A CSCL Script for Supporting Moral Reasoning in the Ethics Classroom

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Abstract. In many engineering schools around the world, ethics is a compulsory subject. However, teaching ethics in engineering is not a simple duty, as engineering students usually attribute less value to learning ethics than to other subjects. Hereby, we report on our initial efforts towards developing a CSCL script for fostering meaningful ethical discussions among engineering students in the classroom. The script comprises successive phases in which the students conduct ethical judgments individually, in a small group and in a teacher-mediated class group discussion. The process seeks that students cast their judgments without inhibitions, so it maintains students' anonymity in all phases. A trial with 35 engineering students confirmed that the tool offers a good usability, averaging a 79.9 score in the System Usability Scale (SUS). Furthermore, the trial cohort highlighted the convenience of anonymity when discussing ethical cases. Analysis of student behavior revealed that ethical judgments tend to be stable across the activity. However, judgments changed mostly in groups where more discussion was generated. In the future, we will study whether group composition that maximizes the heterogeneity of the students in the groups according to their individual ethical appraisals increases the likelihood of students varying their ethical judgments, as a result of argumentative and reflexive processes in discussions.

Keywords: CSCL script · Mobile CSCL · Moral reasoning · Engineering education

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1 Introduction

In many engineering schools around the world, ethics is a compulsory subject in the engineering curriculum at the undergraduate level. Interest in ethics education in engineering has grown in the past decades, mainly because of requirements posed to institutions by accreditation systems such as ABET [1]. In addition, in recent years a number of situations with public and worldwide notoriety have arisen with regard to unethical behavior involving engineers in the workplace [2], as well as engineering students in classrooms [3], which have raised awareness about the necessity to teach students competencies regarding ethical reasoning. Other current concerns such as environmental awareness and advances in areas such as machine learning, cybersecurity and big data have brought about new ethical dilemmas and situations that engineers must be capable to reason about and cope with effectively [4]. Although ethics is present in engineering curricula and is part of the competencies in many graduate profiles of engineering programs around the world, teaching ethics in engineering is not a simple duty, as there are epistemological differences insofar as how teachers and students perceive ethics as an engineering subject [5, 6]. Engineering students usually give less value to learning ethics than to other scientific or technological subjects [7]. On the other hand, there has been a lack of scholarly research as well as teacher awareness regarding pedagogies that can yield the best results in the teaching of engineering ethics [8].

Traditional forms of teaching dominate in engineering classrooms, affording limited possibilities for students to actively participate, and to take an agentic role in learning. Ethical education activities prompting for socialization of points of view, participation in discussions, reflection and student agency are not akin to traditional pedagogy in engineering classrooms, thus for many engineering students it can be challenging to participate in classroom debates about ethical issues, by verbalizing their emotions, reasoning and beliefs. Ethical debates around cases assume that students must not only demonstrate ability to apply moral reasoning and develop ethical judgments, but also to proficiently and meaningfully communicate these processes, expecting to be listened, understood and respected by their peers and the teacher [7, 9].

In this paper we present a Computer-Supported Collaborative Learning (CSCL) script [10] focused on fostering students' reflection around ethical cases in the classroom. Students face the ethical case in several phases comprising individual and collaborative work. The process seeks that students express their judgments without inhibitions, so it maintains the anonymity of the students among themselves, even while working collaboratively. On the other hand, the teacher monitors the activity and he/she can easily notice the groups of students presenting the greatest differences in the ethical evaluation of the case discussed. Lastly, the teacher can engage the entire class group in a discussion, commenting on divergent ethical judgments found, and encourage students to further reason, argue and debate considering different points of view and judgments.

In the following sections, we present a discussion on the current state of ethics teaching in engineering, the design of the proposed CSCL script, a pilot conducted with computer science students and its results, and finally, conclusions and future research avenues.

2 Ethics Education in Engineering

According to Holsapple et al. [5], faculty and administrators in engineering schools often describe ethics education as comprising a balance between knowledge of ethical codes of conduct and understandings of ethical rights and wrongs with a more nuanced, complex understanding of ethical dilemmas that fall into a "gray area". Engineering graduates, however, often report that their ethics education was almost completely based on the application of codes, allowing for a lesser depth and complexity in the analysis of ethical cases. While ethics is meant to be a central component of today's engineering curriculum, it is often perceived as a marginal requirement that must be fulfilled [6].

According to Genova & Gonzalez [7], the pedagogy of ethics for engineers must consider the characteristics of thought inherent in students' scientific training and their future professional focus. The authors characterize the mentality of engineers with the following description: *the real world is what can be touched and measured, the prototype of rational thinking is mathematical-deductive reasoning, and the best results are obtained by following standard procedures*. Therefore, it is a priority to acknowledge the difficulties of engineering students in recognizing the value of philosophical thinking and moral theory. Engineering students may be able to learn ethics based on standards, however, overreliance in this approach may have dangerous consequences, as it may result in reducing ethical reasoning to the application of rules in mechanical or quasi-algorithmic ways, without necessarily developing a deep understanding of the cases or the implications of decisions for the various actors. In addition, under this approach it is clear that students may find themselves in difficulties trying to understand why one ethical standard may be preferable to another or the implications that adopting an ethical standard may have for the student.

In a systematic literature review on interventions for teaching ethics in engineering in the United States, Hess and Fore [8] report that the most common methods involved exposing students to codes or standards, using case studies, and discussion. In half of the analyzed samples, they observed that the interventions integrated ethical units in pre-existing engineering courses. They consider that this is desirable, as teaching ethics in a contextualized manner is achieved by means of adopting more realistic problems and scenarios in engineering practice. The authors emphasize the need to develop learning experiences where students reflect not only on their own emotions, but also on emotions of others and can develop greater empathy with the actors and situations.

May and Luth [11] argue about the importance of students developing moral efficacy, that is, confidence in their ability to actively and positively deal with ethical issues that arise in the workplace, and to overcome obstacles in developing and implementing ethical solutions to ethical dilemmas. Considering Bandura's theorization on self-efficacy [12], as well as Kohlberg's on moral development [8], ethical learning experiences should foster ethical agency, and should not limit students to a role of mere spectators who only seek to apply the most appropriate ethical standard to each situation. In addition, it is desirable that the activities allow all students to participate and express themselves, and facilitate them to conduct their ethical evaluations and argumentation in an honest and authentic way, without feeling inhibited by their peers.

Numerous experiences in Computer-Supported Collaborative Learning (CSCL) settings show that face-to-face discussions supported by computer-mediated communication can provide students with equal opportunities to contribute to the construction of shared knowledge and meanings in the classroom [13]. Furthermore, CSCL scripts provide structure and scaffolding for communication and cognitive processes towards these aims, and can facilitate building on the reasoning of others [14]. Many examples can be found in the literature about CSCL script schemata and patterns, and how these can be instanced (tailored) to suit a specific pedagogical rationale [15]. In particular, in ethics education, AGORA-net [16] is a CSCL script aimed at ethical case analysis. It confronts small groups with the task of identifying and reconstructing different stakeholder positions on controversial ill-structured cases, where students defend their positions in a graphically represented argument by means of interactive software. However, in addition to the tool itself, the authors propose a comprehensive pedagogical framework to apply it in an ethics course effectively. Their approach demands several hours to conduct a single activity, encompassing a variety of individual and collaborative phases, as well as adopting an enabling instructional design that divides the course into parallel tracks; one addressing content issues, and the other ethical skills. Thus, the adoption of this approach demands educators to undergo course transformation that will likely require institutional support and adequate incentives.

Another well-documented technology-enhanced environment supporting the discussions in the class is Peer Instruction (PI), based on either traditional Classroom Response Systems (CRS), or mobile applications, such as Socrative [17, 18]. In these settings, short episodes of lecturing are followed by questions to which students respond to individually and in small groups. The instructor can examine students' responses and provide feedback to the class, based on the observed statistics, commonly depicted as a histogram. However, under the traditional implementation of this activity, it can be difficult for the instructor to present complex ethical cases to the students, prompting them to answer multiple interrelated questions, and track the progress of the groups through these. In addition, students' work in small groups is not anonymous, thus hindering their willingness to propose and defend ethical views and judgments that could appear conflictive with others'.

3 Our Proposal

3.1 Design Principles

Reflecting on the literature discussed above, and taking into consideration the needs of ethics teachers in the educational context of the present study, we adopted the following design principles to create the CSCL script here presented, aimed at supporting teaching of ethical judgment in the classroom:

- **Embeddable in a traditional ethics course:** Ethics educators must be able to embed the script within the time of their face-to-face classes, avoiding other significant curricular or methodological changes in their courses. The script is designed

for ethics educators who use to conduct analysis of ethical cases in their classes, thus it should be possible for them to adopt the script with no need to prepare additional materials.

- **Multidimensional judgments:** The script allows students to perform complex ethical judgments considering several relevant dimensions in an ethical case.
- **Anonymity of judgments and interactions:** In order for students to make authentic ethical judgments while lessening their conflict anxiety with their peers, the tool allows anonymous participation. While the teacher can see the identity of the students, it is the teacher's responsibility to keep student identity confidential.
- **Domain independence:** The script makes no assumptions about the professional or scholarly domain in which the ethical cases are situated, so it can be applied to the teaching ethics in different disciplines and at various educational levels.
- **Device independence:** The script can be used on any mobile device or desktop computer. The interface is responsive and can adapt to different form factors, input methods and screen resolutions.
- **Ease of use:** In the best interest of facilitating user adoption of the tool, the design of the tool focuses on achieving ease of use through user interface minimalism and intuitive design. It is relevant to minimize teacher training efforts, as well as facilitating students' intuitive and quick adoption of the script.

3.2 Script Description

The script comprises successive phases in which the students conduct ethical judgment on a given case, while the teacher configures, controls and monitors the activity of individual students and groups. The phases of the script are Prerequisites and Setup, Reading & Individual Appraisal, Appraisal Sharing, Group Discussion, and a teacher-mediated Whole Class Discussion phase. The script draws some inspiration from the pyramid CSCL script pattern [15]. However, rather than co-constructing shared artifacts, learners always work on their own ethical judgements. Their ethical judgements are ought to evolve independently, as a result of sharing them and commenting on them anonymously in small group interactions. Script phases are as follows:

Prerequisites and Setup. To create and configure an activity, the teacher must indicate its title, a brief description, and provide a PDF file containing the description of the case involved. In addition, the teacher defines the ethical judgment rubric for the case, which will be used by the students during the activity. The components of the rubric are a set of statements (or questions) addressing the relevant aspects of the case, and for each of these statements there is a semantic differential scale that allows the student to conduct a quantitative assessment, on a scale from 1 to 7. The intent of the rubric is to make the ethical judgments of students and groups comparable. In addition, it fulfills a role of scaffolding, helping the student to focus on the relevant ethical aspects of the case, and to submit an ethical judgment in the limited time available during a face-to-face session. The teacher can generate an access code for students to easily join the classroom session. Once the students enter the session in the classroom, the teacher triggers the random formation of groups of two to five students. The teacher can see the composition of the groups, but this information remains hidden to the students, so

students do not know which are their groupmates at this stage. After the groups are formed, the teacher starts the activity and the students' transition to the Reading & Individual Appraisal phase.

Reading & Individual Appraisal. During this phase, each student reads the case presented and issues his/her first ethical assessment individually, without interacting with others. To carry out the ethical judgment, the student has the rubric defined by the teacher to his avail (see Fig. 1a), which includes statements relevant to the case accompanied with their respective semantic differential scales. The software presents the statements in tabbed interface, i.e., each statement appears in a different tab, and completed tabs (ethical judgments) are marked with a green line. Each ethical judgment entered by the student through a semantic differential scale score must be justified with a brief message. The teacher can monitor the progress of the groups through his/her interface (see Fig. 2, 'Individual Appraisal' phase). The interface displays the score that each student has given to each statement/semantic differential scale in the evaluation of the case. The teacher can also inspect the comments written by the students to justify their individual judgments (see Fig. 3a).

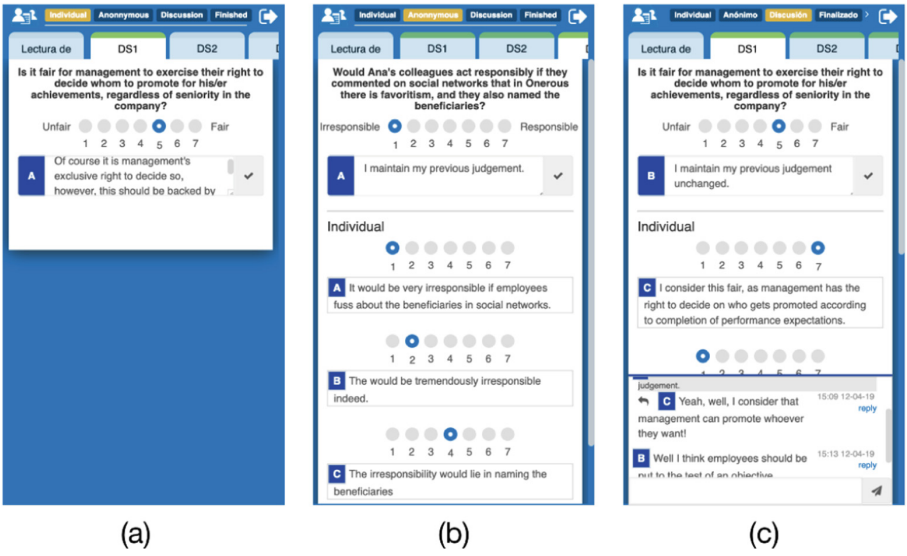

Fig. 1. Students' user interface in the (a) Individual appraisal, (b) Appraisal sharing, and (c) Group discussion phases

Appraisal Sharing. Once the students submit their individual ethical judgment for the case, the teacher triggers the transition to the Appraisal Sharing phase, in which each student sees his/her ethical judgment of the previous phase, along with the evaluations of their classmates (see Fig. 1b). The identity of all groupmates remains hidden. After reviewing the ethical judgments of his/her peers, the student may keep his/her original ethical judgment unchanged, or modify it. In either case, the student must provide a

Group	Phase	Statement 1	Statement 2	Statement 3
1	Individual Appraisal	5 7 1	4 7 2	2 1 4
1	Appraisal Sharing	7 5 1 4.3 6.0	7 5 4 5.3 3.0	1 1 2 1.3 1.0
1	Group Discussion	Chat: 23 1 5 3 3.0 4.0	Chat: 14 7 7 3 5.7 4.0	Chat: 3 1 2 2 1.7 1.0

Fig. 2. Teacher's monitoring grid displaying the progress of a group. 'DS' columns show the points given by the students to each scale of the differential semantics. (Color figure online)

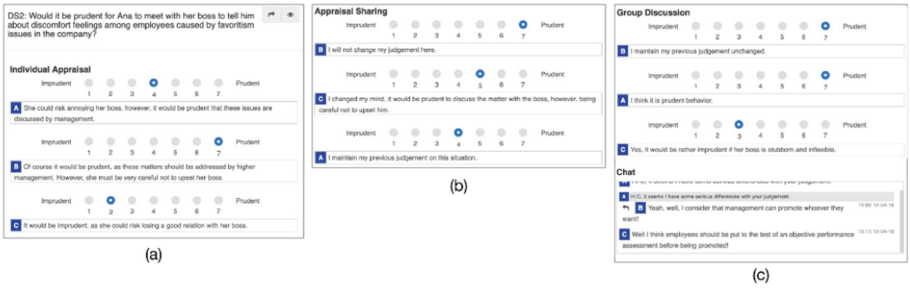

Fig. 3. Teacher's visualization of activity in a particular group, comprising (a) Individual appraisal, (b) Appraisal sharing, and (c) Group discussion phases

score to each for each of the semantic differential scales and issue a comment to justify his/her judgments.

The teacher can monitor the progress of the groups during the Appraisal Sharing phase and quickly review the scores given by each student, along with the average score, the score range, and a color indicator showing the dispersion that exists in the group with respect to the assigned scores (see Fig. 2, 'Appraisal Sharing' phase). It is also possible for the teacher to read students' justification for each ethical judgment (see Fig. 3b). The color indicator follows a traffic light color scheme; if there is a high dispersion in the scores within a group (that is, a high disagreement in the ethical judgments), the color indicator is red. If the dispersion is medium, the color is yellow, and the green color indicates there is low dispersion. In addition, the teacher can review in detail all the ethical judgments that students made in each group.

Group Discussion. Once the groups have finished the appraisal sharing phase (i.e., each student has submitted his/her revised ethical judgments), the teacher triggers the transition to the Group Discussion phase of the activity. In this phase, group composition remains as before, and each student can see his/her ethical judgments performed so far, along with the judgments of his/her peers since the individual appraisal. Students can chat through instant messaging (i.e., by means of an interface resembling instant

messengers such as WhatsApp Messenger or Telegram), and discuss their judgments about the ethical case (see Fig. 1c). In this phase, the students have one last opportunity to modify their ethical judgment, as a result of interacting with their peers and revising the judgments conducted in the group. The teacher sees the deliverables of the Group Discussion phase in his/her interface (see Fig. 3c). S/he can inspect the conversation chat log in each group to further understand the scores each student has assigned to each semantic differential scale. The teacher might be more interested in reviewing group discussions where there is a higher level of disagreement; therefore, the same traffic light color scheme is used to facilitate identifying groups with higher disagreement among peers. Finally, the teacher sees for each group an indicator with the number of chat messages that have been exchanged among its members (see Fig. 2), which helps finding the groups where there has been greater discussion.

Whole Class Discussion. Once the groups finish the Group Discussion phase, the teacher can advance to a Whole Class Discussion phase where s/he can present the class with conflicting ethical judgments from different groups, and prompt students to express their opinions and judgments. The teacher must be careful to select conflicting or divergent judgments judiciously in order to stimulate a debate leading to an ethically grounded case resolution. The goal is that students recognize the virtues of the resolution reached in this final discussion, which can help them build ethical schemata, as well as ethical meaning they can transfer to different cases in their future as students, or professionals in the workplace.

3.3 Script Implementation

The CSCL script is implemented as a web application based on a stack composed of Node.js [19] as the runtime environment, Express.js [20] as the web application framework, a custom-built data access layer based on JavaScript and SQL, optimized for speed and concurrency. PostgreSQL [21] is used as the underlying database engine, and Embedded JavaScript (EJS) [22] is used in view templates. In addition, the Bootstrap [23] library version 3 is used consistently across the user interface. The technologies used to implement the script support utilizing it with devices with different form factors (i.e., in a device-independent manner), and allow simple migration of the web application to a distributed cloud environment, including dedicated/separate nodes for database and the web application itself, in case scalability to large numbers of concurrent users becomes a necessity.

4 Trial Activity

A trial activity was carried out with the intent to conduct a usability evaluation of the script and its supporting software, together with an exploratory study on the potential of the activity to generate ethical discussion in small groups. The exploratory study is an early attempt to examine the extent to which students modify their ethical judgments when facing the judgments of their peers, as well as analyzing student behavioral patterns in discussions, depending on the homogeneity or diversity of ethical judgments.

4.1 Educational Context

We conducted a pilot activity in a Web Technologies course during the first semester of 2019 in a Latin American university. The course lasts one semester, it is compulsory for students pursuing a computer science major in engineering, and optional for students of other engineering majors. In the course the students learn about the design and functioning of the world wide web, including protocols and application architectures, as well as web application development using well-known tools and frameworks. Although the course does not focus on the ethical aspects of web engineering and technologies, we considered the course cohort was apt for a trial of the CSCL script, as the students had already studied an introductory course in engineering ethics, and thus had experience learning ethics based on case discussions and essay writing.

4.2 Sample Description

The trial cohort was composed of 35 students from the Web Technologies course. Six students were female and 29 male. Ages ranged between 21 and 23 years. As for student enrollment in engineering majors, eleven students were enrolled in computer science, seventeen students in industrial engineering, five students in electrical engineering, and two in civil engineering. The students voluntarily participated in the trial.

4.3 Method

The course performed a complete activity based on an ethical case dealing with employee favoritism in a software development firm. The case was inspired by the 'Onerous Favorites' case available at the Markkula Center for Applied Ethics at Santa Clara University [24] (see Fig. 4). The statements and Semantic Differential Scales

Ana is a software engineer working at Onerous, a software development firm with a reputation in banking and finance sectors. Ana has witnessed various incidents of managerial favoritism towards particular employees in the company during her long professional career. Recently, she found a particularly unfavorable scenario because it involved some of his closest collaborators.

Two employees who had recently been hired at Onerous received visible roles in a prominent project. Once the project was completed successfully, management gave the new employees generous promotions. On the other hand, management asked Ana's co-workers to play supporting roles in the project and they were not given any special recognition (ie, promotions) for their work and contribution to the success of the project.

Ana's co-workers were very upset because they perceived that there was favoritism in the company, so they asked Ana for advice, as they knew that she had extensive professional experience in the company. They said that they would leave the company if the management insisted on benefiting the new employees in a clear sign of favoritism.

When Ana listened to her colleagues, she was inclined to take this matter to her manager. However, he felt that would be useless because he considers his manager to be stubborn and inflexible.

Questions:

Is it fair for management to exercise their right to decide whom to promote for his/er achievements, regardless of seniority in the company?

Would it be prudent for Ana to meet with her boss to tell him about discomfort feelings among employees caused by favoritism issues in the company?

Would Ana's colleagues act responsibly if they commented on social networks that in Onerous there is favoritism, and they also named the beneficiaries?

Fig. 4. The ethical case used in the trial activity.

Table 1. Ethical judgment statements and their corresponding Semantic Differential Scales (SDS), as presented in the trial activity.

SDS	Statement/Question	Poles
1	Is it fair for management to exercise their right to decide whom to promote for his/her achievements, regardless of seniority in the company?	Unfair – Fair 1–7 range
2	Would it be prudent for Ana to meet with her boss to tell him about discomfort feelings among employees caused by favoritism issues in the company?	Imprudent – Prudent 1–7 range
3	Would Ana's colleagues act responsibly if they commented on social networks that in Onerous there is favoritism, and they also named the beneficiaries?	Irresponsible – Responsible 1–7 range

(SDSs) utilized in the trial activity are shown in Table 1. The activity lasted for 75 min in total. The first fifteen minutes were used to give instructions to the students, and to wait for the students to connect to the wireless network and join the work session. Then, the activity required 50 min to complete its four phases. Finally, in the final ten minutes an adapted version of the System Usability Scale (SUS) [25] was administered through an online form. Two open-ended items were added to the scale questionnaire, in order to capture students' comments regarding aspects of the tool that were positively valued, and those that should be improved. In addition, a Likert item was added in scale 1–5 asking the student if he would feel satisfied using the tool in a course of the engineering curriculum.

5 Results

5.1 Usability Evaluation

The results of the SUS questionnaire reveal that the script and supporting software were found to be highly usable by the cohort of engineering students. The mean score of the SUS scale, which awards a maximum of 100 points, was 79.9, with a standard deviation of 14.3. For the calculation of the SUS score, only the first 10 items of the questionnaire were used, which correspond to those of the original SUS scale. The distribution of SUS scores is depicted in Fig. 5. According to [25], a score of 72.75 is considered to be ranked as good usability, and a score of 85.58 or above is considered to be excellent. Fifteen students (42.9%) of the sample presented a score equal or above this figure, thus evaluating usability as excellent. Ten students (28.6%) presented a score in the interval [72.75, 85.58), which regards the tool as having a good usability. Of the remaining students, nine (25.7%) considered usability to be 'OK', i.e., SUS score is in the interval [52.01, 72.75), and only 2.8% of the cohort considered usability to be poor.

Table 2 shows the adapted items of the SUS scale that were utilized, together with the descriptive statistics that resulted from administering them to the trial cohort. From the results, it can be observed that students evaluated the tool as easy to learn and use.

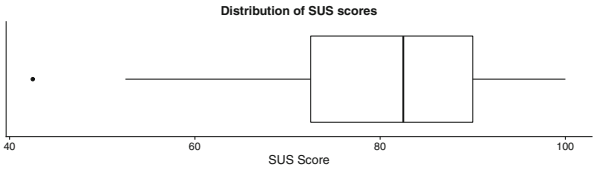

Fig. 5. Distribution of SUS scores as reported in the trial activity.

Table 2. SUS questionnaire item characterization and descriptive statistics.

N	Item stem	Type	*M*	*SD*
1	I think that this application could be used frequently in courses that teach ethics	Likert 1–5	4.45	0.66
2	I think this application is unnecessarily complex	Likert 1–5	1.91	0.78
3	I think this application is easy to use	Likert 1–5	3.88	0.93
4	I would need help if I had to use this application again	Likert 1–5	1.46	0.98
5	I think the functions of this application are easy to understand	Likert 1–5	3.94	1.19
6	I think there are many inconsistencies in this application	Likert 1–5	1.66	0.94
7	I imagine that other students could quickly learn to use this application	Likert 1–5	4.54	0.78
8	I found that using this application is uncomfortable and complicated	Likert 1–5	2.26	1.12
9	I feel very confident when using this application	Likert 1–5	4.14	0.94
10	I have to learn many details before using this application well	Likert 1–5	1.71	1.05
11	Do you think something could improve in this application?	Open-ended	-	-
12	What is the best thing you would highlight in this application?	Open-ended	-	-
13	Would you feel comfortable using this application in a course of your career?	Likert 1–5	4.14	0.91

Item 5, i.e., “I think the functions of this application are easy to understand”, had the greatest variability of them all. This may be explained by the fact that the students used the tool for the first time in the trial without any previous training, and they received instructions as the activity progressed. However, the average of this item was close to 4, which is satisfactory. Arguably, the result of item 9 reveals that the students perceived that the software functioned stably, as this can likely explain their sense of confidence using it. Finally, item 13, which does not belong to the original SUS scale, indicates that the majority of students would agree with the use of the tool in engineering courses.

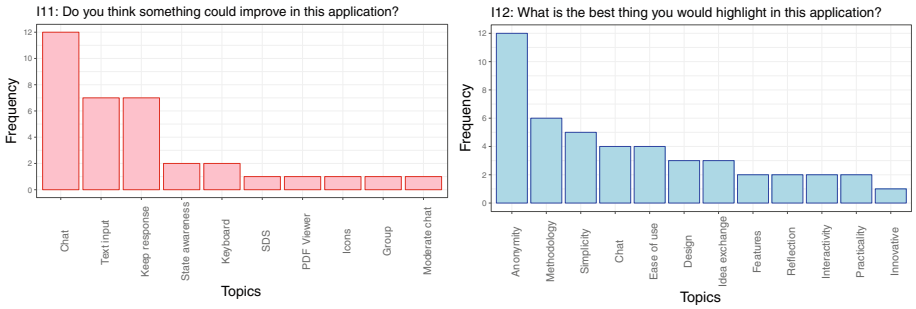

Fig. 6. Responses to open-ended items 11 and 12.

Figure 6 shows the categories of student responses to the open-ended items 11 and 12 of the questionnaire. With respect to the aspects that should be improved, the students emphasized that the chat interface used in the Group Discussion phase should be enhanced. The problems reported relate to the space available on the screen when using the chat interface, since the appearance of the onscreen keyboard pushes the interface upwards, so it becomes difficult to see the chat window and at the same see/read ethical evaluations on the same screen. On the other hand, the text input for SDS comments was uncomfortable for some students, as they claimed it only supported a limited amount of text, and the interface made difficult to scroll along a lengthy line and edit it. Finally, several students stated that it would be convenient for the interface to allow the student to submit the same response generated in the previous phase without changes. We consider that the incorporation of this feature could cause students to misuse it as a shortcut, without consciously making the effort to reconsider their ethical evaluation.

According to the results of item 12, the students valued the anonymity that is afforded by the tool when making ethical judgments, and interact with peers through the chat interface. Several students recognized value in the methodology, which first requires the students to carry out an individual ethical evaluation and then confront it with that of the classmates, to finally participate in a discussion moderated by the teacher. Finally, the students valued the simplicity of the tool and its ease of use, which is consistent with what was reported through the SUS questionnaire.

5.2 Evolution of Ethical Judgments Across the Activity Phases

Figure 7 (a) shows distributions of scores awarded by the students to the three Semantic Differential Scales (SDS) comprised in the trial case. Henceforth, we use colors blue, green and red to identify SDS1, SDS2 and SDS3, respectively. It can be seen that there is little variation in the distribution of scores awarded by students between the phases. Figure 7 (b) complements this information, showing the distributions of the absolute differences of scores of the SDSs between the phases of Individual Appraisal (IA), Appraisal Sharing (AS) and Group Discussion (GD). It can be seen that the most frequent scoring variations are of a single point in each case. In the SDS1, there was only one case of a peer who changed his/her evaluation in three

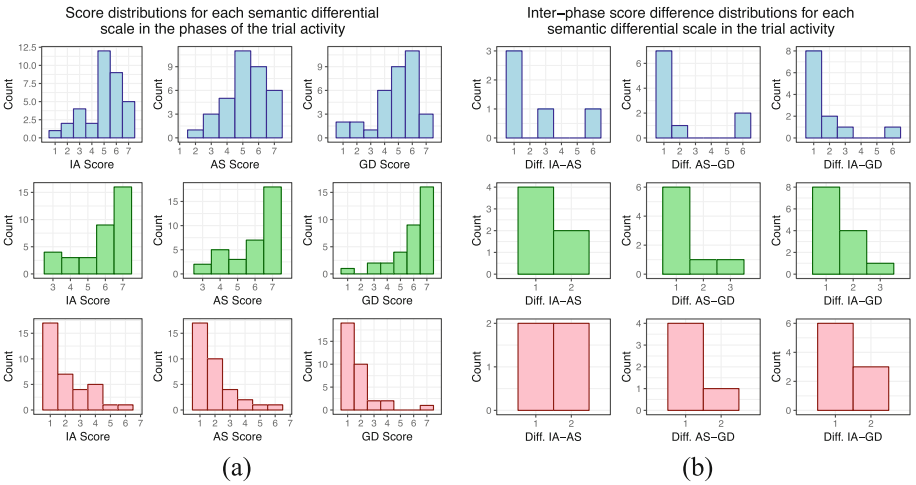

Fig. 7. (a) Score distributions per SDS scale in Individual appraisal (IA), Appraisal sharing (AS) and Group discussion (GD) phases. (b) Distribution of inter-phase SDS score differences (as absolute values). Colors: SDS1 (blue), SDS2 (green), SDS3 (red). (Color figure online)

points between the first and third phase, and another more extreme case of a peer who changed his/her evaluation in 6 points, that is, changed his/her evaluation to the opposite pole of the semantic differential scale. In SDS2, there was only one person who changed his/her evaluation in three points between the first and third phases. In the case of SDS3, there were three subjects who modified their evaluation in two points.

5.3 Chat Comments Versus Variation in Ethical Judgments

Although it is apparent that students modify their ethical judgments scarcely between the successive phases of the activity, we explored whether greater interactions through the chat interface were linked to an increased change in the ethical judgments (i.e., scores of the SDSs). To analyze this, we relied on an environment based on R 3.4.1 and the Quanteda package [26]. We built correlation matrices for each SDS (see Table 3), including sum (i.e., SUM_DELTA) and mean (i.e., MEAN_DELTA) of absolute differences (deltas) in group SDS scores between phases of Appraisal Sharing and Group Discussion, together with the sum (i.e., SUM_NTOKENS), mean (i.e., MEAN_NTOKENS) and standard deviation (i.e., SD_NTOKENS) of the number of tokens generated per group in chatroom conversation.

It can be seen that in the case of SDS1, there is a correlation of 0.72, and highly significant ($p < 0.01$), between the amount of tokens generated by the groups in the chat, and the average score delta, in relation to scores assigned by the members of each group to the SDS. As for SDS2, we did not find relevant correlations between chat activity and changes in ethical judgments. However, in the case of SDS3, we found a correlation of 0.87 ($p < 0.01$), between the average number of tokens written in the chat room by the peers in each group, and the sum of the SDS score deltas of the group

Table 3. Exploring correlations among group chat message statistics per SDS, and SDS absolute score differences per group between Appraisal Sharing and Group Discussion phases.

Statement/SDS 1	SUM_DELTA	MEAN_DELTA	SUM_NTOKENS	MEAN_NTOKENS	SD_NTOKENS
SUM_DELTA	1	0.77**	0.45	0.37	0.29
AVG_DELTA		1	0.72**	0.73**	0.65*
SUM_NTOKENS			1	0.91**	0.87**
AVG_NTOKENS				1	0.97
SD_NTOKENS					1
Statement/SDS 2	SUM_DELTA	MEAN_DELTA	SUM_NTOKENS	MEAN_NTOKENS	SD_NTOKENS
SUM_DELTA	1	0.22	–0.19	–0.12	–0.19
AVG_DELTA		1	–0.05	0.29	0.23
SUM_NTOKENS			1	0.15	0.32
AVG_NTOKENS				1	0.51
SD_NTOKENS					1
Statement/SDS 3	SUM_DELTA	MEAN_DELTA	SUM_NTOKENS	MEAN_NTOKENS	SD_NTOKENS
SUM_DELTA	1	0.96**	–0.06	0.87**	0.75**
AVG_DELTA		1	–0.11	0.79**	0.63*
SUM_NTOKENS			1	0.35	0.54
AVG_NTOKENS				1	0.9
SD_NTOKENS					1

*p < 005, **p < 0.01

peers. Both cases indicate that the more discussion in the chatroom, the greater the likelihood that students will modify their ethical judgments.

To verify the above qualitatively, we reviewed group chatlogs where there was little or no variation of scores between the phases, and on the opposite, groups where there was the highest variation of scores between the phases, in each SDS. Coincidentally, by examining chat interactions related to the three SDSs there was an evident trend that in groups where there were no differences in ethical judgments at the beginning of the GD phase, conversation was trivial and very brief, whereas in the groups in which there was greater change in the ethical evaluation there were significant discussions. To illustrate this, in Table 4 we show discussion transcripts A and B associated with SDS1. Note that both transcripts A and B have been translated to English from original Spanish. In transcript A the group has an extensive discussion where different opinions and points of view are posed. In total there were six points of variation in the ethical evaluations of SDS1 in this group, between the AS and GD phases. Opposingly, discussion transcript B shows a group where there were no differences in the evaluation of the peers for the SDS1 during the AS phase, and therefore the peers were not motivated to discuss the evaluations in the next phase.

Most of the chat messages exchanged between the students ranged from 1 to 10 tokens in each SDS (see Fig. 8). In the case of SDS1, messages larger than 60 tokens were found, corresponding to those in bold in the discussion transcript A in Table 4. These are notorious for having greater argumentative and reflexive content, written by two different peers.

Table 4. (a) Chat transcript of group with notorious SDS1 score change (delta 6) among AS and GD phases. (b) Chat transcript of a group with no change of SDS1 scores.

Discussion transcript A	Discussion transcript B
A: Do you think favoritism can be acceptable in this case? B: I agree that the situation doesn't benefit the organizational climate, but anyway, the company is run by the managers as they want, or they are ordered. C: I agree with that, company management is free to do whatever they want behind the scenes. **A: Yes, but it is important that management ensures that the work environment of the company is healthy, and favoritism is likely to generate chaos and employees may perceive the situation as abusive. In addition, although the manager decides what to do, IMHO it is unethical for a new employee to achieve much greater career advancement in much less time than a person who has dedicated his entire career to the company.** A: I agree that management can do what they want, but it does not mean that it is correct. B: But who says the new employees did not deserve the promotion? Isn't it possible at all that they may have just done an outstanding contribution to the company? A: What if it's the opposite?	A: I think our judgments are very similar. B: Yes C: Yes

(*continued*)

Table 4. (*continued*)

Discussion transcript A	Discussion transcript B
A: Or if all equally contributed to project success? A: What if the new hires did nothing valuable for the company at all? A: There is no way to be sure it is one way or the other. B: Ana is free to go where they value her, or create her own company. C: The one who complaints is not Ana! C: … but they are work mates anyway, loyal with one another. A: Sure, but no sensible person would simply quit his job because other colleagues feel crushed or abused. C: I believe that an ethical company should ensure a long lasting relationship with its employees. C: Issues such as favoritism can ruin the work environment, and as the case says, the pissed colleagues just want to go elsewhere. C: It is quite possible that the company is not willing to follow ethical rules or principles consistently. A: But suppose that management behavior has consistently fallen into ethically questionable practices, such as favoritism. C: If that is the case, I agree that people are free to leave. **B: The fact that Ana and her friends work for their own interest is the 'engine of the economy'. A company must take advantage of personal interests to reward them and exchange them for their service. If for the company Ana and her team do not generate values that equals the reward (salary and benefits) they receive, sooner or later they will be dismissed. It's a company, not a charity work.** A: I'm still in my position. C: I agree with this. C: But it does not mean that the treatment of the company is unethical. C: If it says that there is recognition for those who were in high positions of the project, and not for the supporting team members. A: If I do not say that you are not right in that, but in this case we are specifying that everyone worked on the special project C: That's it	

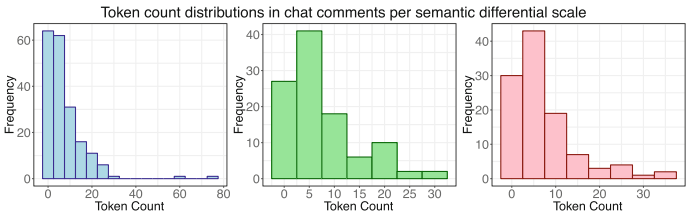

Fig. 8. Token count distributions in chat messages per statement/SDS. (Color figure online)

6 Conclusions and Future Work

In this paper we reported on our initial efforts towards developing a tool for fostering meaningful ethical discussions among engineering students in the classroom. The tool is based on six design principles; namely, the possibility of it being embeddable in a traditional ethics course, support for multidimensional ethical judgments, the anonymity of judgments and interactions, domain independence, device independence and ease of use. A trial with 35 engineering students confirmed that the average student considers the tool offers a very good usability, however, there are still a few aspects in relation to user interface design, mostly about the chat interface, which can be optimized. With regard to the design of the activity, the trial cohort highlighted the convenience of anonymity when discussing ethical cases, as well as the process comprising successive individual and anonymous group work phases.

Analysis of student behavior in the trial activity revealed that ethical judgments tend to be stable across the successive phases. However, judgments tend to change the most in groups where more discussion has been generated. Conversely, in the groups where there is little variation in the ethical evaluation, less discussion is generated and less variation of the ethical judgments. For this reason, we consider that a desirable modification to the activity in the future would be supporting group composition that maximizes the heterogeneity of the students in the groups according to their ethical judgments in the Individual Appraisal phase. We hypothesize this would raise students' interest in discussing the ethical case, and bring greater transactivity [14], along with a greater chance of students varying their ethical judgments as a result of argumentative and reflexive processes.

Finally, it is also necessary to investigate the role of the teacher in the activity. In particular, his/her ability to spur a debate leading to an ethically grounded case resolution, while validating that students recognize the virtues of the resolution reached. It is also necessary to investigate whether the activity can facilitate students' building of ethical schemata, as well as ethical meaning they can transfer to different cases in further ethical discussions as students, or as professionals in the workplace.

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