AC 2012-3311: INFORMATION LITERACY: A FIELD GUIDE FOR THE PATH OF LIFE-LONG LEARNING

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Information Literacy: A Field Guide for the Path of Life-Long Learning

Abstract

Information literacy is the ability to find, organize, and evaluate information. Possessing the suite of skills associated with information literacy will improve the quality of work that students complete during their college years and enable students to more successfully embark upon the path of life-long learning. To ensure that information literacy skills were adequately imparted to students, six modules were introduced into the civil and environmental engineering (CEE) curriculum at Villanova University. These modules, which were first introduced in 2005 and are integrated throughout six courses in the curriculum, were developed jointly by faculty and librarians. Since the initial development of these modules, there have been several changes to the curriculum and the faculty teaching the courses, and some of our assessment tools have been improved. Educational outcomes based on Association of College and Research Libraries (ACRL) outcomes were developed and an assessment protocol was implemented. The first course of the six has been well assessed; a coordinated assessment process is currently being extended to the other courses in which information literacy instruction occurs. This paper will provide the results of the assessments completed to date as well as provide proposed changes to improve information literacy instruction and assessment of that instruction to ensure that students are achieving the educational outcomes.

Introduction

Many professors and students mistakenly assume that students are experts at finding and evaluating information simply because the students have developed into adulthood using the internet[1]. Students are not adept at conducting meaningful searches using widely available search engines (e.g. Google) or paid databases and are often unaware of the resources that their universities afford them[1]. In addition, many students are overwhelmed by the prospect of searching for information and are reluctant to seek help[1]. The electronic age has made information literacy a necessity for students and graduates because being information literate means that you have learned how to learn[2].

The Association of College and Research Libraries (ACRL)[3] defines an information literate person as someone who can:
- Determine the extent of information needed
- Access the needed information effectively and efficiently
- Evaluate information and its sources critically
- Incorporate selected information into one's knowledge base
- Use information effectively to accomplish a specific purpose
- Understand the economic, legal, and social issues surrounding the use of information, and access and use information ethically and legally

To ensure that our students attain these critical skills, a multi-course information literacy sequence was developed and implemented within the civil engineering curriculum at Villanova

University. Faculty from the Civil and Environmental Engineering Department developed these modules in a cooperative effort with librarians from Falvey Library. The modules were initially developed in 2004 and underwent a major revision in 2010[4, 5, 6]. This multi-course sequence covers a wide variety of ways to find information (general web and free and paid database searches), obtain information (web pages, open-access and paid journals, conferences, handbooks, specifications, codes, and syntheses), and use information (case studies, research papers, evaluation of multiple sources, and design projects).

Relationship to ABET Accreditation Criteria and the Body of Knowledge

Information literacy is related to three of the outcomes in ABET criterion 3[7] as well as three of the outcomes described in American Society of Civil Engineers' (ASCE) Body of Knowledge[8]:
- an ability to communicate effectively (ABET g, BOK 16) and
- a recognition of the need for, and an ability to engage in, life-long learning (ABET i, BOK 23)
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (ABET k, BOK 8)

Educational Outcomes

Twenty-six educational outcomes were developed based upon the ACRL standards[3, 4]. These outcomes are divided up by what we expect a student to be able to do by year; however, some of the outcomes are assessed more than once.

By the end of the sophomore year, the students should be able to:
1. explore general information sources to increase familiarity with a topic
2. identify key concepts and terms that describe the information need
3. define a realistic overall plan and timeline to acquire the needed information
4. read text, select main ideas, and restate textual concepts in their own words
5. identify verbatim material that can then be appropriately quoted
6. evaluate a website for authority, reliability, credibility, purpose, viewpoint, and suitability
7. reflect on past successes, failures, and alternative strategies by maintaining a log of information seeking and evaluating activities
8. communicate clearly and with a style that supports the purposes of the intended audience
9. demonstrate an understanding of intellectual property, copyright, and fair use of copyrighted material
10. select an appropriate documentation style and use it consistently to cite sources
11. confer with instructors and participate in class discussions to identify a research topic, or other information needed
12. define or modify the information need to achieve a manageable focus
13. know how information is formally and informally produced, organized, and disseminated
14. determine the availability of needed information and make decisions on broadening the information seeking process beyond local resources
15. select controlled vocabulary specific to the discipline or information retrieval source
16. construct and implement a search strategy using appropriate commands for the various information retrieval system selected

17. integrate new and prior information in a manner that supports the purposes of the product
18. develop a thesis statement and formulate questions based on the information needed

By the end of the junior year, the students should be able to:
19. select efficient and effective approaches for accessing the information needed
20. assess the quantity, quality, and relevance of the search results to determine if additional information is required or if the search strategy should be revised
21. create a system for organizing the information

By the end of the senior year, the students should be able to:
22. recognize that existing information can be combined with original thought, experimentation, and/or analysis to produce new information
23. identify the purpose, audience, value, and differences of potential resources in a variety of formats
24. examine and compare information from various sources to evaluate reliability, validity, accuracy, authority, timeliness, and point-of-view bias
25. extend initial synthesis, when possible, at a higher level of abstraction to construct new hypotheses that may require additional information
26. draw conclusions based upon information gathered

Activities, Outcomes, and Assessment for Each Course

The instruction and assignments for each course are directly related to the outcomes. In-class information literacy instruction by the science and engineering librarian is provided in three of the six courses in which information literacy is stressed and assessed (once in a sophomore required course, once in an elective course, and once in a senior design elective course). These in-class experiences reinforce the accessibility of electronic resources. However, it is also important for students to understand that much of this accessibility is related to their university IP address (many students find this out naturally when trying to complete assignments over a break period). Table 1 through Table 4 summarizes the assessed outcomes and tools associated with the modules.

The achievement of the outcomes is assessed several ways: analysis of student assignments, quizzes, and to a much lesser extent, surveys. The information literacy modules were designed to reinforce previous topics while introducing more complex topics. This methodology is reflected in the assessment process: foundational outcomes are assessed repeatedly while the higher level outcomes may only be assessed in one course. For example, outcomes 9 and 10 are assessed in each of the six classes, while outcome 23 is assessed in two of the courses, and outcome 24 is only assessed in one class.

The information literacy modules in the six classes were developed at different times and have been assessed to varying degrees over the past few years. As the process matures it is hoped that the students achieve more success on the foundational outcomes with repeated exposure to the topics. Determining if this is the case is one of the goals of the assessment process. The information literacy module in Geology for Engineers (GLY 2805) is the oldest and most rigorously assessed[9, 10]; however, improvements to the assessment process were made this past

year. The next information literacy modules developed were for Foundation Design (CEE 4801), Soil Mechanics Laboratory (CEE 3901), and Solid and Hazardous Waste (CEE 4331). The modules for Advanced Transportation Engineering (CEE 3525) in 2010 and Transportation Facilities Design (CEE 4224) in 2011 are the most recently developed. Although the information literacy modules for Foundation Design, Soil Mechanics Laboratory, and Solid and Hazardous Waste have been in existence for several years, the assessment process is still developing. Although there are often intermediate assignments in each class, there is a major work product associated with each class.

Table 1. Summary of Activities, Outcomes and Assessment in GLY 2805 Geology for Engineers (Sophomore Required Course, Major Work Product: Term Paper)

Activities	Outcome	Deliverable	Assessment Tool
Students will receive the term paper assignment with an explanation of the assignment from the instructor. The instructor describes the documentation style used by ASCE and provides an example page. The instructor will also tell them that they need to document their research activities using RefWorks. The student is provided with evaluation criteria for websites. Each student explores sources that are available to the general public (i.e. Web sources).	1, 6	Student completes worksheet evaluating a website	Rubric
Students develop an initial topic and a list of key words developed by general web searching.	2	Student selects preliminary topic and keywords	Rubric
Students receive instruction from librarian on the effective use of databases and other library resources. Students record search progress using RefWorks.	3, 7, 11, 18	Student selects a final topic and submits a plan/timeline to perform the required research	Rubric
Students use appropriate databases. Students obtain sources from the library and inter-library loan. Students record search progress using RefWorks.	4, 10, 12, 13, 14, 15, 16	Student records proper citation of selected articles. Student evaluates and summarizes a selected article.	
Students continue performing research on selected topic and recording progress in RefWorks	10, 17	Student submits outline and reference list	
Students continue performing research on selected topic and recording progress in RefWorks	4, 5, 8, 9, 10, 12, 17, 18	Student submits term paper	Rubric
Students read and critique another student's draft term paper following a set of evaluation criteria	4, 5, 8, 10, 17	Student submits critique	
Student answers a set of questions	6, 7, 12, 13, 14, 15, 16	Student submits information literacy assessment	Score

Table 2. Summary of Activities, Outcomes and Assessment in CEE 3235 Advanced
Transportation Engineering (Junior or Senior Elective Course: Design Solution)

Activities	Outcome Assessed	Deliverable	Assessment Tool
Real-life design scenario found in the preparation of highway construction plans introduced by instructor. Students are instructed on how to use RefWorks in laboratory setting by science librarian		Student selects topic	
Students are introduced to TRIS/TRB/catalog via lecture by science librarian	13, 19	Student submits information literacy pre-assessment	Score
Students are introduced to various resources: CRCnetBASE/FHWA/state specifications in laboratory setting by science librarian and instructor			
Students continue performing research on selected topic throughout semester independently and continue to document their research using RefWorks. Science librarian periodically checks students' progress.	16, 19, 21	Student submits draft list of sources using RefWorks	
Students are (re)introduced to Compendex and provided with specialized help on their topics by science librarian in laboratory setting			
Students continue performing research on selected topic and continue to document their research using RefWorks	14, 19	Student completes resource evaluation survey	
Students continue performing research on selected topic and continue to document their research using RefWorks	4, 8, 9, 10, 17, 22, 25, 26	Student submits design report	Rubric
Students continue performing research on selected topic and continue to document their research using RefWorks	19, 20, 21	Student submits RefWorks bibliography with annotations	Rubric
Student answers questions	13, 14, 16, 22, 19	Student submits information literacy assessment	Score

Table 3. Summary of Activities, Outcomes and Assessment in CEE 3901 Soil Mechanics
Laboratory (Junior Required Course, Major Work Product: Case Study)

Activities	Outcome	Deliverable	Assessment Tool
Students receive the case study assignment with an explanation of the assignment from the instructor. The instructor describes the documentation style used by ASCE and provides an example page. The instructor will also tell them that they need to maintain a journal of their research activities.		Student selects topic	
Students continue performing research on selected topic and making entries in journal	9, 10, 19, 20, 21	Student submits case study	Rubric under development

Table 4. Summary of Activities, Outcomes and Assessment in CEE 4224 Transportation Facilities Design (Senior Design Elective Course, Major Work Product: Two Design Projects)

Activities	Outcome Assessed	Deliverable	Assessment Tool
Two semester-long sequential design projects introduced by instructor. Students are introduced to concept of design standards, guidebooks, and syntheses of practice. Instructor provides examples of how to interpret standards and use guidebooks or syntheses			
Students are introduced to searching TRID,Falvey library catalog, and internet resources via lecture by science librarian	13, 19	Student submits information literacy pre-assessment	Score
Students are introduced to various resources: national/state specifications, codes, and standards. Discussion on reference formatting, bibliography, and a brief introduction to RefWorks by lecture by science librarian	22, 23	Student submits series of lengthy design submittals	Rubric
Student continues referencing of design standards and other guides throughout semester	22,23	Student submits series of lengthy design submittals	Rubric
Student answers questions	13, 19	Student submits information literacy post-assessment as part of midterm exam	Score

Table 5. Summary of Activities, Outcomes and Assessment in CEE 4331 Solid and Hazardous Waste (Senior Elective Course, Major Work Product: Research Paper)

Activities	Outcome Assessed	Deliverable	Assessment Tool
Assignment for research paper is provided. Students are instructed on how to use RefWorks and relevant databases		Student selects preliminary topic	
Students continue performing research on selected topic and continue to document their research using RefWorks		Student selects final topic	
Students continue performing research on selected topic and continue to documents their research using RefWorks	4, 8, 9, 10, 17, 22, 25, 26	Student submits final research paper	Rubric

Table 6. Summary of Activities, Outcomes and Assessment in CEE 4801 Foundation Design (Senior Elective Course, Major Work Product: Paper on Evaluation of Sources)

Activities	Outcome Assessed	Deliverable	Assessment Tool
Students receive the evaluation of resources assignment with an explanation of the assignment from the instructor. The instructor describes the documentation style used by ASCE and provides an example page.			
Students continue performing research on selected topic	9, 10, 13, 23, 24	Student submits assignment	Rubric

Results of Assessment

Selected results from the assessment of student work and the results of quizzes are presented in Table 7 through Table 11. The assessment of the final term paper in Geology for Engineers was completed using a rubric (Table 7). Each element was evaluated on a scale of 1 to 5, with 5 representing the highest achievement. The rubric is directly related to the outcomes described previously. The students receive the rubric used for assessment and grading at the beginning of the semester so they know what is expected of them. The students have consistently performed well on the assignment and there is little difference in the achievement of the outcomes from 2009 to 2011. The greatest difficulty students have is with properly formatting their bibliographies and with remembering to cite the sources used for figures in their papers. Starting in 2011, the students performed a plagiarism analysis using SafeAssign by Blackboard. Their reports revealed that there was no evidence of plagiarism, which supports the results for outcome 9 in Table 7. The many intermediate assignments described in Table 1 contribute to the high achievement of the outcomes.

Table 8 presents the findings from the CEE 3235 Advanced Transportation Engineering assessment quizzes on the inception of the information literacy instruction. The data show that over both assessment years, the general trend was a vast increase in student scores after receiving formal information literacy training. To further assess students' comprehension of information literacy concepts, an attempt was made to compare each individual student's score on the assessment quiz to the information literacy portions of their semester project report. In 2010, 30% of the total semester project grade was based on information literacy-based points, and in 2011, it comprised 20% of the total semester project grade. For the 2010 dataset, the assessment quiz scores were compared with the students with the highest three semester project grades and lowest three semester project grades. The data did not show any direct correlation between an individual student's score on the post-quiz and that student's semester project grade. It should be noted that this is a preliminary finding and will be developed more fully in future semesters to track the progress of the specific information literacy element (built into the 20% of the total project grade) of individual students.

Because the CEE 3235 Advanced Transportation course presented in Table 8 only includes a small group of students who elected to focus primarily in transportation engineering, a separate gauge for information literacy was included in 2011 in a related course. The CEE 4224 Transportation Facilities Design course is a senior design elective that is typically comprised of students who are interested in transportation, as well as a number of students interested in other civil engineering disciplines. This is demonstrated by the class size increase (49 students versus the 11 students enrolled in CEE 3235). Ten of the 11 students included in Table 8 were taking both CEE 3235 and CEE 4224 concurrently. However, it should be noted that the lectures provided by the instructor and the science and engineering librarian only overlapped slightly. In addition, only two questions were the same between the two separate assessment quizzes. The results in the CEE 4224 columns of Table 9 show that there was a consistent increase in students' grasp of the information literacy concepts after they received instruction on those topics. Design submittals collected over the course of the semester also consistently revealed that more than 50% of the students were providing citations for the design standards and guidebooks used to generate design solutions. Approximately 25% of these students were documenting the

literature specifically according to the information literacy instruction provided by the science and engineering librarian. Although this is more than in past years, there is still tremendous room for improvement. It is interesting to note that a majority of the 25% of students were also enrolled in the CEE 3235 course concurrently.

As a starting point to better assess the impact that information literacy is having on our students, the same quiz used in CEE 4224 Transportation Facilities Design was also tested on the graduate-level Civil Engineering Materials (CEE 8439) course in 2011. This course included a mixture of transportation and structural engineering students, 35% of whom are full-time masters students and 65% of whom are part-time masters students working professionals (some of whom are licensed professional engineers). It should also be noted that 40% of the students in the class obtained their BSCE from Villanova University and 60% of the students obtained their bachelors degree in engineering at another institution. Only 13% of the students who obtained their BSCE at Villanova University had taken a previous course in which information literacy had been taught. The data presented in the CEE 8439 column of Table 9 shows that the students in the graduate course generally scored lower on the assessment quiz than the Villanova students exposed to information literacy. There was no formal information literacy training provided by the librarian in this course, but the instructor did lecture on the use of standards and specifications prior to the pre-quiz being distributed to the graduate students. It should be noted that this finding is very preliminary and will be more fully developed in the future to better control the parameters of the information literacy research tools.

The assessment of CEE 4331 Solid and Hazardous Waste, one of the senior CEE design electives, involved writing a scientific research paper that relied on appropriate sources from peer-reviewed journals. Key to the assessment was the students' ability to cite their sources correctly in the text as well as in the bibliography. In addition, the students were assessed on their ability to integrate multiple sources into their report such that the information strengthens their discussion and is combined with original thought to draw appropriate conclusions. An overview of the paper and assessed outcomes can be found in Table 5 and the results of the assessment are presented in Table 10. Each student was evaluated for multiple outcomes on a scale of 1 to 5, with 5 representing the highest achievement. The average score for each outcome are presented for the two years for which the assessment was performed.

Unlike the sophomore level GLY 2805 Geology for Engineers (Table 7), the students did not directly receive the rubric used for assessment and grading beforehand, but the expected deliverables that needed to be included in the report (i.e. appropriate use of peer-reviewed journals, proper citation of their sources, proper integration of sources into the scientific report) were clearly stated in the assignment description that was handed to them when the project was introduced. Results from the assessment (Table 10) show that the lowest score each year involved in-text citations of their sources (outcome 10, part 2). The next lowest scores each year involved the ability to restate textual concepts from sources into their own words (outcomes 4 and 9) and combining existing information with original though and drawing conclusions based on information gathered (outcomes 22, 25, and 26). Overall, the results showed that the majority of the students did have an adequate ability to create a report that satisfied the outcomes associated with this assignment and there was an increase in the achievement of all outcomes from 2010 to 2011. More years of assessment are needed to determine if this increase continues.

In CEE 4801 Foundation Design the students are asked to research a geotechnical topic of their choosing using a variety of sources. The students are asked to find four sources: one source that is available/accessible to the general public, one general web source, one peer-reviewed journal article, and one other type of printed reference such as a conference or technical periodical article. They are then asked to summarize the information in these sources. Lastly, they are asked to compare the sources considering the intended audience, contradictions amongst the sources, communication style, quality, trustworthiness, and biases. The ability to properly format the bibliography continues to be the most troublesome aspect of writing for the students. In addition, remembering to cite all sources used in the text is also problematic. Despite these problems, the students are achieving the outcomes.

Conclusions and Recommendations for Future Work

The assessment results, while still in development, reveal that Villanova University's information literacy efforts are having a positive effect on the students. The general trend of increasing scores on student assessments after formal instruction on information literacy concepts indicates that instruction in these very important concepts is effective. By the time a student graduates from our department they will have received information literacy instruction and completed related assignments in at least three courses and possibly in six. Properly citing sources, both in-text and in the bibliography, presents the most difficulty to students. Additional instruction will be provided to students to help overcome this weakness.

The analysis completed for this paper revealed several improvements that could be made to the assessment process. For example, the assessment techniques will be made more consistent to allow for easier comparisons and more detailed assessments will be made on some of the assignments taught in the various sequence of classes that include information literacy. This will also help to better assess the correlation between students' assessment scores from post-quizzes and final project report grades. The approach being developed will focus on the assessment of students on an individual basis.

In addition, systematic data collection on a sequence of graduate courses is currently being developed to assess the difference in performance between Villanova students exposed to information literacy during their undergraduate curriculum versus students who were not exposed to information literacy concepts or practice during their undergraduate curriculum (including those who graduated with an undergraduate degree from Villanova or from other institutions that do not specifically address information literacy). This assessment is planned based on the products from quizzes and term papers. These improvements will be implemented the next time each of these classes is taught in 2012.

Table 7. Assessment of Final Term Paper in GLY 2805 Geology for Engineers

Outcome(s)	2009	2011
Number of students	61	53
18: Develop a thesis statement and formulate questions based on the information needed	4.8	4.8
12: Define or modify the information need to achieve a manageable focus	4.8	4.7
4: Read text, select main ideas, and restate textual concepts in their own words 9: Demonstrate an understanding of intellectual property, copyright, and fair use of copyrighted material	4.5	4.5
8: Communicate clearly and with a style that supports the purposes of the intended audience	4.2	4.4
17: Integrate new and prior information in a manner that supports the purposes of the product	3.9	3.9
14: Determine the availability of needed information and make decisions on broadening the information seeking process beyond local resources	4.6	4.6
10: Select an appropriate documentation style and use it consistently to cite sources – In-text citations	4.2	4.1
10: Select an appropriate documentation style and use it consistently to cite sources – Bibliography	4.0	3.7
5: Identify verbatim material that can then be appropriately quoted	4.5	4.8
4: Read text, select main ideas, and restate textual concepts in their own words	4.3	3.6

Table 8. Assessment of Pre and Post Information Literacy Assignments in CEE 3235 Advanced Transportation Engineering

Questions/Outcomes		2010		2011	
Number of students		11		11	
Outcome	Assessment Question	Pre-quiz	Post-quiz	Pre-quiz	Post-quiz
13: Know how information is formally and informally produced, organized, and disseminated	What is the most comprehensive civil engineering database?	18	73	50	73
13: Know how information is formally and informally produced, organized, and disseminated	Which statement best describes TRID?	91	82	58	73
9: Demonstrate an understanding of intellectual property, copyright, and fair use of copyrighted material	Which statement best describes peer-reviewed journal articles?	82	100	92	82
14: Determine the availability of needed information and make decisions on broadening the information seeking process beyond local resources	What is the difference between a handbook and a journal article?	91	91	75	100
19: Select efficient and effective approaches for accessing the information needed	Where is the best place to find specifications for transportation projects?	55	73	58	91
22: Recognize that existing information can be combined with original thought, experimentation, and/or analysis to produce new information	Which of the following items are representative of a synthesis?	9	55	25	9
22: Recognize that existing information can be combined with original thought, experimentation, and/or analysis to produce new information	Which of the following items are representative of a case study?	100	100	83	91

Table 9. Assessment of Pre and Post Information Literacy Assignments in CEE 4224 Transportation Facilities Design and CEE 8439 Civil Engineering Materials in Fall 2011 Semester

Outcome(s)		CEE 4224		CEE 8439
Number of students		49		21
Outcome	Assessment Question	Pre-quiz	Post-quiz	Pre-quiz
13: Know how information is formally and informally produced, organized, and disseminated	What is the most comprehensive civil engineering database?	65	70	24
13: Know how information is formally and informally produced, organized, and disseminated	Which statement best describes TRID?	41	54	57
19: Select efficient and effective approaches for accessing the information needed	Which document would not include design standards?	92	95	90
23: Identify the purpose, audience, value, and differences of potential resources in a variety of formats	Which organization would not be able to provide you with design standards?	14	24	14
22. Recognize that existing information can be combined with original thought, experimentation, and/or analysis to produce new information	Match the item below to its best definition. a. Specifications b. Codes c. Standards — 1. Process-driven 2. Value-driven 3. Both value- and process-driven	5	68	29

Table 10. Assessment of Final Research Paper in CEE 4331 Solid and Hazardous Waste.

Outcome(s)	2010	2011
Number of students	20	21
10: Select an appropriate documentation style and use it consistently to cite sources – In-text citations	3.1	3.6
10: Select an appropriate documentation style and use it consistently to cite sources – Bibliography	3.7	4.1
8: Communicate clearly and with a style that supports the purposes of the intended audience 17: Integrate new and prior information in a manner that supports the purposes of the product	3.7	3.9
4: Read text, select main ideas, and restate textual concepts in their own words 9: Demonstrate an understanding of intellectual property, copyright, and fair use of copyrighted material	3.2	3.7
22: Recognize that existing information can be combined with original thought, experimentation, and/or analysis to produce new information 25: Extend initial synthesis, when possible, at a higher level of abstraction to construct new hypotheses that may require additional information 26: Draw conclusions based upon information gathered	3.4	3.6

Table 11. Assessment of Comparison of Sources Assignment in CEE 4801 Foundation Design

Outcome(s)	2010	2011
Number of students	44	43
4: Read text, select main ideas, and restate textual concepts in their own words 9: Demonstrate an understanding of intellectual property, copyright, and fair use of copyrighted material	5.0	4.8
13: Know how information is formally and informally produced, organized, and disseminated	4.0	4.5
10: Select an appropriate documentation style and use it consistently to cite sources – In-text citations	4.5	3.5
10: Select an appropriate documentation style and use it consistently to cite sources – Bibliography	4.1	3.9
23: Identify the purpose, audience, value, and differences of potential resources in a variety of formats 24: Examine and compare information from various sources to evaluate reliability, validity, accuracy, authority, timeliness, and point-of-view bias	4.7	4.8

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