



A Framework for Class Activities to Cultivate Responsible Leadership in Software Engineering Students

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June 7, 2022

A Framework for Class Activities to Cultivate Responsible Leadership in Software Engineering Students

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ABSTRACT

Software and information technologies are becoming increasingly integrated and pervasive in human society, and range from automated decision making to running critical infrastructure like utilities and financial institutions. There is also a growing awareness of the need to develop leaders who will harness these technologies in fair and inclusive ways. Many academic and industry researchers are advocating for the responsible use of information technologies and some academic and research institutions such as IEEE and ACM have published codes of ethics to spread awareness about these issues. In this regard, a number of academic researchers, including the authors of this paper, have expressed the need to teach students computer and information ethics as well as professional and leadership skills. In this paper, we propose an approach that is potentially effective in helping students develop leadership and communication skills as well as learn broader skills of professional responsibility. The proposed approach is modeled after Toastmasters, a very successful association present in over 140 countries with almost 350,000 members across more than 16,000 clubs. We describe our goal and give a general description of a Toastmasters club and how it is conducted. Further, we describe some activities and projects having CS/SE context that can be done by students as part of a relevant class. Finally, we briefly describe the approach that we are undertaking in our first pilot activities and their integration with additional synergetic strategies.

CCS CONCEPTS

• **Social and professional topics** → Sustainability • **Computing education**

KEYWORDS

Human factors in software engineering, Computer ethics, Leadership, Toastmasters club, Responsible software engineering, Sustainable software engineering, Ethics in software.

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CHASE'22, May 18-19, 2022, Pittsburgh, Pennsylvania, USA
© 2022 Copyright held by the owner/author(s). 978-1-4503-0000-0/18/06...\$15.00
ACM ISBN
<https://doi.org/>

ACM Reference format:

Devender Goyal, Renato Cortinovis and Luiz Fernando Capretz. 2022. A Framework for Class Activities to Cultivate Responsible Leadership in Software Engineering Students. In *Proceedings of the 15th International Conference on Cooperative and Human Aspects of Software Engineering (CHASE 2022)*. ACM, New York, NY, USA, 6 pages. <https://doi.org/>

1 Introduction

Many academic researchers and industry leaders have emphasized the need to develop better soft skills in CS/SE students such as written and verbal communication, collaboration across disciplines, ability to give and take constructive feedback, and empathy to help to manage conflict. These teachers incorporate this information into their teaching and research [1], [2], [3], [4], [5], [6]. There is also a call from academic researchers, leaders of society, and many public and private institutions like IEEE and ACM, to research and teach ethics, trust, transparency, and building software systems that are appropriate, safe, reliable and improve the lives of all people [7], [8], [9], [10].

Goyal and Capretz [11] described several methods for engaging students and encouraging them to develop these soft skills, highlighting the need to teach ethics, trust, fairness, and other values to CS/SE students along with soft skills. We termed this combination “Responsible Leadership”. In this paper, our goal is to propose and describe class activities dedicated to teaching and helping CS/SE students to learn concepts of professional and ethical values and computational sustainability with a side benefit of developing soft skills.

In the sections below, we first describe Responsible Software Engineering concepts and present our framework for learning ethical values and developing a Code of Conduct consisting of professional skills, along with learning concepts of Computational Sustainability. Then we describe class activities modeled after the Toastmasters club to teach these concepts and skills, followed by a brief description of our assessment method.

2 Development of Ethics and Professional Values

Many researchers are advocating the adoption of ethical responsibility by businesses and professionals so that information technologies are used in fair, ethical, and inclusive ways and

promote sustainability [12]. Schieferdecker [13] has stressed the need for adopting a broader set of values concerns in Software Engineering, which he has entitled “Responsible Software Engineering”, and which he describes as follows:

1. Sustainability by design: In addition to the promotion of privacy, safety and security, and software quality, sustainability concerns like ecological sensitivity for energy and resource efficiency and value sensitivity in data collections and algorithms should be part of software engineering.
2. Techno-social Responsibility: Understanding how digital models could affect the society and shaping the digital business models and solutions according to agreed upon societal principles.
3. Responsible Technology development: Promoting technology research and development that is aligned with UN sustainable development goals.
4. State-of-the-art Software Engineering: Promoting a sense of societal responsibility for using the appropriate state-of-the-art software engineering methods and tools that fit the level of software criticality.

Based on our professional experience and academic research, in this paper we are also proposing that a broader set of professional values, responsibilities, and leadership qualities be considered [14]. We propose the following framework and principles for Software engineering students and professionals to consider:

1. Use needed software tools and technologies with appropriate caution and a sense of societal responsibility for achieving non-functional qualities of software, like reliability, safety, and security.
2. Consider research and development in the areas of sustainable computing and software development; that is, harness computational and software technologies to achieve environmental, economic, and societal goals for sustainable development. Some of computational sustainability related areas are sustainable supply-chain systems, disaster management and resilience, energy savings and efficiency, smart urban transportation and infrastructure, sustainable agriculture, biodiversity and species conservation, bio-surveillance, poverty mapping and solutions, and ecosystem informatics [15].
3. Consider ethics and fairness when designing and developing software and information systems as well as trust and openness. Teachers should encourage critical inquiry, reflection, and discussion among participants to help students better prepare for the future [7]. It is important to help students recognize that there are multiple stakeholders impacted by the increasing use of technologies like automation of processes, connected systems, social networks, and Artificial Intelligence. In this regard, teachers can also stress the importance of expanding business processes of risk assessment and risk management needed to protect the interests of an organization and its various stakeholders from unethical, many times unintended, use of technologies [16].
4. Be willing to take time to consider wider and long-term impacts of their research and development projects. In this

regard, students can be exposed to various frameworks like the Ethical Decision Making [17] and RRI (Responsible Research and Innovation) process of governance [18], which aims to ensure that the processes as well as the outcomes of the research are aligned with social values by encouraging more inclusive and democratic decision making among various stakeholders.

5. Be professional in their behavior and help each other to learn and grow. As more companies are adopting Agile and Scrum methodologies and becoming aware of servant leadership concepts like empathy, stewardship, healing, and building community [19], it is imperative that students internalize and practice these concepts. It would be helpful for students to learn ‘Virtuous Advocate’ values of concern for others and use moral means for social good [20]

The list of principles and framework is not intended to be exhaustive and students and other researchers are encouraged to add to this list and consider further details that might be added.

3 Toastmasters Approach to Development of Leadership and Communication Skills

We suggest modeling class activities after a very successful organization called Toastmasters club, which is very effective in improving communication and leadership skills of its members according to Yu-Chih [21]. Toastmasters supports its members’ leadership and communication skills in the following ways:

- Participation in club meetings and competitions and providing a safe and encouraging environment to members for practicing their communication and leadership skills.
- Every member supports the growth of other Toastmasters members by way of encouragement and mentoring. The biggest reason that Toastmasters clubs are successful is their encouraging and cooperative environment which helps the members shed their fear of speaking in front of the group.
- Members take various leadership roles in running the club successfully and contributing to the growth of Toastmasters clubs.
- By providing documentation and training to its members for various roles and club activities.
- By helping members build relationships and cultivate a sense of community.

Various activities in a Toastmasters club’s meetings help its members to develop their communication and leadership skills by giving ample opportunities to practice these skills. The main activities of a Toastmasters club’s meeting are as follows:

Prepared speeches. A Toastmasters club gives opportunities to each member to prepare and present speeches in front of other members in a cooperative and encouraging environment. As members gradually become immersed in the encouraging and dynamic environment and listen to other people making speeches, they shed their fear of speaking in front of a group. Giving a prepared speech also helps a member improve his/her planning, organization, and time management skills.

Evaluation and feedback. Giving and receiving feedback is a very important skill. It requires excellent listening skills as well as empathy. Toastmasters training material provides excellent guidelines to its members for providing feedback by first pointing out what the speaker did well and then how he/she can be challenged to improve. The speaker is evaluated on the structure and contents of the speech, and delivery skills like the use of effective gestures, comfort level, vocal variety, and eye contact.

Impromptu speaking. Impromptu speaking is called “Table Topics” in Toastmasters. A member prepares the questions and then asks selected members to answer the questions and ideally speak between 1 to 2 minutes. Besides improving public speaking skills, it helps members know more about one another and build relationships.

In addition to participating in above activities, members further develop their skills by taking on various roles in each Toastmasters club meeting. All the above roles require excellent listening skills and mindfulness from the members. The “Table Topics Master” also teaches the skill of asking questions. Finally, members also learn better speaking skills by getting feedback and learning about proper use of grammar.

4 Toastmasters Approach to Development of Responsible Software Engineering Skills

Based on the experience of attending many Toastmasters meetings and as confirmed by Yu-Chih [21], we believe this approach has great potential in teaching and learning new concepts, and creating intrinsic motivation in students by encouraging engagement and interaction among students in the learning process. Based on our experience in the professional and academic sectors, we propose the following workshop-style presentations in addition to the normal presentations, for learning ethical values and professional skills/codes of conduct:

1. Members present papers, articles, or case studies related to responsible software engineering.
2. After the end of presentation by a member, other students are given 5 more minutes to perform the following tasks:
 - a. Evaluate the speaker on the content structure and communication aspects of the speech. What did they like in the speech and what could be improved upon? They would do this by first appreciating the good aspects of the speech and then challenging the speaker to improve upon a couple of areas.
 - b. Briefly write what they learned from the speech, paper, or article presented by the speaker and whether they had any new insights.
 - c. Write at least one question that they would like to ask the speaker or discuss with the group.
 - d. Have a group discussion, based on the two points above.

The initial outline will be fine-tuned according to the outcomes of the first pilot activities that we are currently running. For example, from our preliminary experience it seems necessary for the faculty to be the initial talk moderator, in order to practically demonstrate how to run such sessions. The faculty could then delegate this function to the students, as soon as they appear ready to take over.

Besides the case studies provided in the ACM code of ethics and other computer ethics resources [17], we propose the following seed papers related to Responsible Software Engineering for students to present and discuss. Students are however encouraged to do their own research and come up with any other papers or presenting articles based on current events related to Responsible Software Engineering:

- ACM code of conduct [9], which describes principles and guidelines for general ethics, professional responsibilities, and professional leadership that the authors consider important. It also gives further direction describing several case studies that students can discuss.
- Responsible Software Engineering [15], which calls for promotion of concepts like sustainability by design, technological responsibility, and responsible technology development.
- A survey of Computational Sustainability work [15] applied to a range of sustainability domains like bio-surveillance, poverty mapping, renewable energy production forecasting, and crop disease monitoring.
- Becker et al. [12] provide the rationale, development process, and description of the Karlskrona Manifesto for sustainable design, a well-founded point of reference in the areas of software and sustainability.
- Jirotko et al. [18] describe the RRI (Responsible Research and Innovation) process of governance, which aims to ensure that the processes as well as the outcomes of the research are aligned with social values by encouraging more inclusive and democratic decision making among various stakeholders including citizens.
- A growing need for Responsible AI [17], which describes risk assessment and risk management processes as well as various principles of responsible AI.

Besides presenting research papers and other case studies, we encourage students to get creative about their presentation materials. For example, as described by Burton et al. [7], science fiction stories can be an effective way to teach and discuss computer ethics and the authors give some useful reference that students can also present and discuss.

5 Assessment of Progress

We plan to measure the progress made by students in improving their responsible leadership skills by using both quantitative and qualitative approaches. One of the authors has started some pilot activities including the Responsible Leadership Toastmasters Pathways approach in adult-education specialized computer-

science courses in Italy, in the context of activities linking software engineering with the UN Agenda 2030 for a sustainable development.

Students in these classes, who have very diverse technical and cultural backgrounds, are exposed to materials previously indicated and are required to present and discuss the material in informal toastmasters-like meetings. At the beginning and end of the session, students are required to complete a pre and post survey as well as produce annotated conceptual maps synthesizing their understanding of the domain. The purpose of the assessment is to measure the progress of students in understanding these topics and achieving two-fold goals in relation to them: (1) raise awareness, (2) develop interest and inner motivation while developing professional and leadership skills. The answers to the survey are then cross-checked with the conceptual maps.

Below, we present a preliminary sample questionnaire intended to gather information on students' perception and attitude towards learning responsible software leadership concepts using the Toastmasters approach. The questionnaire uses a 7-point Likert scale whose responses range from 1 (strongly disagree) to 7 (strongly agree). We have organized the survey questionnaire under general awareness as well as two main themes of Responsible Software Engineering:

- General awareness of social, professional, and ethical responsibilities of a software engineer as well as general awareness of the Toastmasters approach.
- Code of Conduct (Computer ethics, professional responsibilities, and leadership principles)
- Sustainable Development.

The survey questionnaire based on these categories for both pre-survey and post-survey is as follows:

Pre-survey Questionnaire for general awareness:

1. I am aware of the critical nature of software in today's society.
2. I am aware of the ethical responsibilities of being a software engineer.
3. I am aware of the professional responsibilities of being a software engineer.
4. I am familiar with the Toastmasters club.

Pre-survey Questionnaire for Code of conduct:

1. I consider the reliability aspect of the software when working on a software project.
2. I thoroughly investigate security aspects of the software when doing a software project.
3. I understand the need to consider the long-term impacts of software projects that I engage in.
4. I understand the need to be careful when sending emails as they can possibly be read by anyone on the internet.

5. I understand the need to consider all the stakeholders in software / computing projects.
6. I consider the professional development of everyone in my team.
7. I understand the need for knowing the professional leadership principle of how to treat everyone involved.

Pre-survey Questionnaire for Computational Sustainability:

1. I am aware of various ways that software can be harnessed to help people in society.
2. I am aware of various ways that software can be harnessed for improving ecology and the environment.
3. I understand many computing technologies involved in sustainable development.
4. I understand the need for using computing resources in an energy efficient way.
5. I understand the need for equipment recycling to reduce the environmental impact of using computing resources.

Additional Post-survey Questionnaire for Code of conduct:

1. I agree that it is important to teach code of conduct given the critical importance of software and information systems today.
2. I am motivated to encourage the fulfillment of professional responsibilities by members of the organization / group.

Additional Post-survey Questionnaire for Sustainable Development:

1. I am familiar with the Toastmasters club.
2. I agree that it is important to teach computational sustainability to CS/SE students.
3. I am motivated to encourage contribution to computational sustainability by members of the organization / group.

Additional Post-survey Questionnaire for general awareness:

1. I am familiar with the Toastmasters club. The Toastmasters approach is helpful in improving my communication skills.
2. The Toastmasters approach is helpful in improving my professional skills.
3. The Toastmasters approach helped me know more about other members.

Based on the preliminary results of the pilots that we are running, which have not yet been formally analyzed, these surveys are likely going to be modified and possibly extended. A first potentially useful extension is by employing the strategy adopted by Rader et al. [22], where they asked students to rank their interest for a series of proposed projects, associated with specific responsible leadership topics. The revised NEP scale [23], widely and effectively used to measure the attitudes towards the environment, could be conveniently integrated too. Finally, the peculiar ethical perceptions of the students having very diverse

cultural backgrounds could be more explicitly exploited. All these instruments would be used before and after the main activity to help measure impact.

6 Synergetic Exploratory Activities

Given the early stage of this project, we are also exploring other synergetic strategies. A first one is to engage students in related concrete actions, pursuing the development of Open Educational Resources with an Open Pedagogy approach, in the context of the Quality Education goal of the UN Agenda 2030, following-up some activities that were already carried out in the last few years by Cortinovis [24].

A second one follows the values approach described by Goldweber et al. [6], assigning to students in introductory courses, CSG-Ed projects demonstrating social relevance of computing and potential positive societal impact. In addition to an adapted version of a project suggested by Goldweber et al., the “Radioactive mice”, a new one has been developed, intended for slightly more advanced students, related to the assessment of their ecological footprint. The encouragement to reflect on the social good aspects of these assignments is fairly limited, to control their complexity in introductory computer science courses. Yet, should the pilots reveal that their impact is too limited, we will attempt to broaden their scope following a more systems thinking oriented approach, as suggested by Eriksson et al. [25].

All these activities would then be integrated in the previously described Toastmasters approach, by providing students with the opportunity to present, reflect upon, and discuss their insights.

7 Conclusion

In the sections above, we advocated for teaching human and social values and responsibilities as well as soft skills to CS/SE students and presented some class activities to implement in a university setting. These suggested class activities are modeled after the Toastmasters club to help develop student’s communication and leadership skills in an encouraging, dynamic, and cooperative environment, while learning concepts about code of conduct and computational sustainability.

Gradually, members develop public speaking skills, and excellent listening and feedback skills, while being exposed to Responsible Software Engineering concepts like non-functional quality measures, computer ethics and trust, sustainable computing, and becoming aware of the wider impacts of computing

Faculty can encourage students to participate in these class activities by providing extra credit for participation. In our preliminary experiments, even short exposure to developing these soft skills and understanding values and responsibility is very much appreciated by students. In our future research, we plan to further study its impacts by offering these class activities in collaboration with more faculty members. These activities would

then be integrated with additional synergetic strategies, such as the development of OER and CSG-Ed projects.

ACKNOWLEDGMENTS

We would like to thank the reviewers for providing extremely useful suggestions to improve our work.

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