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Dignified Engineering Education: An Introduction

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***Abstract*— Human dignity, though challenging to define precisely, holds immense significance in our lives. It is the foundation of human rights and considered by researchers to be the most essential and influential existing value referring to the state of being worthy of honor or respect, as well as the moral right of not to be humiliated. Feeling dignified contributes to human well-being. In the field of education, some scholars argue that human dignity should not only be a guiding principle but also the ultimate goal of education and life. An education that integrates dignity offers more than just knowledge acquisition. It provides a way for society to support individuals explore their self-identity, internalize fundamental values, develop personal responsibility, and gain a deeper understanding of their character and identity. However, recent efforts, particularly in traditionally male-dominated and non-disabled-centric engineering education, have focused primarily on promoting diversity, equity, and inclusion (DEI). This paper defines dignity within the context of engineering education and introduces a novel vision: "Dignifying Engineering Education" (DEE), which extends beyond DEI principles. Emerging from combining insights from literature on engineering education and human dignity, DEE emphasizes providing students with choice, respect, usefulness, inclusion, safety, equity and diversity (CRUISED). The implementation of DEE in universities allows creating an educational environment that not only equips students with up-to-date technical skills and tools but also promotes their well-being and personal growth in a respectful, inclusive, safe, fair and diverse environment. To do so, joint efforts of researchers and faculty are needed to set an action plan that is customized to the special needs of their organization and students' population. The paper concludes with recommendations for engineering universities seeking to transition to DEE. Follow-up research will outline the "DEE framework," detailing actionable steps in six interconnected categories: facilities, course content, teaching/learning material, assessment, interactions and faculty.**

Keywords—engineering education, dignified education, human dignity, values.

I. INTRODUCTION

Engineering education (EE), like all aspects of society, is continuously evolving to address societal and environmental changes. Over the past decade, researchers not only focused on the integration of smart technologies [1], artificial intelligence [2] and active learning approaches in education [3], but a significant number of publications were dedicated to the importance of insuring diversity, equity and inclusion (DEI) in education [4][5][6][7], particularly in traditionally male-dominated and non-disabled centric field of EE [8]. DEI are considered co-dependent and central to engineering [9]. For this reason, they form an initiative for many engineering universities to develop in their culture [10]. Researchers call for a paradigm shift in how to perceive and integrate DEI in EE [11]. The remaining questions are: Are DEI enough? Do they form the ultimate ethical goal of EE for a better integration of students in the curriculum? What about human dignity? Shouldn't *dignity*, referred to as "a fundamental human value" [12], be part of this paradigm shift? Should EE's ultimate goal not to put students' dignity at stake?

Human dignity is often considered to be "the most fundamental and powerful value" [13][14][15]. According to the Oxford Encyclopedic English Dictionary, human dignity is defined as "the state of being worthy of honor or respect" [16]. It refers to the moral right of not to be humiliated [17]. It has an "inner moral worth" that goes beyond price [18]. In this perspective, it is considered "unconditional", and corresponds to the freedom of people, as well as their capacity to act morally [19]. The recognition of human dignity is important [10]. According to researchers, it should be the guiding principle of education [20] as well as its ultimate goal [21]. Human dignity, human rights and education are bound with human rights in internation law, however existing human rights and national policy documents do not explain how this connection should be understood [18]. This is why, dignity in education should be emphasized [18], and efforts are needed from researchers in this regard. Although, human dignity is considered central to inclusive education [22], there is still a gap in literature about research on dignity in education [23][24].

Addressing this gap is the primary focus of this paper. To do so, it introduces a novel vision on education called "dignified engineering education" (DEE), that goes beyond the promises of DEI to an education system that treats its students with dignity, and does not put it at stake. This allows them to fully focus on the conduct of their study, neutralizing any unnecessary frustration. This paper focus on DEE in the context of EE, as EE is still perceived as male-dominated, with reduced efforts to increase different representations [8]. It reports on how it was designed based on synthesizing literature findings, providing core values defining it. To bridge between the theoretical foundation of DEE and practice, this research provides a set of recommendations that engineering universities can adopt over the years to ensure a dignifying environment for its diverse students.

This paper is organized as follows: Section 2 summarizes the state-of-the-art related to EE, dignity and dignity is EE, and draws conclusions based on what was learnt from the studied literature. Section 3 introduces a novel vision on engineering education DEE, explaining its foundation, its requirements (also referred to as pillars) and its relevance. Section 4 provides a list of recommendation to follow by engineering universities and institutes towards the implementation of DEE. Finally, Section 5 concludes this paper by listing its main messages and highlighting future research. In this paper dignity and human dignity are used interchangeably.

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II. LITERATURE REVIEW

A. Engineering education

Over the years, significant efforts have been dedicated to DEI in engineering education [25]. DEI can have different interpretations. In the United States, Canada, the United Kingdom, and Ireland, DEI focuses on race and ethnicity [26]. In Europe, it focuses on the integration of different genders and cultures [26]. Finally, in the Global south, DEI ranges from quality evaluation and disability to multiculturalism, race and gender [27]. In this work, the following definition of DEI is adopted: diversity refers to the existence of all possible differences, equity refers to fairness, and inclusion refers to having resources and opportunity [28].

To implement DEI strategies in engineering education, tools and metrics have been developed to measure, analyze and improve diversity in engineering education [29], as well as programs to promote equity in engineering relationships [30], or introducing fellowships for women [31]. There is also a worldwide effort in implementing inter-disciplinary and multi-disciplinary approaches in EE [32]. This allows students from different backgrounds, experiences, opinions, perspectives and skillsets to work together towards the achievement of much needed sustainable solutions [33]. Research claim that this is the only way to tackle complex challenges of society [34]. In EE, DEI strategies also include dynamic classroom, to inclusive classroom environment, scholarships, trainings (e.g. mentoring, personality development), staff development programs, academic collaboration, exchange programs, language classes, project-based learning, inter-disciplinary research groups, and incubation [28].

In EE, grounded theory can be used to study DEI in terms of gender and racial disparities [35], the challenges faced by underrepresented groups as well as the causes of limited diversity in engineering workplaces [36]. Theories about identity can also be used in DEI within EE [37]. These can include social learning theory and cognitive theory which can lead to understanding the learning and the skill development processes in EE [38]. They also include professional identity development that allows to explore the influence of diverse experiences (e.g. internships, extracurricular activities etc.) on developing (engineering) professional competencies within EE [38]. To study DEI within EE, more theories can be experimented with, such as theories about race and gender and exploring how different identities intersect in the field [39][40]. Such theories allow the investigation of how gender operates in EE and to determine opportunities for support integration and support of women and minorities [37]. On the classroom level, researchers report using theories about learning and teaching [41]. These include project-based learning to see how different diverse teams deal with engineering challenges and how project-based learning can be organized as inclusive approach that supports students in their engineering education [42]. Student retention theory can be used to analyze the factors that impact student success and retention in higher education [43]. This framework enables researchers to study how aspects such as belonging, mentoring, and academic support influence the success and persistence of students from underrepresented backgrounds in EE [44]. In the process of designing DEI strategies for EE, researchers should choose a theory that allows the understanding of the target students before being able to identify an adequate strategy that promotes DEI in their organization [45]. This should be taken seriously, as DEI related issues influence teaching and learning within EE [37].

In practice, DEI is expected to reduce engineers' conscious and unconscious biases (own views, perspectives and experiences) resulting in limiting the production of harmful technologies for marginalized populations [46]. Understanding different perspectives of these populations is crucial for ethical engineering practices [47]. For example, the lack of disabled engineers is a big concern, as their involvement in the design of products and systems, especially for disabled users is crucial [11]. Although significant efforts are documented about DEI in engineering education, EE still faces challenges in embracing them [48].

B. Dignity

Dignity is one of the fundamental values of a human [49]. It is the fundamental moral worth that all people are supposed to equally have [50]. Human dignity is a complex and multi-faceted value that reflects how individuals perceive themselves in relation to how they are treated by others [49]. This value is paradoxical, revealing tension between contradictory characteristics and perceptions that emerged throughout human history [51]. Dignity is both inborn and acquired [52], universal and comparative [50], personal and social [53], as well as rational and emotional [54]. It is considered to be an antecedent, a consequence, a value, a principle, an experience, and a contingent and non-contingent exhibition [55].

Dignity is an umbrella concept (e.g. love, integrity), that is at the same time inclusive and comprehensive but also challenging in terms of scope and precision [56]. It intertwines with several values:

- Capacity of choice or autonomy: it is the basis of dignity, and represents human capacity of act with free will rather than external pressure [57]. "The right to choose is a basic expression of one's dignity" [58].
- Respect: researchers might also call it respectful treatment [59]. It means that a person is not only widely known for his/ her/ their accomplishments but also excels in a way that benefits society's virtue [49].
- Usefulness or merit: it is one of the oldest and most traditional interpretations of human dignity. It represents the utilitarian value that a person has based on his/ her/ their usefulness in society (person's market value) [60].
- Inclusion: dignity is an inclusionary concept [61]. Researchers claim that because every person has equal dignity, than he/ she/ they should be granted equal human rights and should include as an equal in communities, processes and systems [62].
- Safety: it is a precondition of dignity, since unsafe situations (violence, discrimination, etc.) violate human dignity, by making a person feel devalued and powerless [63]. Dignity as a universal right should focus on creating a system that equally protects humans from threats to their safety [49].
- Equity: it is considered a factor of dignity, ensuring that human's inherent value is respected to the same extent [48]. Researchers claim that "the idea that some

lives matter less is the root of all that is wrong with the world" [64].

- Diversity: dignity and diversity are interdependent values [65]. Allowing and respecting each other's diversity and uniqueness lead to dignified inclusive societies [66].

Dignity is context-dependent and varies significantly across regions, individuals and over-time [67]. This leads to a lack of convergence on the definition and foundations of human dignity, which does not undermine its existence, rather, it suggests that a widely accepted understanding of human dignity is still a work-in-progress [68]. The wide range of meanings that can plausibly be attributed to human dignity "at least raises a presumption that something is amiss" [68].

C. *Dignity in engineering education*

Literature on dignity in engineering education is very limited. Although education plays a role in promoting human dignity, the connection between them has not gained more attention in recent scholarly works [69]. Available research mentioning dignity in EE recognizes that the tensions between socializing goals of education, the pursuit of personal growth and the aspiration of moral agency, and freedom are not contradictions but rather essential, interconnected aspects of all educational practices [70]. A nuanced, adaptable, and dignity-aware approach can help navigate these tensions, allowing educators to engage with and honor them meaningfully [70]. In this same perspective, researchers call for designing protocols for dealing violence and situations that threaten human dignity, in combination with initiatives to reduce the gender gap in education [10]. Promoting recognition of human dignity in engineering universities and institutes involves working to create an environment that is increasingly safe, egalitarian, diverse and inclusive that facilitates student growth [71].

The adopted definition of dignity in EE literature is that every person deserves respect for his/ her/ their integrity and full development. In other words, dignity is a characteristic of each individual, signifying that people possess human rights simply by virtue of being human [72]. An education that integrates dignity presents itself as more than just knowledge acquisition. It serves as a means for society to support individuals to discover their self-identity, assimilate fundamental values, develop personal accountability and understand their character and identity [73]. Researchers suggest that dignity in education can be studied via two different angles, "one related to whether education systems teach us to respect the dignity of others, and the other is related to whether these systems themselves treat us with dignity when we go through them" [74].

D. *Synthesis*

Based on the literature findings discussed above, the following was learned:

- Although lots of efforts are dedicated to engineering education, it remains for a large part exclusive, and male-dominated.
- There is no explicit action plan on moving towards the implementation of DEI of dignity in EE.
- There is not one solution that fits all, in terms of DEI in education, as these values can be interpreted differently based on the population's needs.
- There is a need for a paradigm shift in EE in terms of its central values.
- Dignity should be one of the guiding principles in engineering education.
- The importance of human dignity is clear in the literature, however not much is available in the connection of dignity to engineering education.
- Dignity is an umbrella of values. It intertwines with the capacity of choice, respect , usefulness , inclusion, safety, equity, and diversity.
- Dignity is dynamic and context-dependent.
- Dignity and education can be combined in two ways: (1) dignifying education referring to whether education systems teach students to respect the dignity of others, and (2) dignified education referring to whether these systems themselves treat students with dignity as they go through them.
- No concrete solution is provided on implementing dignity in EE's context.

III. Novel Vision on Education: DEE

The literature synthesis not only highlighted the importance of dignity in EE, but also its high complexity. Since dignity is context-dependent [67], there is not one way of viewing it and implementing it in education. For this reason, in this paper, the focus is on introducing dignified education in engineering context. This novel vision is called DEE: dignified engineering education. Based on the literature synthesis presented in the previous section, since human dignity is central to DEE, it has than the following requirements: capacity of choice [57], respect [49], usefulness [60], inclusion [62], safety [63], equity [48] and diversity [65]. In other words, DEE should be CRUISED, see Fig. 1.

As choosing is a right that forms the base of human dignity, within DEE, students, as actors, should have a choice. This can include choices in curriculum trajectory, courses to follow, projects to conduct and the role to play in them. In engineering universities, there is a heterogenous representation of students with different backgrounds, learning styles and capacities, needs, expectations and career choices. For instance, students can be either introverted or extroverted. This is why it is important to also give them a

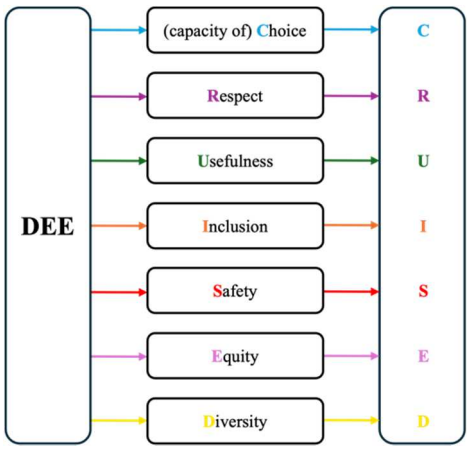

Fig. 1. Requirements of DEE

choice in the teaching activities, as some active learning methods or their excess can be overwhelming to some, and the absence of interactive activities can be boring for others. In terms of respect, DEE implies that interactions between students, and between them and teachers, administration, and faculty in general, should be respectful. Students should be heard, and the difference in backgrounds, gender, personalities etc. should be respected. Interactions should focus on shared commonalities rather than differences. The concepts of majority and minority should not define these interactions. Instead, they should engage with each student as an individual. This principle should also guide the (re)design of the curriculum. Furthermore, in DEE, students should be and feel useful in there relation to the university/ institute, and to society. In the first relation, students should be active actors, rather than receivers of information, they should be able to and feel as contributors to the enhancement of engineering curricula. They should also be supported to be useful in there group assignments and other related activities. Concerning the second relation, educators should constantly update their teaching material and projects to meet the needs of the rapidly growing societies. This will allow a students to be better prepared for their careers, be useful actors in society with an increased market value.

In the same direction of recently published work on ethics in EE, a DEE is an education that emphasizes on DEI. In EE, promoting diversity can be done by encouraging individuals from all segments of society to pursue careers in engineering. This contributes to a representation within this field that reflects the diversity of the broader population [75]. For a diverse group to succeed, it is crucial to address the specific questions and needs of each person. However, without prioritizing inclusion, students from underrepresented backgrounds may feel marginalized and ultimately leave the field [76]. Experiencing inclusion differs among students from underrepresented groups, with various ethnic communities perceiving inclusiveness in different ways. Universities need to investigate approaches that improve the overall institutional experience, creating a more welcoming atmosphere that encourages the successful integration of individuals from diverse backgrounds and cultures [77]. To achieve equity, researchers in EE must critically examine and define how practices, policies, and systems influence the experiences, outcomes, and access of students, and actively work to dismantle those structures [26]. In EE, equity is generally approached either by promoting methodologies that ensure equal access to education, or by advancing research aimed at challenging or disrupting power imbalances to create equal access to engineering opportunities. These two approaches are interconnected. The first focuses on scholarship, while the second emphasizes action. Research that integrates pluralistic, cultural, and decolonial methodologies plays a key role in challenging deficit-based ideologies that have shaped both past and current research efforts [26].

Finally, DEE cannot take place without one extra requirement/ pillar: safety. In recent research in EE, safety can either be linked to the potential impacts of providing (or not) emotional and social safety in the classroom, to the strategies for establishing conditions that supports students' intellectual growth, or to the role that teachers play to create suitable learning environment [78]. Universities should take action to allow students to take physiological and social risks by having a voice, confronting divergent points of view, as well as conflicting ideologies and novel theories [79]. Safety of students should be taken seriously to protect them from distress related to bullying and harassment, or to prevent negative emotions felt during discussion of sensitive (controversial, disruptive, etc.) topics [80]. By doing so, universities contribute to the enhancement of performance, engagement and self-confidence of students, while supporting the development of interpersonal skills such as empathy [81] and contributing to the reduction of social inequalities [82]. This ensures that all students are being dignified [83].

The claim of this paper is that DEE represents the future education vision to be implemented in engineering. Being characterized as CRUISED, DEE does not exclude preparing students to deal with emotional strains associated with new ideas and with difficult situations. DEE-based organizations engage students in emotionally challenging yet very constructive discussions on sensitive topics. While preventing students from being in situations that put their dignity at stake, it also makes mechanisms available to restore any possible damage to it. Accordingly, it is important to implement DEE in universities to create an educational environment that not only equips students with up-to-date technical skills and tools but also promotes their well-being and personal growth in a respectful, inclusive, safe, fair and diverse environment.

IV. Recommendation for implenting DEE

DEE's core concept is dignity. As stated earlier in this paper, dignity is dynamic and context-dependent.

TABLE I. Sample of recommendations for DEE's implementation

Pillar	Recommendations
C	- Assign students to projects of their choice [84]. - Provide a wide range of electives for personalized/ unique curriculum trajectories [85]. - Involve students in decision-making, on course-level or curriculum-level [86]. - Provide assessment options to choose from [87].
R	- Move towards a collegial relationship between faculty and students [88]. - Provide continuous and constructive feedback at all times [89]. - Develop mechanisms to report and handle disrespectful behaviors [72].
U	- Collect students feedback regularly and implement it in the enhancement of university/courses etc. [89]. - Continuously update courses based on market's/ society's needs [90]. - Make new technologies and tools available for students [91]. - Focus on development of students' soft skills, needed for their career trajectories [92].
I	- Teach students to use inclusive language when interacting with each other [93]. - Design slides and teaching material considering the needs of different students (neurodivergent students, introvert etc.) [94]. - Choose assessment types and conditions that are inclusive to all students, independently from their mental/physical capabilities [94].
S	- Implement "safe spaces" [78]. - Give information to students on how to report unsafe situations and provide a follow-up [72]. - Implement serious measures to handle unsafe situations [72].
E	- Provide mentorship for students [95]. - Conduct training for faculty on reducing bias [90]. - Reduce studying fees for low-income students [96].
D	- Recruit a diverse faculty to reflect diversity and inspire students [97]. - In group work, make the group as diverse as possible [98]. - Teach students and faculty the importance of diversity and its impact on technology/ systems developments [99].

Accordingly, there is no solution that fits all, when it comes to implementing DEE. CRUISED can be interpreted differently based on demographic, social, religious, financial, etc. considerations. In this section, the authors present examples of recommendations for DEE implementation, see TABLE1. They are illustrative and provide opportunities, but they are not exclusive. They are based on experience and literature findings. This means that these recommendations are not individually novel as they are already implemented by some universities. The novelty is in the combination of all potential recommendations in the context of implementing DEE. For more inspiration, some of the pillars are further discussed in the literature, with different options for implementation [100][101][102].

Once the objectives of CRUISED in education are understood, researchers/ faculty can work together to set a different action plan that is customized to their own organization and students' population.

V. Conclusions and Future Work

This paper introduced DEE as a novel vision in engineering education. This vision contributes to enhancing the well-being of students by allowing them to (1) have a choice, (2) respect and be respected, (3) be useful, (4) feel included, (5) be safe, (6) be treated equitably, and (7) experience and value diversity. This work represents a starting point towards the implementation of a dignified engineering education. It serves as a starting point rather than an endpoint in the ongoing process of defining and implementing DEE. It is intended to evolve iteratively, based on continuous research incorporating feedback, and emerging perspectives to ensure that DEE continues to grow, be more explicit and adapt in response to different environment.

In ongoing research, the authors are focusing on the exploration of DEE in terms of facilities (campus, classrooms, etc.), course design (content, activities, formative and summative assessments), interactions (between students, and with faculty), as well as the role of university actors in facilitating DEE. Future research will focus on exploring how a dignified education system could better support teachers, researchers and support staff, as essential actors in engineering curricula, without putting their dignity at stake.

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