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Lost for Words! Defining the Language Around Role Models in Engineering Education

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Abstract— **This full research paper contains a vocabulary to describe role modeling in engineering education. The term role model is widely used in the literature, particularly in broadening participation. However, it is loosely defined. Both its everyday and academic use varies. This was also observed during our interviews with teachers in the discipline: there was no consensus on what a role model is nor on the meaning of adjectives used to describe a role model. Considering the benefits of role models and the need for terminology that supports a common understanding of role modeling, we have developed a vocabulary around this phenomenon. We aim to support educators by providing them with a means to reflect on different dimensions of role modeling. We define what a role model in engineering is, and what they may model: an aspect (a competency, a character attribute or an attitude) or an achievement. Main actors and types of awareness and intention of the modeling are covered, as well as how the modeling may be perceived by others. We indicate differences and overlaps with terms such as mentor. Finally, we discuss challenges due to subjectiveness: who defines the norm for what an ideal professional in engineering is?**

Keywords—*role models; terminology; diversity; equity; inclusion; engineering education; computing education*

I. INTRODUCTION

The literature in engineering education contains many examples of how presenting students with role models is an effective strategy for sparking the interest in the field among children [1] and for improving recruitment and retention in different career stages [2], [3], [4], [5]. Role modeling is being particularly studied for women and members of underrepresented groups [6], [7], [8].

Role modeling is a topic worth studying, considering the benefits of role modeling for the individuals emulating them (see Section II). Many questions around the phenomenon of role modeling arise and are relevant for the community. What does role modeling mean? What is an effective role model and how can educators in engineering become one? What are factors that affect the impact of the modeling, particularly for underrepresented groups? What are good ways to present students with suitable role models? The literature in engineering education in this area is scarce, and the existing work tends to focus on the point of view of the person emulating the role model, particularly in a teaching context, i.e. students looking at professionals.

Moreover, the examples in the literature use different definitions of the term role model. This is because the term is loosely defined [9], [10]. It is used in different

ways, sometimes even interchangeably with terms such as mentor. Some describe role models as people who set norms of behavior and achievement [11]. However, as we have discussed elsewhere [12], this is not always the case: sometimes a role model's level of influence is not enough to set norms. The power a role model has depends on the social context. This is just one of the examples that illustrates how there are different assumptions about what being a role model means, depending on what definition is used. Without a shared vocabulary, studying role modeling can be problematic. Bricheno and Thornton mention how participants give their own meaning to the term role model, affecting the results of their study [13].

Thus, there is a need for terminology that supports a common understanding of role modeling. With this aim, we have developed a vocabulary. In particular, our ambition is to support educators by providing them with a means to reflect on different dimensions of role modeling, including their own experience as role models for their students. We analyze different definitions and usages of the term role model both in an everyday and academic context, and we complement this with interview data from our project on teachers' experiences as role models for their students in computing. We describe role modeling with an emphasis on the point of view of the model, particularly from a teacher's perspective. Topics such as what is that a person may model, how they are modeling and how this may be perceived by others are presented, besides differences and overlaps with other terms. Finally, we discuss how the subjectiveness of the topic makes it challenging: who defines the norm for what an ideal professional in engineering is?

II. ROLE MODELS IN THE LITERATURE

Gibson defines role models as "person(s) an individual perceives to be similar to some extent, and because of that similarity, the individual desires to emulate (or specifically avoid) aspects of that person's attributes or behaviors. Individuals attend to role models as possible exemplars of the professional competencies and personal attributes needed to achieve desired goals [9]." (popular and academic definitions of role model are analyzed in Section IV-A). That someone considers an individual a role model depends not only on that person perceiving the model as relevant for their goals or needs, but also on whether the model's success seems attainable [14]. If so, role models motivate individuals

looking at them to achieve greater goals, although the level of motivation depends on how positively the individual regards themselves [15]. The individual's self-perceived likeness to the role model is significantly related to self-esteem, particularly for women [16].

There are several factors that affect role modeling. Career stage affects the choice of role models: Gibson talks about early, middle and late career differences [9]. Besides culture (see section IV-A), other factors related to socio-economical background are relevant. When a student's role model's gender and ethnicity match with theirs, their academic achievement is higher than that of students with no match in this regard or no role models at all [17]. Gender plays a role in the value placed in role models. Women rate their role models as more important than men do [18]. When female students have contact with female STEM experts, they value these role models higher than men do [19], while for men gender does not determine the impact of a role model [20]. This difference seems to come from the fact that a female student is part of an in-group that is negatively stereotyped, i.e. women in engineering are expected by society to perform worse than men. This impact is not related to actual performance, where they may not be a gender-related difference (or women may even outperform their male counterparts). Rather, it is about the individual's confidence regarding this performance [19].

It follows that an increase in exposure of role models to students and other members of the community has a positive effect. However, studies show that this is not always the case [21], [22]. If the person regarded as a role model embodies the stereotypes associated to the profession, this may in fact negatively affect women's sense of belonging to the field. In this case, the gender of the role model is irrelevant. What matters is whether the role model conveys a sense of belonging to the women who learn about or interact with them.

III. TEACHERS' EXPERIENCES OF ROLE MODELING

As stated above, the engineering education community has initiatives to increase the exposure of role models to students and other members of the field. These studies tend to be focused on the point of view of the person who can potentially emulate the models. In order to contribute to the complementary perspective, i.e. the role model's, we interviewed teachers as potential role models in engineering education.

We selected teachers at the Department of Information Technology at Uppsala University in order to study their experiences as role models for their students. These interviewees had different levels of teaching experience (in terms of years, geographical location, pedagogical background, and level of studies taught). These men and women were from different areas in computing, and had different cultural backgrounds: participants were natives, i.e. from Sweden, and first or second generation immigrants. Their ages ranged from early thirties to close to retirement age. The interviews

were conducted in English and lasted 55 minutes on average. The questions referred to the participants teaching experience, their own definition of the term role model, their opinion on the academic definition, how role modeling may have affected their behavior when teaching, and other topics that the participants felt were relevant, e.g. administration of education. We continued with questions related to the research question: "How do teachers in computing include other role models in their teaching?, part of our larger project. The interviewees had to reflect again on what they understood a role model was in order to reflect on how they made use of role models in their courses.

A first analysis [23] of a subset of these interviews showed different understandings of role modeling, depending on what is modeled, how the modeling is perceived and who is affected by the modeling. The results of the preliminary analysis show that our participants understood the phenomenon of modeling in different ways and referred to it by giving different meanings to the same terms. We have highlighted an example, being a "bad role model", in Section IV-E. In this paper quotes from the same interviews have been used to illustrate choices to define a vocabulary around role models in engineering.

IV. VOCABULARY DEVELOPMENT

The vocabulary combines the meanings found in the literature with examples of the uses of the different terms seen in our data. When appropriate, we include references to related work. However, since the literature is not focused on the role models' perspective but on that of the individuals emulating them, in some parts we could only use our study; there were no other studies, to our knowledge, with which we could compare the use of the terms in a teaching context.

A. What: Definition of Role Model

Considering the lack of consensus on the details of what a role model is, we have analyzed both popular and academic definitions of the term in order to develop our own. Drawing from definitions of the general phenomenon, i.e. for any field, we look for a definition that can later be used for the particular case of engineering.

Gibson's definition [9] (see Section II) includes the understanding of role models as people that others observe to emulate in some way. This was the core of all the definitions we have found. He specifies that this is done in order to help that individual achieve a goal. But it may strike the reader as odd that, besides copying part of what the role model does or is, Gibson mentions specifically avoiding as another strategy around role modeling. This is because popular definitions of the term, as the ones included below, refer to what some academics call a positive role model, i.e. individuals who embody aspects to emulate. An extended definition includes negative role models as well, i.e. individuals who embody aspects to avoid. An example in engineering would be a junior software developer who wants to become project leader. They may look at what they consider good examples to reach that goal and imitate them, while considering bad

examples to avoid reproducing their mistakes. A preference over either kind of role model can be related to culture. Individuals from collectivistic cultures, e.g. East Asian, tend to favor preventing failure. Thus, they are most motivated by negative role models. Conversely, individuals from individualistic cultures, e.g. Western Europe, have a stronger promotion focus that leads to being more motivated by positive role models [24], [25].

It is worth raising the topic of language at this point: it is our experience that non-native English speakers may be dismissive of the use of role models in their negative alternative, simply because other languages may make it sound incompatible, e.g. in Spanish and Swedish, role model translates to "model to follow", so there is little room to interpret the possibility of avoidance. However, here we have decided to incorporate all possible uses of the term role model (and its modifications through adjectives and others) that we have encountered so far in the literature and our work.

In this spirit, we analyze aspects of several popular definitions and how they apply to engineering education. One look at several dictionaries already shows differences in their definitions of role model. A role model is a person (emphasis added): 1) whose behavior *in a particular role* is imitated by others [26], 2) who someone *admires* and whose behaviour they try to copy [27], or 3) regarded by others, *esp younger people*, as a good example to follow [28].

The first definition states that the role model is observed in a particular role. However, clearly defining a particular role can sometimes be challenging. Consider, for example, teaching. What is the role if we are talking about educators? A teacher may act as instructor in a course, as an advisor, as a researcher, etc. There is oftentimes no clear line between those roles. Even if there was, there is no consensus among teachers on what can be considered as teaching. For example, one of the teachers in our study, Robin[1], seems to separate assisting at a lab from teaching when saying: "And I didn't really teach a lot? I was still more about the whole lab assisting thing."

Thus, we understand this mention of "a particular role" and incorporated it in our definition below in a similar manner as Gibson: the goal of the individual imitating the model is not to become the model themselves as a whole but rather to incorporate a part of the model's behavior to the individual's own. Highlighting that role modeling is limited to a particular role may also signal, though, that the behavior may be useful for the individual only in a particular context and/or that the model is only showing one part of their behavior.

The second definition mentions admiration. We interpret this as the individual simply judging an aspect or achievement of the role model as worthy of emulation. While what is considered as outstanding in a person may inspire imitation, our definition of role modeling includes ordinary examples as well. For example, a student may choose to imitate the

[1]This paper does not contain the teachers' actual names

TABLE I
POSSIBLE COMBINATIONS, DEPENDING ON WHETHER THEIR FIELD IS ENGINEERING, OF ROLE MODELS AND THE INDIVIDUALS EMULATING THEM (INCLUDING EXAMPLES)

		Emulator (E)	
		In engineering	Not in engineering
Role model (RM)	In engineering	RM: Developer E: IT student	RM: CS Teacher E: Education student
	Not in engineering	RM: Parent E: IT student	RM: Biologist E: Education student

fairness perceived in their teacher, regardless of how common or uncommon this attribute is perceived to be. Rather, it is simply an available example worthy of being copied.

Age is a potential factor according to the third definition, with the role model tending to be older than the person emulating them. But can someone be a role model for an older person? Can a teacher learn from a student? In a study of role models as a reflection on ways to engage in computing [12], we have seen how students can have other students as role models, and not only professionals who are older and more experienced. Role models may be *perceived* as more experienced, regardless of their age and actual level of knowledge in the area.

All these definitions refer only to the model's skills or traits. However, in everyday life and the literature we may see another meaning: role models represent achievements (see Section IV-C).

Thus, we define a role model in engineering as a person who embodies a seemingly attainable achievement and/or an aspect (competency, character attribute, or behaviour) which, through its imitation or avoidance, may help another individual achieve a goal. This definition includes previous research and our own, and is further motivated in the following sections by discussing role modeling from several angles: who - mainly - participates in the modeling, what the model may embody, how awareness and intention play a role, and perception of the modeling by others.

B. Who: Main Actors in Role Modeling

Role modeling involves mainly an individual who perceives another person as a role model, and the role model themselves. Although others affect and/or are affected by this modeling, here we have decided to focus on the two main actors. We refer to them as role model and individual emulating (or simply "emulator"). When we say role models in engineering, there are four potential interpretations of the expression, depending on whether the role models and their emulators belong to the field or not. This is represented with examples in Table I. We consider someone to be in the field when engineering is their main occupation, regardless of their background, and not in the field when they use engineering-related skills for careers outside of engineering.

While the intuition could be to focus only on those in engineering, we are interested in all the four interpretations,

inasmuch as they refer to engineering. The four possible combinations, with examples, are:

1) Both the role model and the emulator are in engineering. A professional developer in a company as a role model for an IT student is one possible example. Notice that this developer could have a background in another area, such as physics, and she would still be considered as in the field in our classification due to her current occupation.

2) Role model in engineering for an emulator from another discipline: the emulator could be a student who has not yet decided whether they will study engineering, or perhaps who takes courses in engineering but is in a different field, e.g. students in education who will incorporate computational thinking into their curricula. The role model could be the teacher responsible for such a course. In later career stages, the emulators could be individuals who work in a field that is not engineering but require IT competencies of some sort.

3) Role models who are not in the field but embody competencies or achievements useful for an emulator in engineering. Examples are a good speaker from any area, a parent showing perseverance and grit, a physicist who codes, a biologist teaching sustainable development, etc. Notice how some examples are not engineering-specific, such as displaying grit, but are useful in the field nevertheless.

4) Neither the role model nor the individual emulating are in the field, but either or both may be related to the area partially, e.g. the education students emulating the parent. While this case may initially be considered outside of scope, we believe it is not. We argue that it is important to study role modeling aspects and/or achievements that are relevant for the engineering education community, even if these aspects and achievements are not restricted to just this field. Moreover, it is crucial to include the experiences of teachers such as those mentioned in 2), who may not be in engineering but will incorporate computational thinking into their curricula.

The definition of these four combinations is the result of considering the literature, mainly about who potential role models for engineering students are, and our work on ways of engaging in computing available through role models in computing education [12]. We claim that it is important to better emphasize the diversity in engineering, by highlighting different backgrounds, such as the developer's mentioned in this section) and what is valued -or not- in the community, such as grit.

When creating this vocabulary, sometimes we had to make choices based on the perspective of our target group. Different words may be used depending on whether we are referring to the modeling from the perspective of the model or that of the emulator. The two perspectives often overlap, particularly because the model reflects on what the emulator may think. Others, as we interpret it, have studied
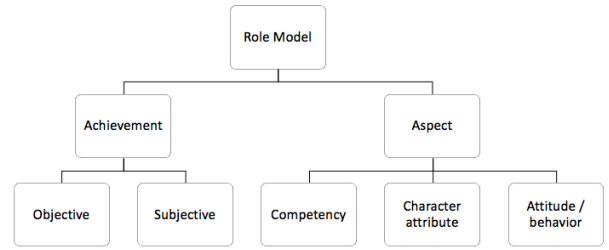

Fig. 1. What the model embodies and classification of these types of embodiment

the phenomenon and its vocabulary from the perspective of the emulator. McCullough [29] talks about motivational and imitative role modeling. This is described from the point of view of the emulator and the effect of the role model on them: the emulator gets inspiration or imitates the model (or perhaps both simultaneously). This paper aims to contribute vocabulary to describe how a role model may intend to have an impact on others. Whether the desired effect takes place is left for other studies. Particularly, the aim is for this vocabulary to be used when describing how educators may be role models themselves or may reflect on complementary role models for their students as we have discussed elsewhere [23]. Thus, we have favored the perspective of the model when a choice needs to be made, as in Section IV-C. This was not possible, though, when we looked at the perception by others in Section IV-E.

C. What: Embodiment by the Model

We have summarized in Fig. 1 our view on what a role model may embody that can be imitated by others. Based on our investigation of teachers as role models [23], we have chosen the word embodiment to represent the model's intention to take an abstract concept and use their own example to show potential emulators a concrete version of that concept, making it perceptible. We divide this embodiment in achievements and aspects. Achievements are given by someone external (an individual or a community), while aspects are inherent to the role model.

Individuals can be regarded role models because they have achieved a particular goal. Consider the definition of goal as a desired target that has not been reached, while an achievement can be described as that target being finally reached. In this way, goal is the perspective of the emulator, because they have not yet achieved this, while achievement signifies the success of the model in reaching the target. We use the term achievement, instead of goal, to favor the role model's perspective. Thus, we refer to individuals who represent the achievement of a goal as achievement role models.

Using the lens of objectivity, two kinds of achievements are possible: objective and subjective. We define an achievement as objective when it as a fact that leaves no room for discussion. Examples are being an associate professor or the first Latina under 25 to be CTO of a company in the country. While associate professor may have different implications

depending on the affiliation, it is a fact that an employee with that title holds that position in a particular institution. Subjective achievements are those that may depend on who interprets them as such. For example, being considered a successful woman in engineering depends on how success is defined by the observer. Individuals may have their own understanding of what it means to be successful. Therefore, they may disagree on who may represent the concept of success.

If what the role model embodies is inherent to that person, we refer to them as aspect models. Aspects may be a competency, an attribute of their character, or an attitude or behavior. The teachers that we interviewed mentioned aspects that were specific to the profession, and others that were not, as part of their role modeling. For example, Tage says:

> Tage: I feel you want the students to see me as a role model, [...] who both knows how to code and to understand the deeper issues behind the design of programming languages and the theory of engineering.

Here Tage highlights subject domain knowledge (and the display of it) as part of what he aims to do when he thinks of role modeling. It is important to show the students that the teacher knows well the specifics of their study topic. Gustav, on the other hand, reflects on how he is as a person and what kind of behavior he displays in the classroom:

> Gustav: Because I show what I care about, and [...] to some extent that's part of being a role model. I want to show that I care about everyone getting their say or treated fairly [...]. So I behave in a "good" way, in a way which I think can be mimicked, if you like.

Gustav is considering how he can transmit to the students aspects of himself that are related to his behavior but not necessarily specific to his profession.

The aspect may or may not be related to the achievements of the role model. Robin reflected about her teaching and who among her students could have role models in education:

> Robin: If, as a student, I'm thinking of... "I have a teacher as a role model" [...] it has less to do with what that person can do [...] it has more to do with finding similarities with this person and who this person is.

If a student does not have as a goal to become a teacher, then the teacher is not an achievement model in that sense. However, the teacher can still embody desirable character attributes as an aspect model.

Our classification of aspects fits the results of studies about role modeling in other fields, such as health care [30], [31]. These studies used a different classification and terminology. For example, what we call character attributes are "humanistic characteristics" in [31].

In some cases, it is not trivial to categorize what is being embodied by the role model as an aspect or an achievement.

There are some specific cases we deem particularly interesting to consider here. One study on teachers as role models for children shows the children wanting to have their teacher's knowledge (for us, part of a competency) and also "a teacher's power [32]". Although competencies are needed to use power in an ethical way, and power may affect behavior, we do not classify power as either competency or behavior. Instead, we consider power a subjective achievement, since it is given by others in a debatable way. The same study mentions how children in the study wanted to be "smart as [their] teacher". Intelligence can be seen as fixed or possible to develop [33]. For the former, it cannot be imitated, so it is not part of modeling. For the latter, it is a subjective achievement, as it is possible to aim to have this -subjective-level of intelligence through hard work.

When an individual observes a potential role model, the line between achievements and aspects related to reaching the goal that achievement represents may be blurry. Achievement models do not necessarily display what aspects helped them reached what they accomplished. If they do, they are simultaneously achievement and aspect models. For example, a student who wants to become a software engineer may observe one such engineer and see in her not only the embodiment of his goals but also of aspects related (or not) to achieve this goal. However, for a potential emulator may be that it is not clear or salient which aspects are needed to reach the success of their role model. This is more likely to occur when the emulator lacks knowledge of the area. For example, a student may not be able to discern what competencies a professor needed to get the title. While a guess is possible, it is also plausible that there is a mismatch between this uninformed guess and reality. This is even more salient when the achievement is subjective, since it may be harder to define the achievement in itself and, thus, how someone else can get there (or, in the case of negative role models, what should be avoided).

D. How: Awareness and Consciousness of the Modeling

When analyzing role modeling, we can look at how aware the model is of what they are embodying, and whether it is their intention to have that aspect or achievement imitated by others. Our participants mentioned examples of the different possibilities, which are summarized in Fig. 2. We have chosen this graphical representation, with arrows, to indicate that there are different levels of awareness and of intention. For example, one may be very aware of their accent and only slightly aware of the style of clothes they wear.

As quoted above, Gustav *wants to show* that he cares about everyone being treated fairly. Thus, Gustav is aware of his modeling of fair treatment and has the intention of modeling this for the students.

Alex is also aware of his modeling but the intentions are not to have it imitated:

> Alex: I think my behavior is very important. I think I actually base most of my teaching results on behavior. Like acting stuff. But I think it's... I mean, that's not something to emulate. You see the
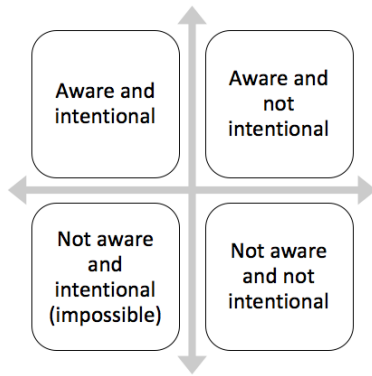
Fig. 2. Possibilities of awareness and intention of the modeling by the role model

point. So... I think it is very effective when maybe you make a joke [...]. Then of course if someone says "I would also like to teach and make jokes" that's maybe fine but that's not the point. That's not what I'm trying to achieve there.

Here Alex is very aware of how he uses jokes in his teaching. But his intention is not to -necessarily- have this as an example to follow. However, Alex is also aware that students may see him as a role model in this aspect, regardless of Alex's intentions.

There are also role models who are not aware of embodying an aspect or achievement but may still be emulated, regardless of their intention. Joe points at this possibility when talking about other researchers:

Joe: this was a student who started, he remembered sitting in meetings discussing research where people were being really aggressive and he thought "OK, this is the way I have to be"[...] [These people] were role models whether they wanted to be it or not.

What we see here is Joe's perspective, where he evaluates the behavior of these researchers as a bad example for the student to follow. These researchers may be aware or not of their aggressive behavior. If they are, they may or may not have the intention to have it imitated by the student. However, these researchers were role models for the student regardless of what they wanted, as Joe perceives it (we briefly consider the alternative perspective, that of the researchers, in Section IV-E). These academics could be an example of role modeling that is not intentional, since the role models are unaware of what they represent. Since Joe is describing a group, it is also possible that there were different levels of awareness of that perceived aggressiveness depending on each researcher.

The option of having the intention to model something, but with the model being unaware of the embodiment, is not possible. This is because we see intention as the conscious aim to do something. If one does not realize that they embody a particular aspect, how can they consciously plan to have it imitated?

E. Perception by Others

It is the emulator who defines another person as a role model, regardless of the intentions and/or awareness of this second individual. An interesting example of this are people with impostor syndrome. They may consider themselves a fraud but can nevertheless be perceived as outstanding by others [34]. However, it is not always the emulator who refers to someone as a role model. Consider another popular use of role model when referring to an achievement role model, for example: "Jane Doe is a role model for women in engineering". It is not uncommon that the author of such an statement has no knowledge of whether there *are* actual emulators of Jane. Rather, the author may be conveying their conviction that Jane Doe *should have* emulators, due to how she embodies aspects and/or achievements that the author deems desirable for a particular target group (in this case, women in engineering). We label this second interpretation as endorsed role model to reflect how, in this example, Jane Doe is endorsed by an individual or even a community as a role model for women in engineering. As it is common when discussing role modeling, this categorization of Jane's modeling is subjective. But this time the use of the term role model does not represent the emulator's (if there is any!) view. Rather, it reflects what an individual or group consider the emulator's perspective to be.

The definition of role model is affected by other adjectives used to describe it. Some of these adjectives can be interpreted in different ways, making some statements ambiguous. Here we give an example of the intention to communicate - negative - judgment. A "bad role model" could refer to someone who:

1) gives an example of an achievement or aspect that an observer or a community judges as detrimental to emulate but that the emulator sees as useful to copy. For example, in Section IV-D Joe described "aggressive" researchers, and adds that they "were bad examples of how you should behave". While Joe sees these academics as examples to avoid, he talks about the observing student seeing them as examples to follow.

2) gives a detrimental example that is seen by the observer as something to avoid. For example, a student who fails a course can be a role model for a peer that wants to avoid that outcome.

3) fails to be imitated. For example, a teacher who models a particular competency but whose students do not follow her example (even if they think they would be able learn it).

4) embodies an aspect or achievement that is desirable but that the emulator does not see as attainable. The gap between the emulator's competencies and the model's reality is too big, or there is no time to bridge it [14]. Here the observer does not become an emulator because, as opposed to the previous case, they consider that they will not be able to reach the level that the role model embodies.

We have defined these cases as 1) detrimental, 2) negative (as in [25]), 3) inadequate role model, and 4) unattainable role model.

Others have referred to unattainable role models as outliers, when the model's path is considered unfeasible, as opposed to non-outliers, when the model's path is considered feasible [7]). Since their embodiment is not possible to imitate, they are not part of our definition of role model. But we include them here to have a way of expressing this lack of attainability.

Classifying a role model as any of these four options (or the equivalent for positive judgment) is again subjective. The classification depends on each individual. For example, Joe sees some researchers as detrimental role models because these researchers have, in his opinion, an aggressive behaviour. These same researchers may use a more positive adjective, e.g. proactive, confident or assertive, to define their behavior. Or they may simply see being aggressive as necessary to be a researcher. In any of these last two situations, the academics may consider themselves a positive influence instead. For the presented four cases of negative judgment of a role model the perspectives considered are a combination of the emulator's and other observers' views. This differs from the case with endorsed role models, where what is considered is the emulator's perspective but as interpreted by someone external.

V. Other Terms

There are other terms, such as mentor or hero, that have characteristics in common with role model but should not be used interchangeably. Here we describe briefly some of these terms with regard to factors that make them different from role modeling. Since these terms are not our current focus, we facilitate pointers to other studies on each of them.

Is contact with an individual necessary for that person to be a role model? Teachers in our study mentioned examples of role modeling as a passive endeavor, where the role models themselves may not even be aware that they are being emulated. For example, Gustav talked about a role model in his teaching being "a writer of a text who you don't meet". Thus, we consider that there can be an interaction between role model and emulator but it is not essential. A mentor, on the other hand, has a personal relationship with the mentee. It is possible for a role model to also be a mentor and vice versa. All of this coincides with Vescio et al.'s definition [35]. However, others have expressed a different view, such as the mentor always being a role model (see [10] for more detailed comparisons).

Intuitively one may believe that role models invest less time and effort than a mentor, while reaching more individuals, due to the passive nature of their role. However, it may also be the case that a community's work towards increased exposure of role models leads to a higher workload for that person. For example, women may be asked to be the token figure in committees.

An individual may be neither a role model nor a mentor but instead a hero. For this term, researchers have again different definitions, depending on whether that person is imitated or not. A hero may be someone who is admired but whose success seems unrealistic, or admired but not wanted to be imitated by the individual admiring them [36], [13]. In this paper we have defined the first interpretation as an unattainable role model, thus choosing the second interpretation for hero.

Which of these terms can be applied to teachers in engineering? Since educators may have different roles, such as researcher, head of committee, or supervisor, teachers may be a role model, a mentor and/or a hero depending on the role that the student is observing and this student's goals and beliefs.

VI. Discussion and conclusions

One of the challenging aspects of discussing role modeling is the subjectivity of the phenomenon, as we have highlighted above. Some of the particular challenges for the engineering education community are related to its -improvable- diversity. Who sets the norm? One may be a role model according to the community, i.e. an endorsed role model according to our defined vocabulary. But who decides who embodies an example that should be followed? Here we understand diversity in two ways.

First, in terms of socio-economical background, for example gender and ethnicity. Are we raising the members of our community equally, regardless of to which group they belong? Studies show that women and men are evaluated differently. For example, women can be held to a stricter standard of competence than men even when the level of performance is the equal [37]. This is when achievement models can play an important part. They do not only embody achievements for individuals who are from a similar socio-economical background but also to others who may have unconscious bias. This bias can be reduced through the exposure to the examples embodied by the role models.

Secondly, Peters' work [38] shows that our understanding of what it means to be a computer scientist is far from diverse. As an example, one can wonder: what competencies does one need to be considered a computer scientist? Again, who decides this? And is the decision unbiased? This seems virtually impossible to define, at least at a global level. For example, is being assertive a good example to follow, or can this attitude be considered as too bold? The answer depends on cultural aspects.

Role models are a way to give a concrete image of the variety within our community, in terms of where we consider ourselves to be and how we understand our field. The terminology defined in this paper can be used by teachers as a way to reflect on how they are role models for their students and on which aspects they want to improve their role modeling. For example, a teacher may realize that they are an aspect model because a student has mentioned in the course evaluation how she observed and tried to imitate the teacher's public speaking skills. This teacher may then consider how he can become an achievement role model as well, perhaps by making more visible what his achievements

are, and how he achieved them (expanding his behavior as aspect role models in the process). Another example is a teacher who holds an administrative position as well, such as study program coordinator, who can reflect on her levels of awareness of what she may be modeling to teachers in her program. She can then think about what is her intention and compare it to what she thinks she is transmitting to other educators as an example to follow.

As educators, we may be role models ourselves. However, a teacher cannot model everything that students need to achieve their goals. Thus, other role models need to be presented. There may also exist a difference between what teachers regard as important to model (and, therefore, on where they will focus their efforts), and what students seek in a role model. It follows, then, that analyzing role models from the perspective of the emulators (students in particular) is a relevant line of work. Drawing a parallel with the work presented in this paper, some topics to study are who our students' role models are, what aspects and achievements the students value, and whether emulating a role model is something of which these students are aware.

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