11th International Conference on Higher Education Advances (HEAd'25)
Universitat Politècnica de València, València, 2025
DOI: https://doi.org/10.4995/HEAd25.2025.20093

Fostering Democratic Attitude within Engineering Education

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How to cite: Fuhrmann, T.; Niemetz, M. (2025). Fostering Democratic Attitude within Engineering Education. In: 11th International Conference on Higher Education Advances (HEAd'25). Valencia, 17-20 June 2025. https://doi.org/10.4995/HEAd25.2025.20093

Abstract

According to the education ideal advocated by Wilhelm von Humboldt, education should be a holistic process to develop the whole human being and should not be narrowed toward job training. For example, in democratic societies, education should be directed to fostering a democratic mindset of students to strengthen pluralistic democracy. It is always possible to introduce a general course into a study program that deals with democratic education from a theoretical point of view. But by introducing such a course, the time spent on technical subjects will be reduced. The other major disadvantage of such solutions is that democratic education is seen to be separated from technical education. But in the contrary, democracy should be included in the whole life as a general way of thinking and cooperation between individuals. Therefore, ideas and lecture experiences are presented in this article on how democratic education can be integrated into all engineering subjects as an elementary educational design concept. Students should be led toward a general democratic attitude by practical application. To achieve this, democratic learning environments can be established in all types of courses like lectures, seminars, and labs. This includes, for example, the design of exercises, the presentation of the theoretical content, and the interaction between professors and students as well as the interaction between the students themselves as induced by the teaching activities. Also in exams, elements to promote democratic thinking are possible: Exams should be not directed to learning only content but toward understanding, creativity, and problem-solving competence. They should include, where possible, the fact that correct technical solutions are not unique but that a multiverse of solutions exists, with each solution featuring various strengths and weaknesses. This not only sensitizes the students for the need for (e.g. socially or environmentally) responsible technical design choices but also allows them to find optimized solutions for the engineering challenges at hand. In sum, lecturers should be aware that a democratic learning environment is a demanding process, as students must be taken as serious partners in a joint learning process and surprises are to be expected.

Keywords: *Engineering Education; Democratic Education.*

1. Introduction, Motivation, and Research Question

According to the education ideal advocated by Wilhelm von Humboldt, education should be a holistic process to develop the whole human being and should not be narrowed toward the job training. Universities should embody this ideal and educate students to become holistically mature personalities.

On the other side, a report from Freedom House (2024) states that global freedom declined for the 18th consecutive year in 2023, and an extensive deterioration of political rights and civil liberties is seen. But there are many people all over the world who work to defend and expand freedom. Not only large initiatives with broad media coverage promote democracy, but also many small measures in everyday life. The logical consequence is that all democratically minded people can promote democracy in their everyday lives through small actions.

Education plays a central role in promoting human rights, democracy, and the rule of law (Council of Europe, 2010). Learners should gain knowledge, skills, and understanding to develop a democratic attitude. They should be empowered to exercise and defend their democratic rights and play an active part in democratic life.

The authors are of the opinion that professors should not only teach the subject content that is documented in the module handbook of the curriculum. Students should also be prepared for life in a democratic society by communicating these values in a democratic atmosphere.

The research question therefore is:

How can students be encouraged toward a democratic attitude
due to didactic settings in engineering lectures and lab courses?

Section II lists exemplary previous research. The authors describe their implementations in lectures and lab courses to foster democracy in engineering education in Section III. Section IV gives a summary and conclusion.

2. Previous Research

There are diverse approaches to include holistic learning approaches in an engineering curriculum.

“Democracy and Education” by John Dewey (1916) is seen as one of the first books that deals systematically with the aspects of a democratic education. He describes the democratic ideal as more than only a form of government but a way of living, and the aims in education how to go toward this ideal.

An early article about the connection between engineering education and democracy is written by Doherty (1937). He advocates a broader focus on engineering education to enable young

people to participate in democratic processes. The suggestion is to change the curriculum to less technical subjects and more general subjects. However, there are no ideas on how to integrate democratic education into existing programs.

A very extensive literature review is given by Sant (2019) that examines democratic education. Eight different academic movements are analyzed, which are pro or against democratic education for different reasons. Extensive analysis and discussions are given for all identified movements. Three different educational policies are summarized: Education for democracy; education within democracy; and education through democracy.

Brown, Flick, and Williamson (2005) suggest developing curricula further to develop the social and human capital of students to increase their performance in their later life and raise productivity. Democratic education in this context is utilized to increase the social and human capital of students but not as an ethical value itself.

An integrated course model is developed by Catalano (2004) to educate about peace, democracy, and sustainable development. In the face of the Iraq war, the author proposes a model that educates toward peace with us, other people, and the planet. These goals are connected to a democratic culture with participation in societal affairs, a sense of responsibility, and solidarity. Many educational goals are listed but no real ideas are given to integrate these goals into the limited time frame of an engineering curriculum without losing other goals.

The literature review from Hamad, Hasanain, Abdulwahed, and Al-Ammari (2013) about ethics in engineering education shows that a democratic form of information exchange is a part of ethical engineering skills.

Helland (2023) describes aspects of democratic education in ten international teachers' curricula. A very thorough analysis is of the democratic aspects of curricula. Two main aspects of democratic education are given: Pupils should be prepared for democratic citizenship. Universities themselves should be democratic spaces.

Generic skills of graduates are described by Kamsah (2004). It is stated that democratic approaches are more effective than indoctrinal approaches in the classroom to teach generic skills. Democratic teaching is here a measure to increase the learning effect, not to foster democratic behavior itself.

A democratic classroom environment was established by Palpanadan and Ahmad (2018) and the improvement of communication skills was tested. The difference in communication between democratic and non-democratic classroom environments is emphasized. Democratic education is not seen as a value in itself but a vehicle to increase the communication skills of students.

Wegerif (2022) emphasizes that dialogue instead of democracy should be promoted when teaching children. The author argues with a narrow concept of democracy and focuses on the

aspect of voting. But it is obvious that a democratic atmosphere is a prerequisite for an open dialogue, which is strongly emphasized by the author as the ideal of education.

Jónsson and Rodriguez (2021) developed seven democratic competencies based on the definitions by the Council of Europe. However, they show no idea how to implement these competencies into practical teaching.

In sum, some research has been done about democratic education, only a few exemplary articles are cited here. It is seen that most research is done on theoretical aspects of democratic education. Not much research can be found about practical implementations, especially in engineering courses. The authors therefore decided to write about their own experiences of promoting a democratic atmosphere in engineering education.

3. Aspects of Democratic Education in Engineering Education

The authors consider it important that democratic ideas are not only taught in specific courses about democracy but that they are an integrated part of every course. Therefore, they have incorporated the ideas presented here into their own engineering courses as good as possible.

3.1. General Ideas

Democratic learning is a lifelong learning process to create a mindset. This can't be done during one specific course and verified by exam questions. Students and professors are partners during this process, and can learn together and from each other. This whole process starts with a democratic mindset of the professor and the wish to pass on this democratic attitude to the students. He or she should be willing to give up some control of the lecture to the students and accept students as equal partners in this learning process. Students can have a say in the content (as long as this does not compromise the overall aim of the course) and how it is taught. This also implies that the professor has to act as transparently and comprehensibly as possible for the students. There are clear rules that apply to everyone, both the students and professor, just like in a constitutional democracy. Justified criticism from students is valuable in two ways. It provides the impetus to learn from it and to develop oneself further. It also shows that students are allowed to criticize, which is only possible in an open and democratic atmosphere.

Open and respectful discussions are one of the basic prerequisites for a democratic atmosphere and can only flourish in an appropriate setting. It is important to create a culture of discussion. Students should be taken seriously with their opinions and problems. They should be encouraged to engage in discussions, and everyone should be invited to do so. This is especially true for shy and reserved students. These discussions are encouraging for students to reflect on their work and behavior. Discussions do not always have to be harmonious; they can also be controversial. However, they should always be respectful toward the other person. This often

makes these discussions particularly valuable, as opposing ideas can be exchanged and new ideas can be generated. When moderating such discussions, it is important to point out this value and encourage the students to communicate with each other. In this way, students learn to engage with other ideas, to think about their ideas more carefully, and to formulate more clearly. They learn to accept other opinions, to value them, and to accept them if they are better than their own ideas. In discussions that are based on facts, students learn how to deal critically with fake news and untrue statements.

It is essential to teach students the importance of individuality and diversity and to encourage them to think about these topics by themselves. To reach this goal, it is helpful if students get intellectual impulses and are encouraged by the professor to look beyond their own horizons.

Students should be responsible for themselves to learn or not to learn. The professor should not force them to learn but should provide support and encouragement. Students should be allowed to make their own decisions and make their own mistakes. This encourages students to take responsibility for their own lives and shows them that they have to make their own decisions and live with them. This is a similar situation in a democracy, where the people make the decisions and then must deal with the consequences.

A democratic society does not function if all members only look selfishly at their interests. It is necessary that people also have the welfare of the community in mind and are committed to it. This attitude can be promoted through group work and projects in teams. Students learn that there is added value for everyone if they work as a team to achieve common goals.

The above ideas are not intended to be implemented in a separate course but can be integrated into all courses of an engineering degree program. Compared to concepts in which democracy education is outsourced to separate courses, the time for teaching technical content is not reduced here. As a result, there is no need to cut back on the amount of technical content on a degree program. The other major disadvantage of separate democratic courses in the curriculum is that democratic education is seen to be separated from technical education. But in the contrary, democracy should be included in the whole life as a general way of thinking and cooperation between individuals.

The authors are of the opinion that it is important to let students experience the freedom of democracy. This freedom is only limited by the freedom of other persons who think differently. Students should not be educated to accept everything that is said by authorities but to think critically and make their own decisions. This is how democratically responsible citizens are educated.

Democratic education should not be political education. It should not deal with political topics, neither from a philosophical point of view nor concerning day-to-day politics. Different political opinions should not play a role during study as long as they are based on democratic values.

Should political discussions arise, they should be ended. These are possible topics for private discussions, but they have no place in the professional setting of an engineering education curriculum.

3.2. Lectures

Lectures lay the theoretical foundations of all subjects and present exemplary applications. These can be designed in different ways. In the lecturer-centered variant, knowledge is told by the professor and students are educated to listen passively to what the professor says. In student-centered lectures, students are educated to be active individuals who question and discuss topics. Active participation of all individuals is an important prerequisite for education toward a democratic attitude.

There are many possibilities to design participative lectures. Voting systems are an interesting option to help implement this goal. One application of these systems is the control of the learned knowledge. However, they can also be used to carry out secret and equal democratic elections, allowing students to express their opinions and even influence the course of the lecture.

Democracy is a constant process of discussion, which can be very exhausting. This also applies to a lecture in a democratic environment. Students discuss and question certain aspects and topics. You may also be questioned in your role as a professor. Lecturers should welcome discussions, criticism and dissenting opinions. This should be promoted by encouraging and thanking students for their participation. Overall, this makes the lecture more educational for everyone involved.

Exams are not only for defining grades, but they influence the whole learning process during the course as students prepare their minds for the exam. Closed questions, the extreme form are multiple choice questions, promote students who are good at memorizing given topics without their own creative thinking. Open questions in a competence-oriented exam promote students' solution competence and critical thinking which are also important for critical citizens in a democratic society. Exams should include, where possible, the fact that correct technical solutions are not unique but that a multiverse of solutions exists, with each solution featuring various strengths and weaknesses. In this way, democratic education can be promoted by giving appropriate exams that encourage critical and open thinking, which is important in a democratic society.

3.3. Practical Courses

Practical courses are used to deepen theoretical knowledge by applying it to practical challenges. In principle, practical courses can be predefined where students carry out given tasks to achieve an already known experimental result. On the other side, practical courses can have open topics where students can find their own creative solutions to solve a given challenge.

Students should work in teams, organize themselves, plan their work, and take responsibility for their success or failure. Professors act as coaches without taking students responsibility for their projects. Democratic decision-making and teamwork should be promoted by professors.

Students should be encouraged to work on topics with practical relevance, if possible for society. Examples are developing aids for handicapped people or ideas on how to help underprivileged persons. This work can strengthen social and therefore also democratic behavior.

The assignment of practical courses could be done in this way that students' efforts to develop the team, foster discussions and democratic team structures give positive grading points additionally to the points that give a working technical solution.

4. Summary and Conclusion

The authors are of the opinion that the type of teaching has an influence on the development of a democratic mindset in students. For this reason, numerous suggestions have been developed in this article to promote democratic thinking through a suitable atmosphere in lectures and practical courses. Over the years, the authors have changed their lectures and lab courses based on their experiences with students to create an atmosphere that encourages reflection and discussion.

It is very difficult to test democratic behavior in tests or evaluations. A democratic mindset evolves over a long time due to many influencing factors. A lecture or lab course has only a small influence on building such a mindset. During the lectures with a democratic setup, the authors see increased openness to ideas, group discussions, and responsibility for their own learning and the group. These are indications that democratic atmospheres in lectures and lab courses have positive impacts on the democratic behavior of students.

This process of creating a democratic atmosphere during teaching is not finished but is a continuous learning process in which professors and students explore new paths together.

Acknowledgment

The authors thank Claudia Trotzke and Teresa Ehl for the interesting discussions that contributed to the ideas of this article.

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