Using Peer Feedback to Enhance Student Meaningful Learning

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Abstract

This study was designed primarily to investigate the impact of anonymous peer feedback on student meaningful learning in higher education. Forty-seven students from three undergraduate classes from a central US university participated in this study. Students were asked to build a web-based project. In the experimental group, technology-mediated peer review and feedback were provided for students to use in improving their projects prior to instructor assessment. The control group received no peer feedback. Students' projects were independently evaluated and analyzed. Results indicated that there was no significant difference on project quality between the control and experimental groups. However, post-assessment survey indicated that students had generally positive perceptions of this process.

Introduction

Promoting student autonomy and encouraging student meaningful learning has become an important focus in higher education in recent years. When students take a more active role, learning becomes more meaningful and their achievement is improved. Researchers (Orsmond & Merry, 1996; Orsmond, Merry, & Reiling, 2002) argued the need for academic staff to switch their roles from teaching to facilitating learning in order to achieve higher student engagement and responsibility and suggested that in assessment practices, some "power" should be "handed over" to students.

Students' behavior and attitude toward learning are shaped by the assessment system (Freeman, 1995). To achieve the outcome of meaningful learning, appropriate assessment methods should be applied. Unfortunately, the traditional instructor-led assessment method provides only limited opportunities for assessment and feedback. Peer assessment is believed to be one of the solutions, as it not only provides additional feedback but also stimulates student interaction and involves students in thinking critically about assessment criteria. Within this context, the assessment process can be viewed as "the learning exercise in which the assessment skills are practiced." (Sluijsmans, Brand-Gruwel, & van Merrienboer, 2002).

Peer assessment, according to Topping and his colleagues (Topping, Smith, Swanson, & Elliot, 2000), is a process in which peers evaluate the achievement or performance of others of similar status. Cheng & Warren (Cheng & Warren, 1999) further defined this assessment form as reflection on "what learning had taken place and how." Peer assessment, as an alternative to traditional solo instructor assessment, has been applied in higher education courses such as writing, computer science, arts and engineering, etc (Liu, Lin, & Yuan, 2002). There are a number of studies illustrating how this process can be applied in both summative and formative evaluations. The majority of the literature on peer assessment in higher education has focused on the "assessment of individual contribution to group work" or the correlation between peer rating and instructor rating (Hanrahan & Isaacs, 2001, Sluijsmans et al., 2002). There are also some studies exploring the perceptions and feeling of students towards this process.

Peer assessment's benefits on higher thinking and cooperative learning have been established. Pope (2001) suggested peer assessment stimulates student motivation and encourages deeper learning. Freeman (1995) argued that studying the marking criteria and evaluating peers' work can improve students' critical assessment skills. Topping (1998), after reviewing 109 articles focusing on peer assessment, confirmed that peer assessment yields cognitive benefits for both assessor and assessee in multiple ways. Those "benefits might accrue before, during and after" the process. He further concluded that feedback yielded from this process has a positive impact on students' grades and subjective perceptions.

Most current peer assessment methods are conducted through paper-based systems. Two concerns associated with this system that hinder the widespread acceptance of this process are anonymity and the administrative workload.

Researchers noted their concerns towards the anonymity issue in peer assessment (Davies, 2002). One assumption of this process's credibility is that students usually provide fair and unbiased feedback to their peers. However, as reported by a number of studies, students find it difficult to rate their peers. They don't want

to be too harsh on their peers; they are uncomfortable critiquing others' work (Hanrahan & Isaacs, 2001; Topping et al., 2000). Conducted in an open environment, potential biases like friendship, gender or race could cause students to rate good performance down or poor performance up. Instructors need to design and maintain a distribution system to keep both reviewers' and reviewees' information confidential and anonymous, and at the same time, traceable for instructors to maintain the fluency of the process.

Taking more control of their learning process motivates students. Assessing peers' projects deepens their understanding of the topic being reviewed. Constructive feedback from peers helps to reevaluate and improve their own performance. These steps all contribute to more professional performance. At the same time, one of the advantages of peer assessment is the reduced assessment time for instructors. The instructor will spend less time diagnosing the underlying problems of student response, providing feedback, and reassessing students' revisions. This, of course, is good news for instructors who face the pressure brought by continuous growth in student enrollment and limited instructional time. However, another problem might be raised at the same time: the management of feedback documentation (Davies, 2002). Hanrahan and Isaac (2001) reported more than 40 person hours for documentation work in classes with 244 students. The load increases with larger classes. This is one of the major reasons some researchers found this process time consuming.

Technology-mediated peer assessment has been proposed as a solution to provide anonymity and minimize the workload. In this system, data can be automated and summarized, and students and instructors have instant access to data once they are generated. The whole process can be conducted in an anonymous way via the Internet. Reviewers and reviewees are not aware of each other. However, the integration of technology in peer assessment in higher education is still at an early stage of development. Limited data are reported even though various forms of computer-assisted peer assessment methods have been described (Topping, 1998). Our study addresses this issue by investigating an application of a peer assessment process that is delivered via an anonymous Web-based feedback management system. Our interest is in the impact of technology-based peer feedback on student meaningful learning and students' perceptions of this method in higher education.

In this study, peer assessment and feedback were utilized only for promoting learning, not as a substitute for instructor grading. Its three critical aspects include: 1) defining assessment criteria, in which students think about what is required; 2) evaluating the performances of peers; 3) providing constructive feedback for further project improvement. Compared with other methods in this area, this study is innovative because it utilizes a database-driven peer feedback website to ensure anonymity, simplify data management and stimulate student interaction.

Based on the outcome of previous studies, our hypothesis is:

1. Web-based peer feedback engages students in critical thinking and promotes meaningful learning, thus improving project quality.
2. Students gain positive perceptions about this process. They feel the process promotes deeper learning and helps them improve their project quality.

Facilitating Website

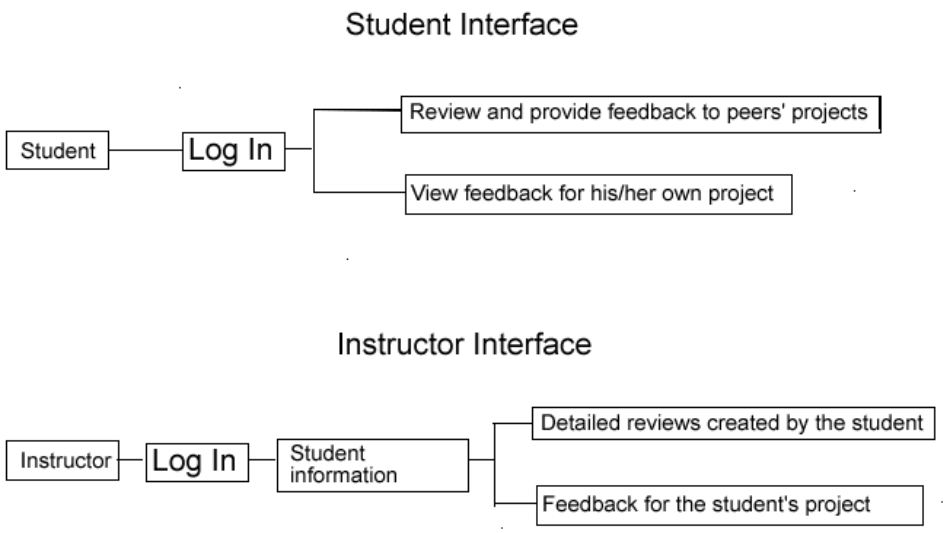
The emergence of information technology and rapid increase of online capacity have provided a new arena for education. Like other instructional platforms, innovative methods integrating technology have been proposed and tested in the assessment field. In the early 1990's, a novice collaborative learning network was studied at the University of Liverpool, England (Rada, Acquah, Baker, & Ramsey, 1993; Rushton, Ramsey, & Rada, 1993). One feature of this multi-user database-driven system was designed for facilitating peer assessment. This cost-effective tool constructed an environment where students could easily read, grade and provide suggestions to each other's work. Although this system presented incomparable superiority in stimulating students' interaction and reducing administrative load, as noted by the authors (Rushton et al., 1993), this process was not anonymous. Assessees' identities could be easily revealed.

Tsai and his colleagues (Tsai, Liu, Lin, & Yuan, 2001) employed a peer review network to foster students' critical thinking skills. Students completed their projects and uploaded them to the network. This network enabled students to review each other's performance and provide constructive feedback. Then students revised their own work according to the comments from peers. This procedure was repeated two or three times. Preliminary observation suggested that this system had positive influence on students' assignments. Tsai further asserted that peer assessment supported by a network was the most effective

Based on the previous research, our study was designed to ensure anonymity and facilitate the peer review process. A database-driven website was built that enabled students to register and log in with the username and password they specified. This system contained separate interfaces for instructors and students

(Figure 1). In the student interface, each student was randomly assigned two WebQuest projects created by two peers. Once students logged in, they could perform two roles — reviewer and reviewee. As reviewers, they reviewed the two assigned projects and provided their feedback confidentially according to the marking criteria for each project. The data were summarized for the author of each project; as reviewees, they had access to the feedback for their own projects. The instructor interface was designed to enable instructors to keep track of the peer review process. For each student, the instructor had access to the two reviews created by the student as well as the feedback this student's project received from two peers.

Figure 1



This system has the following major merits:

1. Anonymity was assured. This system ensured anonymity in two ways. First, students' identities were coded as numbers. No personal information, such as initials of their names, could be associated with their work. Secondly, students' projects were WebQuest web sites. Since they were typed and running on the Internet, no handwriting would reveal their identities or characteristics, such as gender. The potential risk of gender bias demonstrated by Falchikov and Magin's study (1997) was eliminated.
2. Management workload was reduced. All the data were aggregated and transmitted from users' computers to database. Management workload was minimal.
3. Students' interaction was stimulated. Submitted data were instantly summarized. Students and instructors had immediate access, which encouraged students' engagement and promoted their interaction.

Methods

Subjects

This study was conducted with forty-eight students from three undergraduate classes at a central US university. Although two teachers instructed these three classes, the same procedure was followed. Students were all from the same course entitled "Instructional Technology" at the College of Education and Human Sciences. Students were randomly assigned into an experimental group (27) and a control group (21). One student in the experimental group dropped the study for personal reasons. Since this course is a required technology application course for pre-service teachers at a college level, students have different academic backgrounds and range from freshman to senior.

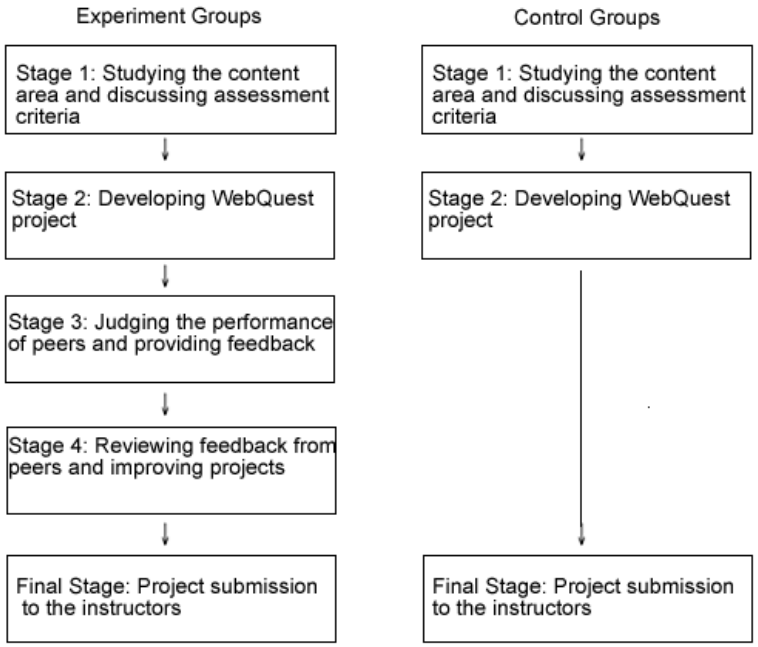
Procedure

In this study, students were asked to build a WebQuest project and upload it to the Internet. A WebQuest is "an inquiry-oriented activity in which most or all of the information used by learners is drawn from the Web" (Dodge & March, 1995). This model, developed by Bernie Dodge and Tom March in the early

1995, is designed to involve users in a learning process of analysis, synthesis and evaluation, which promotes their critical thinking and scaffolding skills.

In the control group, students were asked to individually develop WebQuest projects by themselves after studying the content area and the assessment criteria. In the experimental group, the following five stages were involved (Figure 2):

Figure 2



Stage 1: Studying the content area and discussing assessment criteria

After thoroughly studying the content area, students were presented a rubric and were asked to study it. Students were informed that this was the evaluation criteria that would be used by the instructor in assessing their projects and for their use in reviewing peers' projects. It depicted the basic elements required for a quality WebQuest; thus it was important and beneficial to the assignment. The assessment rubric was studied in two levels in a student-centered atmosphere. First students formed groups and discussed the rubric; then they were encouraged to share their understanding in class.

Stage 2: Developing WebQuest project

Students were requested to make a WebQuest project, build it a web site, and upload it to the Internet.

Stage 3: Judging the performances of peers and providing feedback

The website built to facilitate the peer review process was introduced to students. Once students logged onto the peer feedback website, they had access to two peers' WebQuest projects, which were randomly assigned to them. Students were asked to rate the projects and provide detailed comments according the rubric criteria.

Stage 4: Reviewing feedback from peers and improving their own projects

Feedback from peers was automatically summarized and made available to the creator of each project. After viewing the peer rating scores and comments, students had the opportunities to go back to improve their own projects.

Final Stage: Project submission to instructors

Students submitted their projects to instructors for grading.

Survey

After students in the experiment groups submitted their final projects, they were asked to complete a survey. Twenty-two students in the experimental groups responded to this survey. The survey replicated from previous study (Lin, Liu, & Yuan, 2002) consisted of 11 5-point Likert Scale items dealing with their general perceptions about the process, as well as two open-ended questions related to their likes and dislikes: "Please specify what you like most in this peer assessment procedure." "How would you change this peer assessment procedure? And why?"

Scoring Procedure

Two independent raters were trained and each of them graded all the projects using a rubric (Appendix 1) with slight modifications from an established rubric by Dodge (2001). Projects were assessed in six areas and received a score from 0 to 50 points. Both of the raters were former instructors of this course. They were knowledgeable in the content area and experienced in assessment. Furthermore, they were not associated with the course or students at the time of scoring, which minimized any potential existing biases. Students were instructed to remove any personal information in their projects. Projects from both experimental and control groups were coded and mixed together. Raters could not identify individual students or identify which group projects were from.

Inter-rater reliability was assessed for the two raters. The Pearson Correlation between the scores from two raters was .680.

Results

Two types of data were gathered in this study. The first type compared the difference of student learning represented by project quality between the experimental and control groups. The second type considered students general perceptions of this technology-mediated peer assessment procedure.

Difference of Projects Quality

Each project received two scores from two independent raters. The mean score was calculated and awarded to each project. ANOVA was utilized to test if there was any significant difference between the project scores of the control group and the experimental group.

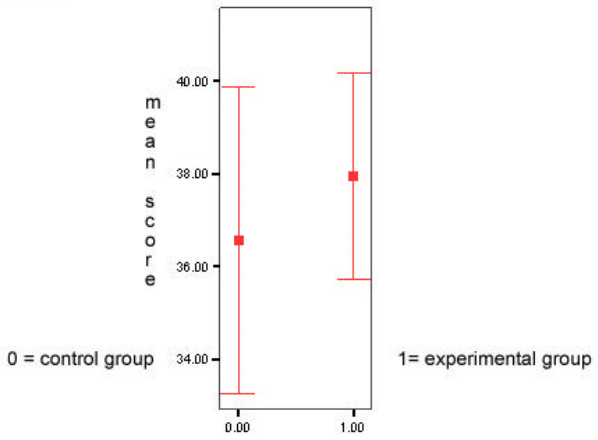
Table 1

Group	Mean	SD	N
Experimental	37.95	5.54	26
Control	36.57	7.28	21

The difference between the two means (37.95 vs. 36.57) is not significant, F (45) = .545, p = .464.

Interactive graph (Figure 3) shows the confidence intervals of the group means present a large overlap. There is a trend that the mean score in the experimental group was slightly higher than that of the control group and scores in the experimental group were located in a more condensed cluster.

Figure 3



Students' Perceptions on Peer Assessment

Twenty-two students in the experimental group responded to the post-assessment survey. This survey consisted of two parts. The first part was an 11-item 5-point Likert Scale ranging from 1 (strongly disagree) to 5 (strongly agree). The second part consisted of two open-ended questions regarding students' likes and dislikes: "Please specify what you like most in this peer assessment procedure." "How would you change this peer assessment procedure? And why?"

Table 2

Peer Assessment Survey

	Mean	SD	Minimum	Maximum
1. I am content with my own work.	4.45	.67	3	5
2. I learn more from peer assessment than from traditional teacher assessment.	3.64	.73	3	5
3. The procedures on how to do peer assessment are clearly outlined.	4.55	.51	4	5
4. Peer assessment is a worthwhile activity.	4.18	.59	3	5
5. Peers have adequate knowledge to evaluate my work.	3.73	.63	3	5
6. I benefited from peers' comments.	4.32	.65	3	5
7. The peers' comments on my work were fair.	4.23	.75	3	5
8. Peers can assess fairly.	3.95	.65	3	5
9. I have benefited from marking peers' work.	3.91	.92	2	5
10. I took a serious attitude towards marking peers' work.	4.64	.49	4	5
11. I felt that I was critical of others when marking peers' work.	4.00	.93	2	5

This table provides a picture of students' positive perceptions on peer assessment. Students reached a general satisfaction level for all of the items.

For the first open-ended question ("Please specify what you like most in this peer assessment procedure."), three major themes were depicted. First, the opportunity to review and grade peers' performance urged students on to greater efforts in the content area and the marking criteria. Secondly, feedback students received from peers helped them improve their projects. The third was the comfort brought by anonymous marking and instant feedback.

For the second open-ended question ("How would you change this peer assessment procedure? And why?"), three themes emerged. Several students stressed their satisfaction with this technology-mediated process. They stated that they wouldn't suggest any changes. Some students would have liked more than two peers rating their projects. They found it difficult to decide what to do if two peers gave them conflicting comments. Some students asked for more critical and constructive feedback.

Discussion

This study, investigating the influence of peer feedback in student meaningful learning and exploring student satisfaction level of this process, presented us an interesting picture. Data indicated that there was no significant difference of the project quality between the control and experimental groups. However, post-assessment survey revealed students' general recognition and acceptance of this process. These seemingly contradictory outcomes may be explained in part by the following.

First, independent ratings were used to compare the difference of students' project quality between two groups. To assure the reliability and consistency of scoring, inter-rater reliability was assessed. Two independent raters graded all projects according to the rubric. However, their grading didn't reach an agreement at a satisfactory level (the Pearson correlation equaled .680). Therefore, we cannot conclude that the scoring was reliable. There are many possibilities. It could be that our marking criteria was not categorized and described well enough for raters to evaluate students' projects and reach an agreement. Or it could be we need to provide more training to raters before they started grading. Or our measurement may not have discriminated levels of quality.

Secondly, Topping (1998) suggested that the benefits from peer assessment could accumulate anytime before, during or after the procedure. Peer assessment could have a positive impact on students' grades; it could also aid in the building of transferable skills and the foundation of lifelong learning. Like most peer assessment studies in literature, this study only focused on summative evaluation. Though statistically it revealed no significant difference of project quality between the control and experimental groups, the general agreement students reached in the post-assessment survey suggested students valued peer assessment as a worthwhile activity and they benefited marking peers' work. If formative evaluation was applied, there might be some indicators that student meaningful learning is enhanced by this process.

Finally, in the interactive graph (Figure 3), though the confidence levels have a large overlap and the difference between the two groups of scores is not significant, there is a trend that the mean score in the experiment groups was slightly higher than that of the control groups. If a bigger pool of students had participated in this study, the result might be the different. The variability of the scores in the experimental group was smaller than the control group. Further study may reveal that the procedure had a differential impact on the lower scoring students.

Based on these interpretations, we suggest that further study with a larger number of subjects and more instructors, and improved quality assessment measures is warranted.

The merits of this computer-mediated peer assessment process — anonymity and promptness — were recognized and addressed in students' survey responses. One student stated, "it helped out not knowing who the person was critiquing my project", another noted "it probably puts less pressure on the grader." Students liked "the instant feedback" from peers. At the same time, the instructors recognized a significant reduction of management workload. All the data were automatically summarized by the system. Students and instructors had instant access to data once they were generated. This certainly reduced the administration load.

Though the difference of project quality between groups was not significant, students expressed a rather high level of satisfaction toward this computer-mediated peer assessment process. Overall, we felt the peer feedback process in this study was a worthwhile activity. During this process, students were fully engaged and they changed their roles from reviewers to reviewees, and then improved their work. During this process, students' interaction was stimulated and their critical thinking skills were fostered. Compared to paper-based

systems, a computer-mediated system is certainly promising and provides advantages.

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Appendix 1 WebQuest Rubric

	Beginning	Developing	Accomplished	Score
Overall Aesthetics (This refers to the WebQuest page itself, not the external resources linked to it.)				
Overall Visual Appeal	0 points There are few or no graphic elements. No variation in layout or typography. OR Color is garish and/or typographic variations are overused and legibility suffers. Background interferes with the readability.	2 points Graphic elements sometimes, but not always, contribute to the understanding of concepts, ideas and relationships. There is some variation in type size, color, and layout.	4 points Appropriate and thematic graphic elements are used to make visual connections that contribute to the understanding of concepts, ideas and relationships. Differences in type size and/or color are used well and consistently.	
Navigation & Flow	0 points Getting through the lesson is confusing and unconventional. Pages can't be found easily and/or the way back isn't clear.	2 points There are a few places where the learner can get lost and not know where to go next.	4 points Navigation is seamless. It is always clear to the learner what all the pieces are and how to get to them.	
Mechanical Aspects	0 points There are more than 5 broken links, misplaced or missing images, badly sized tables, misspellings and/or grammatical errors.	1 point There are some broken links, misplaced or missing images, badly sized tables, misspellings and/or grammatical errors.	2 points No mechanical problems noted.	
Introduction				
Motivational Effectiveness of Introduction	0 points The introduction is purely factual, with no appeal to relevance or social importance	1 point The introduction relates somewhat to the learner's interests and/or describes a compelling	2 points The introduction draws the reader into the lesson by relating to the learner's interests or goals and/or engagingly describing a compelling question or	

	OR The scenario posed is transparently bogus and doesn't respect the media literacy of today's learners.	question or problem.	problem.	
Cognitive Effectiveness of the Introduction	0 points The introduction doesn't prepare the reader for what is to come, or build on what the learner already knows.	1 point The introduction makes some reference to learner's prior knowledge or previews to some extent what the lesson is about.	2 points The introduction builds on learner's prior knowledge or effectively prepares the learner by foreshadowing what the lesson is about.	
Task (The task is the end result of student efforts... not the steps involved in getting there.)				
Connection of Task to Standards	0 points The task is not related to standards.	2 point The task is referenced to standards but is not clearly connected to what students must know and be able to do to achieve proficiency of those standards.	4 points The task is referenced to standards and is clearly connected to what students must know and be able to do to achieve proficiency of those standards.	
Cognitive Level of the Task	0 points Task requires simply comprehending or retelling of information found on web pages and answering factual questions.	3 points Task is doable but is limited in its significance to students' lives. The task requires analysis of information and/or putting together information from several sources.	6 points Task is doable and engaging, and elicits thinking that goes beyond rote comprehension. The task requires synthesis of multiple sources of information, and/or taking a position, and/or going beyond the data given and making a generalization or creative product.	
Process (The process is the step-by-step description of how students will accomplish the task.)				
Clarity of Process	0 points Process is not clearly stated. Students would not know exactly what they were	2 points Some directions are given, but there is missing information. Students might be	4 points Every step is clearly stated. Most students would know exactly where they are at each step of the process and know what to do next.	

	supposed to do just from reading this.	confused.		
Scaffolding of Process	0 points The process lacks strategies and organizational tools needed for students to gain the knowledge needed to complete the task. Activities are of little significance to one another and/or to the accomplishment of the task.	3 points Strategies and organizational tools embedded in the process are insufficient to ensure that all students will gain the knowledge needed to complete the task. Some of the activities do not relate specifically to the accomplishment of the task.	6 points The process provides students coming in at different entry levels with strategies and organizational tools to access and gain the knowledge needed to complete the task. Activities are clearly related and designed to take the students from basic knowledge to higher level thinking.	
Richness of Process	0 points Few steps, no separate roles assigned.	1 points Some separate tasks or roles assigned. More complex activities required.	2 points Different roles are assigned to help students understand different perspectives and/or share responsibility in accomplishing the task.	
Resources (Note: you should evaluate all resources linked to the page, even if they are in sections other than the Process block. Also note that books, video and other off-line resources can and should be used where appropriate.)				
Relevance & Quantity of Resources	0 points Resources provided are not sufficient for students to accomplish the task. OR There are too many resources for learners to look at in a reasonable time.	2 point There is some connection between the resources and the information needed for students to accomplish the task. Some resources don't add anything new.	4 points There is a clear and meaningful connection between all the resources and the information needed for students to accomplish the task. Every resource carries its weight.	
Quality of Resources	0 points Links are mundane. They lead to information	2 points Some links carry information not ordinarily found in	4 points Links make excellent use of the Web's timeliness and colorfulness.	

	that could be found in a classroom encyclopedia.	a classroom.	Varied resources provide enough meaningful information for students to think deeply.	
Evaluation				
Clarity of Evaluation Criteria	0 points Criteria for success are not described.	3 points Criteria for success are at least partially described.	6 points Criteria for success are clearly stated in the form of a rubric. Criteria include qualitative as well as quantitative descriptors. The evaluation instrument clearly measures what students must know and be able to do to accomplish the task.	
Total Score				/50