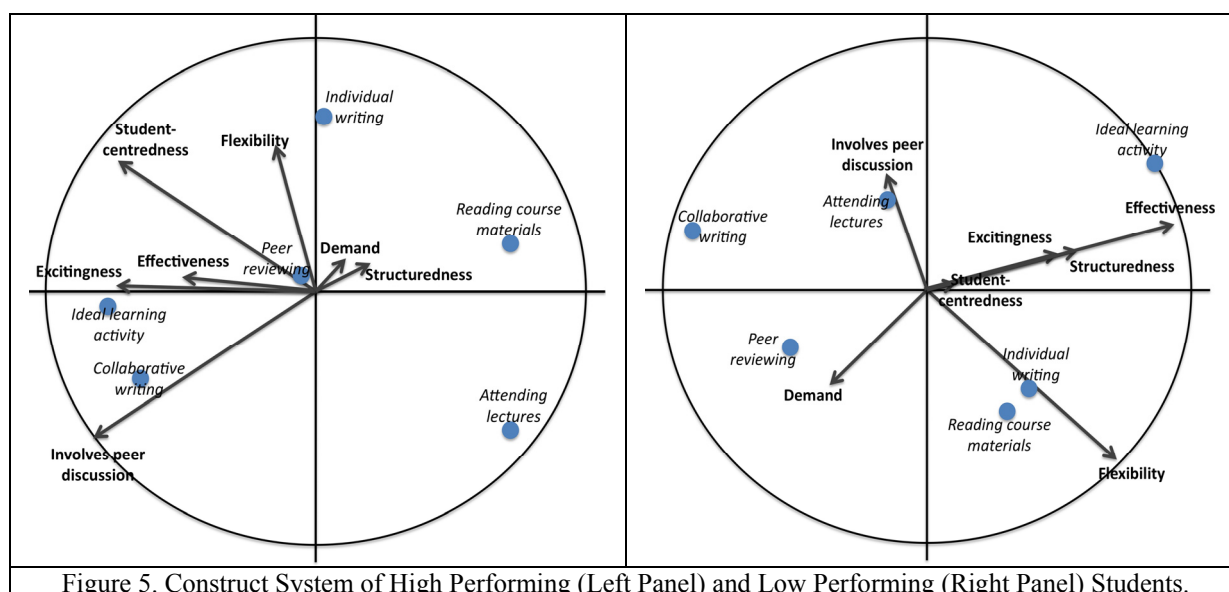
Figure 5. Construct System of High Performing (Left Panel) and Low Performing (Right Panel) Students.

Discussion and Conclusions

This study aimed, firstly, at revealing students' perception of (technology-supported) peer review pedagogy, an arguably rudimentary but frequently employed method for collaborative learning in undergraduate education. Secondly, we were interested in relations between students' perceptions and their success on writing assignments.

We found that writing, particularly when done in groups, was perceived to be quite student-centered. This indicates students' awareness that writing requires them to do some independent research and construct their own argument. CW and peer reviewing were seen to be moderately exciting, more so than attending lectures and reading. However, on average, writing and peer reviewing were seen to be only moderately effective for learning, not more effective compared to attending lectures and reading. In addition, while individual writing was (as predicted) considered to be flexible, CW was considered to be only moderately flexible. This indicates that in performing their writing assignment, many of these students still see the need to have face-to-face meetings, despite the possibility of online, asynchronous collaboration afforded by the technology.

Comparisons with students' imagined ideal learning activity provided some more insights. CW was seen to be ideal only in terms of structuredness. In terms of the other constructs, however, CW did not meet students' expectations: it was seen to be *too* student-centered and demanding, and at the same time not effective and flexible enough. Peer reviewing was as more ideal in terms of student-centeredness, structuredness, and flexibility, but still less effective and slightly more demanding than ideal.

These findings highlight some of the challenges of introducing CW to engineering students. If CW is seen as too stressful and demanding too much time/effort, while at the same time providing little learning benefits, then it would be difficult to persuade engineering students to adopt a deep approach to their writing assignments. On the positive side, these students still considered writing and peer reviewing to be more exciting and student-centered than attending lectures and reading course materials. Hence, the students were aware of some of the positive aspects of CW and peer reviewing. It is this dimension of students' perception that lecturers can tap into when trying to motivate students to adopt productive approaches to CW/peer reviewing.

This study also demonstrates that the repertory grid technique (RGT) can be fruitfully applied to explore the multi-faceted nature of students' perceptions. The specific approach we adopted – using constructs elicited through interviews in a follow-up survey – proved both useful and practically viable. Although it may gloss over individual students' unique construct systems, this approach provided insights into students' complex view of CW and peer reviewing. For instance, from the findings we can point out specific aspects of CW that students appreciate and other aspects which they don't. We were also able to demonstrate not only *whether*, but *how* high performers' construct systems differ from the low performers'.

Furthermore, the approach employed here yielded insights that enrich the traditional findings of phenomenographic studies. Whereas phenomenography focuses on cohesive and fragmented conceptions of learning, our study suggests that affective dimensions (e.g. exitingness) and pragmatic effort calculation (e.g. demandingness) are also important parts of students' experience of CW and peer reviewing. When we consider a richer set of dimensions of students' perceptions, it is difficult to dismiss the engineering students in this

sample as mere surface learners: While most saw CW and peer reviewing as demanding tasks, they were also aware that those tasks require time, effort, independent work, and the construction of personal arguments.

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