# PRE-PRINT VERSION

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# The Student View on Online Peer Reviews

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## ABSTRACT
Peer review is used as an effective quality assurance measure in many contexts, including science, business, programming or education. In education, several studies confirmed the positive effects of peer reviewing on student learning. Based on recent research concerning the role of media in the peer review process this study investigates how students perceive the process, content and effects of peer reviews. We also analyze students' opinions on different modes of peer reviewing activities, e.g. online vs. face-to-face reviewing. In the context of a computer science course on scientific writing, these research questions were addressed by administering an online questionnaire (n=38) and analysis using quantitative and qualitative methods. Results indicate that students value the peer review activity, take peer reviews seriously and provide comprehensive and constructive reviews. Findings also show that students prefer written online reviews with the possibility of oral follow-up questions to reviewers.

## Categories and Subject Descriptors
K.3.1 Computer Uses in Education: Collaborative Learning

## General Terms
Human Factors, Design, Measurement

## Keywords
Peer review, Peer assessment, Online assessment, Communication

# 1. INTRODUCTION
In many disciplines, like in software engineering [11, 17, 19, 22], in accounting [1], or in the scientific community [21], peer reviews have become an essential means of quality assurance. Gradually, peer reviews have also been gaining importance as a pedagogical element within the higher education context, particularly in the social sciences [6, 8, 12, 13, 20] and in engineering [5, 14, 17]. Although peer review has been used in many different educational settings, it is most often discussed in the context of writing classes, for instance, to improve writing and communication skills as well as to learn from reviewing others' work and reviewers'

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comments [11]. Although many studies focus on validity and content of reviews [7, 8, 11, 14, 19], they also discuss positive effects of peer reviews on students' "generic skills." This includes development of evaluation skills, increasing reflection skills, developing awareness of the quality of own work, and learning from peer contributions [8, 19].
A central concern in this paper is to investigate students' perception of online peer review activities and outcomes, and how they perceive the suitability of written online peer reviews compared to oral face-to-face peer reviews. We present the design and results of an empirical study with computer science bachelor students in a course on "Basics of Scientific Writing".
The paper is structured as follows. The next section introduces background and applications of peer reviews. Section 3 is dedicated to the empirical part of the study, which includes the research questions, research design, methods used, a description of the course context, as well as the results of the study. Section 4 concludes with a summary and outlook on future research.

# 2. PEER REVIEWS

Peer reviews are used for different purposes in a variety of disciplines. For instance, in software engineering processes peer reviews are used to detect deficiencies in the code or other project artifacts, and to identify possibilities for improvement [10, 22]. In writing classes peer review is used as a feedback mechanism in the writing process; students assume the roles of editors or reviewers giving feedback on their peers' work [12]. While many studies investigate the effects of peer and educator reviews on revisions [6, 11, 12, 20], other studies compare different modes of evaluation, e.g. pencil-and-paper reviews vs. online peer reviews [15, 18]. In the scientific community, peer review is the primary method of quality assurance, applied for example by editors of scientific journals or conference proceedings. Based on expert comments on submitted papers, they decide which articles will finally be published [4].
In the educational context, several studies reveal that peer reviews can bring significant benefits to students' learning processes. Some of these are summarized in the following:

- Reviewing peers' work promotes the reflection and awareness of the quality on one's own work; the fact that both educators and peers will review student contributions may contribute to an atmosphere of positive reciprocal stimulation and competition [8, 19].
- Often, students are not that interested in their peer's work, since they are primarily occupied with managing their own workload. With the implementation of peer reviews in courses, students get the opportunity to learn and benefit from peer contributions [7].
- Based on the feedback provided by their peers, students can improve their own performances [7, 11], which may finally result in better learning outcomes.
- As a method of cooperative learning, peer review activities in teams may further social skills of team members [22].

In computer science education, peer review is used primarily in programming and writing courses. Our study, which is presented in detail in the following section, is situated in the latter context.

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# 3. EMPIRICAL STUDY

## 3.1 Research Questions

In this study we investigate the impact of media for peer-reviewing activities in higher education. Based on findings of previous studies in our teaching context [2, 3, 9] we analyze students' perceptions of the process and outcomes of online peer-reviewing in general and in comparison to face-to-face peer reviews. We focus on the following research questions:

- What perceived impact do peer reviews of student papers have on their learning process?
- What are the benefits and limitations of online peer reviews as a means of cooperative learning, i.e. how can they contribute to learning "from each other"?
- How can different review modes enhance the peer review process?
-

## 3.2 Research Design and Methods

For this case study we decided to select a course on scientific writing, in which peer reviewing is not just an enhancement of the assessment process, but also inherently relevant to the subject of the course: Students practice what they learn theoretically about peer reviews by reviewing their peers' papers. At the end of the course, we asked students to reflect on the peer-reviewing activities by administering an online questionnaire via the course homepage. The questionnaire included items about students' perception of the review process and outcome, which had to be scored on a five-level Likert scale. In the questionnaire we also posed open questions on different review scenarios to compare online with face-to-face peer reviews under certain assumptions.

In summer term 2008 the study was conducted in the context of a course on "Basics of Scientific Writing", which is part of the computer science bachelor curriculum at the University of Vienna. Instructors present relevant materials on scientific writing, e.g. literature research and use of (digital) libraries; structure of a scientific paper, guidelines for citing and referencing; scientific language, comprehensible writing; publishing processes in journals and conferences; and presentation at scientific conferences. The course activities were designed to resemble the complete process of a scientific conference, including paper submissions, peer reviews, and an oral paper presentation. Student teams had to select a topic, write a paper according to given guidelines, and "submit" it to the instructor. After the submission deadline students and instructors peer-reviewed all submitted papers such that each paper was reviewed by at least three persons (at least two students and the instructor). For the reviews, we used an online form as displayed in Table 1.

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**Table 1. Online peer review form**

| | ++ | + | ~ | - | -- |
|---|---|---|---|---|---|
| **Brief summary** | | | | | |
| 1. Brief summary of the reviewed paper (3-5 sentences) | | | | | |
| **Formal aspects** | | | | | |
| 2. Appropriate title | ○ | ○ | ○ | ○ | ○ |
| 3. Clear paper structure (cf. hourglass model) | ○ | ○ | ○ | ○ | ○ |
| 4. Appropriate introduction | ○ | ○ | ○ | ○ | ○ |
| 5. Motivation for topic selection | ○ | ○ | ○ | ○ | ○ |
| 6. Appropriate summary / results | ○ | ○ | ○ | ○ | ○ |
| 7. Correct use of style sheet | ○ | ○ | ○ | ○ | ○ |
| 8. Sufficient identification of sources in text | ○ | ○ | ○ | ○ | ○ |
| 9. Correct style for citations and references | ○ | ○ | ○ | ○ | ○ |
| 10. Compliance with paper length restriction | ○ | ○ | ○ | ○ | ○ |
| **Language and presentation** | | | | | |
| 11. Visual impression | ○ | ○ | ○ | ○ | ○ |
| 12. Spelling and grammar | ○ | ○ | ○ | ○ | ○ |
| 13. Avoidance of typing errors | ○ | ○ | ○ | ○ | ○ |
| 14. Coherence | ○ | ○ | ○ | ○ | ○ |
| 15. Scientific writing style | ○ | ○ | ○ | ○ | ○ |
| **Content aspects** | | | | | |
| 16. Authors demonstrate subject knowledge | ○ | ○ | ○ | ○ | ○ |
| 17. Accuracy of content | ○ | ○ | ○ | ○ | ○ |
| 18. Quality of content | ○ | ○ | ○ | ○ | ○ |
| 19. Appropriate argumentation and reasoning | ○ | ○ | ○ | ○ | ○ |
| 20. Thematic thread is identifiable | ○ | ○ | ○ | ○ | ○ |
| **Sources and references** | | | | | |
| 21. Use of “scientific” sources (i.e. no references of dubious origin) | ○ | ○ | ○ | ○ | ○ |
| 22. Reasonable number of sources | ○ | ○ | ○ | ○ | ○ |
| 23. Critical review of sources | ○ | ○ | ○ | ○ | ○ |
| 24. Original work (no plagiarism, no unaltered copying from other sources) | ○ | ○ | ○ | ○ | ○ |
| **Overall impression** | | | | | |
| 25. How would you grade the work (according to school grading system)? | ○ | ○ | ○ | ○ | ○ |
| **Suggestions** | | | | | |
| 26. Detailed comments and suggestions for improvement for the team: | | | | | |

Following the peer review phase, there was a face-to-face meeting between the instructor and each team of authors to discuss issues concerning the review outcomes and required paper revisions. After these meetings, students revised their submissions and prepared their final papers according to the reviews and instructions they received. In the final plenary meeting, students presented their papers to the whole group, with the instructor acting as the session chair similar to presentation sessions at conferences. Figure 1 illustrates all peer-review related course activities performed by authors, reviewers and instructors.

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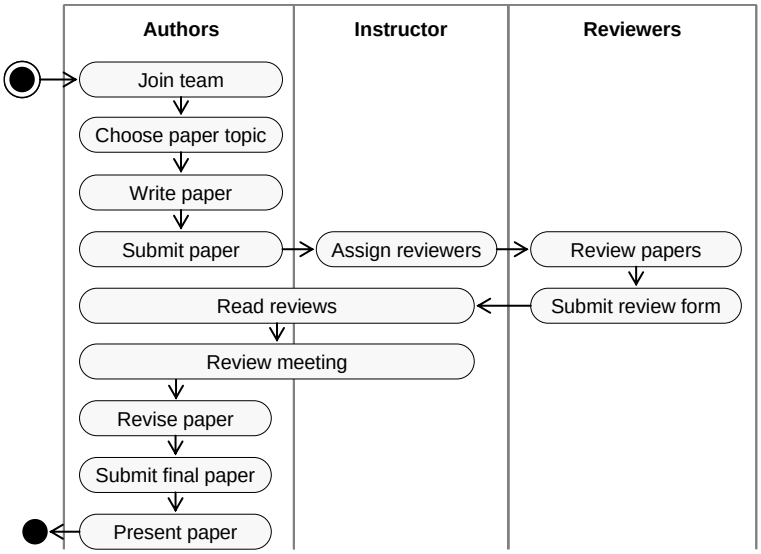


**Figure 1. Peer review related activities in the course.**

## 3.3 Results

**Sample.** Of the 52 students who participated in the three parallel course groups, 38 students (73%) filled out the questionnaire. Results of the quantitative part of the questionnaire are presented in terms of mean values (M) and standard deviations (SD). For the evaluation of students' responses to open questions, we applied a qualitative content analysis methodology [16]. The content classification scheme required for this method was developed inductively by two researchers to increase inter-subjectivity.

**Review Setting.** In general, students value the online peer review in the course as a very positive experience (M = 4.42, SD = .76). Reading the paper to be reviewed and writing the review took students about one and a half hours (M = 106.77 minutes, SD = 22.86). 39% of students have the impression that reviewing changed their perception of their own paper. On the one hand this leads to better recognition of the quality of their own contributions (e.g., "As the paper [I reviewed] was rather badly formatted and also on the content level by far less understandable than ours, I was particularly proud of our paper."), on the other hand they received inspiration on how to improve their paper (e.g., "As I have read my peers' papers more objectively than my own paper, I noticed what I could change in order to improve my paper.")
As evident from Figure 2, students think that they had thoroughly read their papers assigned for review (M = 4.27, SD = .65). On the one hand, this could mean that students were truly interested in their peers' papers. On the other hand, this could also be the effect of social desirability response set, particularly if they anticipated that their instructor would consider the questionnaire results for their grades (which, of course, was not the case). Besides the papers that they received for review, students did not show a lot of interest in reading additional papers (M = 2.53, SD = 1.46). Still, the peer reviewing task was perceived as a positive experience and students even had fun writing their reviews (M = 3.81, SD = .74).

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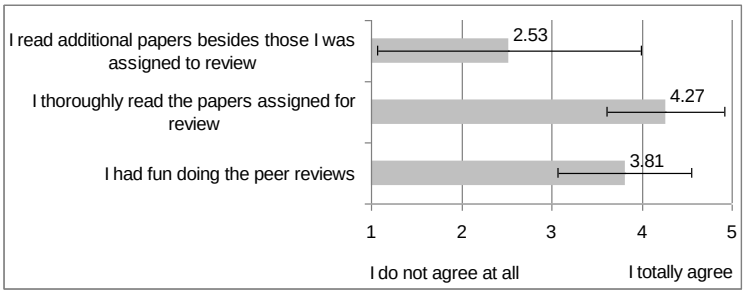


**Figure 2. Feedback on writing the peer reviews (n=38).**

**Difficulties in reviewing other papers.** As expected, some of the predefined review criteria (cf. Table 1) were more difficult to assess than others. As displayed in Figure 3, the criteria that are easiest to assess are the paper's language and presentation (M = 4.14), followed by its formal aspects (M = 4.00). We assume that having difficulties in assessing the correct use of sources and references (M = 2.95) and aspects concerning content (M = 3.34) arise from the fact that both require considerable subject knowledge and expertise for judgment. Additionally, beginners in scientific writing are not yet confident in the correct use of references and citations. Accordingly, it is evident that the mean value for difficulty of grading their peers' work is "located" somewhere in the middle (M = 3.58) of the review criteria.

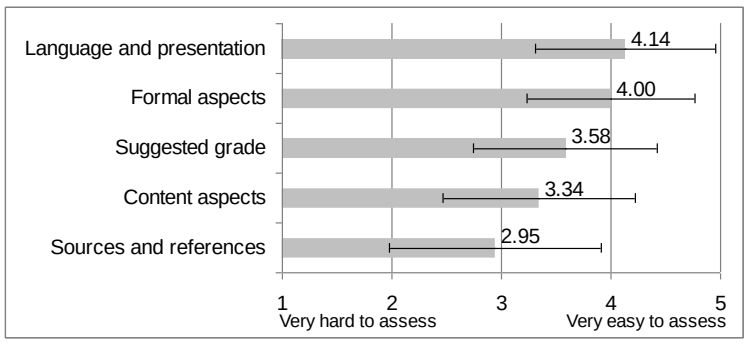


**Figure 3. Difficulty of assessing various review criteria (n=38).**

Figure 4 demonstrates that received reviews were considered as helpful (M = 3.82, SD = .83). Students had the impression that their peer reviewers had been competent in acting in this role (M = 3.87, SD = .83) and had read their paper thoroughly (M = 3.79, SD = .87). This result is in line with students' answers that they had thoroughly read their assigned papers to be able to write a good review. Additionally, this is supported by the responses to items regarding the quality of the received peer reviews. Students generally perceived them as being detailed, comprehensible, and consistent (M = 3.36, 3.62, and 3.81, respectively; see Figure 5). Furthermore, students answered that their peers brought up highly justified points for improvement in their reviews (M = 3.95, SD = .91). It is also evident from Figure 4 that students would generally not have written their papers differently if they had known the detailed review criteria (cf. Table 1) beforehand (M = 2.08). Also, there is only moderate appreciation for the possibility to ask questions to their reviewers (M = 3.03) or to write a reaction on their reviews (M = 2.78). The impact of the reviews on the revision of the paper was not judged very highly as well (M = 2.68).

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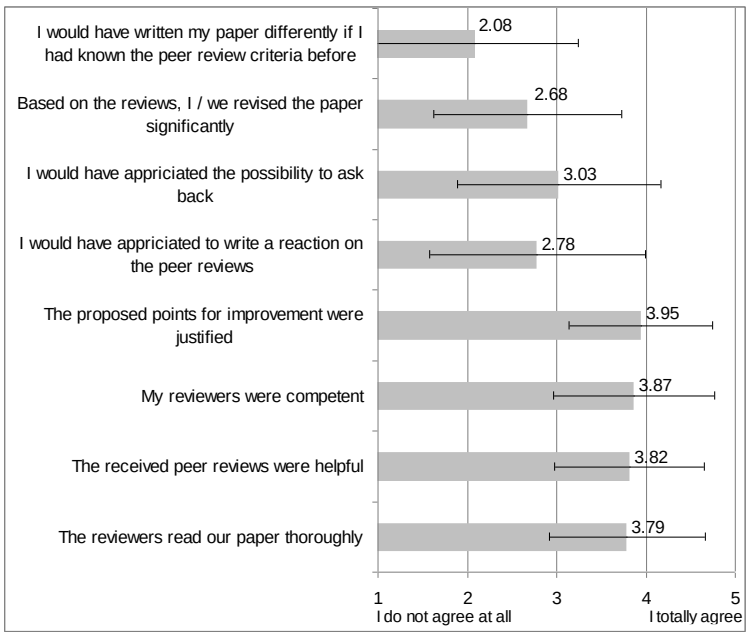


**Figure 4. Feedback on receiving the peer reviews (n=38).**

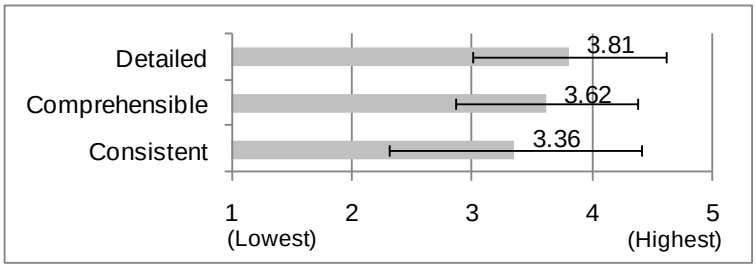


**Figure 5. Perception of qualities of received reviews (n=37).**

As only five students (13%) indicate that they would have judged their peers work differently in a setting of absolute anonymity, we conjecture that most peer reviews were accomplished on a fair and honest basis.

**Influence of peer reviews on students' learning.** As displayed in the histogram in Figure 6, students rated the impact of the peer reviews on their perception of essential elements of scientific papers as very high (M = 3.92, SD = 1.01). Additionally, they perceive a positive impact of the peer review activities on their own performance, as indicated by the following items: increased awareness about the quality of the own work (M = 3.86, SD = .79), increased confidence about own performance (M = 3.68, SD = .87), and increased reflection on own performance compared to other courses (M = 3.61, SD = .95). Moreover, the influence of peer reviews on the awareness of the own responsibility for the learning process, getting acquainted with the scientific peer review, and the own review competence were positively valued.
Considerably less valued was the impact of peer reviews on the learning climate (M = 3.05, SD = 0.97) and on putting more effort in the paper writing task (M = 2.35, SD = 1.16).

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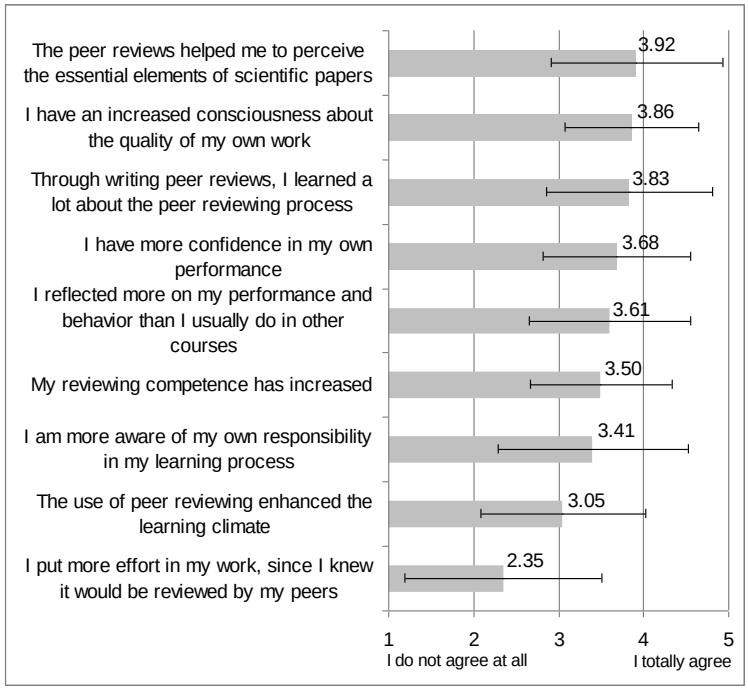


**Figure 6. Influence of the peer reviewing on various aspects of students' learning processes (n=38; sorted by mean value).**

**Online vs. face-to-face peer reviews.** While we used written online peer review in the course, we also asked students open questions about their preferences regarding different peer review scenarios. The questionnaire presented the following scenarios: (1) online written peer review; (2) oral feedback in a personal conversation; (3) written peer review providing the author with the possibility to address questions to the reviewers in a personal conversation; and (4) oral feedback in a personal conversation with the provision of a written handout.
Qualitative analysis showed that students clearly favored written peer reviews with the possibility of asking questions to reviewers (26 positive statements). Only five students judged this mode as unsuitable, and two judged it as appropriate under reserve. Generally, the answers to the open questions were rather heterogeneous. Reducing the original response classification scheme to a simple positive/negative scale reveals that the ratio of positive statements compared to negative ones is particularly high for written reviews in general (82%; scenarios 1 and 3) and for written peer reviews with the possibility to address questions to reviewers (72%; scenario 3).
Students emphasized that in settings with oral elements it is easier to resolve misunderstandings (19 statements). As an advantage of written reviews, students mentioned the later availability of review documentation (10 statements). Being able to address questions to reviewers was also found explicitly in 7 responses. Furthermore, analysis of responses revealed that many students are reluctant to express critique in face-to-face settings (3 statements). Students expect that oral reviews would therefore be "milder" than written ones and thus less constructive (3 statements). One student, for instance, explains that "[oral peer reviews are] good, but difficult to realize because nobody has the heart to say anything." Probably also due to a reluctance to criticize their peers, three nominations emphasized that feedback is not objective (e.g., "due to sympathy for the author, oral feedback may get biased / useless.")

The combination of the advantages of oral and written communication is particularly positively highlighted for written peer reviews with the possibility to address questions to reviewers in a personal conversation (11 statements); five students explicitly consider this alternative as the best mode. For combining oral feedback with handouts, some students added that oral reviews would be sufficient and handouts would not be necessary (5 statements). More detailed discussions on the results of this qualitative analysis can be found in [3].

# 4. SUMMARY AND OUTLOOK

In this paper we presented a case study in an undergraduate computer science course on "Basics of Scientific Writing" held during summer term 2008 at the University of Vienna. First, we analyzed students' perceptions about the peer reviewing activities and outcomes. Second, student opinions on differences between written online peer reviews and face-to-face peer reviews were investigated.

The results show that students appreciate the use of online peer reviews in the course and take the task seriously, i.e. they read the papers to be reviewed thoroughly and they see that their peers also put effort into their reviews. However, we also found that students perceived several review criteria as difficult to judge. In particular, they perceive it as difficult to evaluate the correct use of sources and references as well as content-related criteria. Further research is required to see if more advanced students (the course is offered to third-semester computer science bachelor students) would have more confidence in assessing these criteria.

Students' responses also indicate that they are confident that their peer reviewers were acting competently. The received reviews were generally perceived as considerably detailed, comprehensive, and consistent. Moreover, students reported that the peer-reviewing activity had a positive impact on the perception of the essential elements of scientific papers, which is a desirable outcome in a course on scientific writing. The peer review setting also seemed to increase awareness about their co-responsibility for their own learning processes.

Concerning their opinions about different peer review scenarios, analysis of open questions in the questionnaire revealed the following results:

- Written reviews offer better documentation of review outcomes.
- Some students mention the importance of having the possibility to address questions to reviewers during the review process.
- Some students clearly favor written reviews because they believe that many students do not have the "heart" to criticize in a face-to-face review setting. They expect that oral reviews are "milder" and, hence, not as constructive as written ones.
- Students frequently highlight that a face-to-face peer review setting would help in preventing misunderstandings.
- Regarding oral feedback using written handouts, students consider handouts as needless, since oral feedback would be sufficient.
- Out of the four peer review settings (written peer review, written peer review with questions, oral peer review, oral feedback with written handouts), students favored the written peer review with the possibility to ask questions to reviewers. One future research thread could be setting up a study to thoroughly test and evaluate such a setting.

In sum, the findings encourage further use of peer review scenarios in computer science education. This activity is capable of helping in facilitating the development of generic skills (e.g., giving feedback, communicating, collaboration, etc.) as well as subject-specific

competences (i.e., the hard facts), and both of these skill sets are pivotal assets of our Computer Science graduates in the job market.

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