

“Mature” to Doubt: Using Ethical Theories for Role Modeling in Computing Education

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Abstract—This full research paper uses ethical theories to discuss role models in computing education. Role models are beneficial for students but there is little work on how role modeling works and how teachers can reflect on their role modeling for their students. To address this we connect different theories to role modeling and their use to analyze role modeling as a teacher in engineering. We present theories with ethical implications from Aristotle, Wittgenstein and Biesta, then the themes related to these theories found in our interview study on computing teachers’ experiences of role modeling.

Our aim is to show how these theories could help deepen teachers’ understanding of role modeling in the concrete classroom situations from an ethical perspective. According to these theories, students first see the teacher as a whole as a potential role model. Gradually and through guidance, students “mature” to doubt: to being able to question which aspects and achievements of their teachers are desirable to emulate and which to avoid imitating. We discuss the teacher’s responsibility to make ethical judgements that include the scaffolding of this process.

Index Terms—role models, ethics, Aristotle, Wittgenstein, Biesta, values, virtue, computing education, engineering education

I. INTRODUCTION

In some countries of the Western world engineering education has a concerning lack of diversity among students and faculty, where diversity refers to different genders, abilities, sexual orientations, ethnicities, etc. There are initiatives for recruiting and retention to address this issue (see for example [1], [2]). One of the points made when analyzing these processes is the need of role models [3], whose use is a strategy that has a wide acceptance among the community [4]–[7]. These role models are people who represent potentially good examples for the students to follow in order to become successful professionals and students in engineering. They are specially beneficial for and are valued more by students of underrepresented groups, particularly when there is a match between the role model’s and the student’s gender and/or ethnicity [8], [9]. There are initiatives looking at role models for broadening participation in engineering, such as [10]–[12].

Unfortunately, it is not as simple as increasing the exposure of potential role models of a particular underrepresented group. There are studies [13], [14] that show that role models who embody stereotypes associated to the profession can instead have a negative effect: they may hinder the sense of belonging

of the female students observing them, regardless of the match in gender. This illustrates the complexity of role modeling in engineering and the need for theory to understand it.

There is little research on how the phenomenon of role modeling in engineering works, particularly in a teaching setting. What are the values/virtues that we need to model in engineering education? What are theories that we can use to focus on ethics when studying role modeling in engineering? Are teachers reflecting about this, consciously or unconsciously, when they think about their own role modeling? When we look at computing and how an individual can be a member of this field, is there a common idea of what should be imitated? In engineering education there seems to be the assumption that, by simply providing students with people who represent examples of different skills and attitudes valued in computing, the students will be able to first identify and subsequently copy these traits and competencies, and make them their own. But how does this happen? How can the process be described? And, more importantly, what are the pitfalls of this process? How are teachers in engineering reflecting on their being role models for their students from an ethical perspective? Do these teachers emphasize virtues to be imitated? What is (un)ethical to role model as a teacher? What is the relationship between ethics and what a teacher is unaware of modeling? When and how can students distinguish what they should copy from others and what they should avoid? To deepen the understanding of role modeling we need to use theory, such as philosophy theories provided with the framing that enables new types of reflections when we e.g. as teachers simultaneously act as role models for our students.

In this paper we connect role modeling and ethical and philosophical theories to the classroom situation in a way that benefits understanding of role modeling in computer science education. This connection is presented in section IV, linking role modeling to virtue ethics and Aristotle, then to knowledge and language philosopher Wittgenstein’s work and to Biesta’s in education. We focus on how students need to be able to - through guidance from their teachers - “mature” to doubt, to be able to discern and critically judge what their teachers represent as role models. This means that they need to be able to question which aspects and achievements of their teachers, who act as potential role models, are desirable to emulate and

which are best avoided to imitate. We present different ethical perspectives on the responsibility of the teacher in this process.

The first author is conducting an interview study on how computing teachers experience being role models for their students. Here we re-analyze the data focusing on the ethics of teaching using as themes the theories described above.

We conclude with a discussion of how these theories can be used for reflection on one's teaching, how in practice teachers may differ in their application of these theories, and some actions that can be taken to support those educators willing to reflect on the ethics of their role modeling as teachers.

II. ROLE MODELING IN STEM

There is a variation in the uses that we give to the term role model, due to how loosely this concept is defined [15]. There is a gap in the literature in terms of explaining this phenomenon: What does it mean to be a role model? How is the modeling done? What can be modeled? We describe work addressing these questions and role modeling from an ethical perspective in the teaching of engineering.

A. Theory of Role Modeling

While we have seen in section I that the term role model is used in engineering education, the uses and nuances of the term and others related to it are varied.

When teachers in a computing department are asked about how they experience that they can be role models for their students, different levels of understanding can be seen in their answers [16]. The more basic levels of understanding of role modeling focus on the subject domain. More complex levels of understanding reflect on the impact that the role model has beyond an individual student. Teachers see that the student cohort is not homogeneous and thus students are differently impacted by the teacher's potential role modeling. It is not only those in the classroom that are affected but also the profession and society as the students will be part of both and spread the influence of their role models, including their teachers.

In the study the participants used the same terms with different meanings. This led to the development of a model [17] to describe role modeling in engineering education. Among other work, the model includes a definition of role modeling focused on what can be modeled in general terms, and a reflection on the different combinations of awareness of role modeling and whether it is the intention of the role model to be emulated. The model is based on the results presented in [16] and on existing research in fields such as psychology and economics.

The definition of a role model in engineering in this model is "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." Students in engineering have their own goals. Their role models are people who represent one (or more) of their goals or a way to achieve it in a way that the student thinks is doable for them. Achievement in this definition refers to the realization of a goal, such as someone who is a CEO may be perceived by a student as a

concrete realization of the goal of reaching a high position in industry. The achievement represented is one that the person emulating the role model desires to achieve. This achievement is given externally, e.g. the formal recognition of winning an award, or being perceived as a successful professional. On the other hand, a role model embodying an aspect refers to what is inherent to the role model, e.g. their proactiveness. Thus, those who want to reflect on how they are role models (or how they can expand their role modeling) can consider if they are modeling achievements and/or aspects, and which ones they can highlight more. For example, a teacher may be very active in voluntary work but could work on increasing the visibility of this line of work in their online profiles. Learning about how the teacher takes part in these initiatives may inspire students who would be unaware of this particular work otherwise.

Students may desire to be recognized as part of the engineering profession, and thus look for examples that represent professional identities that match the student's goals. In this interpretation, a role model in engineering is "an individual who embodies one or more desirable ways of engaging with the discipline and/or profession." [18]. Social contexts and cultures, and particularly their role in the level of influence that a potential role model may have, are important factors to consider when evaluating who the students choose to emulate.

When learning what is valued in their cultural contexts, students may identify "good" and "bad" role models. The same terminology was used by the teachers in the study. Other researchers have defined a "good" or positive role model as a person that the student wants to emulate to achieve a goal [19]. This looks at the student perspective. In the study above, when a teacher said someone was a "good" role model, the meaning was that the teacher (or a community that the teacher belonged to) highly regarded someone and recommended that person as a role model, i.e. worthy of emulation. To avoid ambiguity with the previous meaning, this has been defined as an endorsed role model [17]. For the definition of "bad" role model we find even more meanings. The opposite of a positive role model is a negative role model: a person who represents an example of what should be avoided in order to achieve a goal, such as a smoker represents something not to copy if the goal is to be healthy [19]. Here the person looking at the role model is aware of the need to avoid copying that achievement or aspect. However, we may refer to someone as a "bad" role model when a student perceives them as an individual that should be copied but a teacher, from their experience, thinks the opposite. The model refers to this kind of role model as "detrimental" role model. In total the model includes a distinction between four cases, depending on whether the student and the teacher agree on whether the model is someone to copy or avoid becoming, or if the emulation seems feasible [17]. This is just an example of the variety of uses of terms related to role model, and how there is a connection to what teachers may aim to model and the different values they may have. It is this link to "right" and "wrong" that started the inspiration for the work presented in this paper: theory from ethics and education needed to be added to the project.

B. Ethics and Role Modeling in STEM

There is research on how to teach ethics in engineering education but it is harder to find work on the ethics of role modeling as a teacher. In virtue ethics exemplars, or role models, are concrete examples of the ideal virtues a person should have. Values can be defined as statements about norms and expressed in terms of “ought to be” and virtue as a trait or quality that is valued as being good. Pennock and O’Rourke [20] talk about scientific virtues, which are the subset of virtues that specifically apply to the scientist. Examples of these virtues for STEM (Science, Technology, Engineering and Math) are curiosity, perseverance, skepticism, honesty, and innovation. Pennock and O’Rourke then discuss how members of a culture, in this case scientists, share a set of values and rules that are taken for granted and rarely explicitly discussed, and that role models embody. They argue for an approach to teach ethics to students using role models that represent ideal scientific virtues, and encouraging the students to have explicit discussions about these virtues. Rather than having each virtue in isolation, the recommendation is to pair them. To support this recommendation, Pennock and O’Rourke give the following example: that a researcher needs to be persistent enough to go through a project that may come with certain obstacles, while also being humble enough to understand when they should stop (for example, when there is a growing body of evidence against the original hypothesis).

Pennock and O’Rourke have tried this method of teaching scientific virtues in introductory courses. But they argue that it works better the more experience the student has. Thus, they recommend trying it with post-docs and graduate students due to their more developed view of the field. Looking at Peters’s work in computing education [21], we see this recommendation as dangerous. It is vital that students are provided with diverse role models from as early as possible, since this will help them shape their view of the profession and what is valued:

One can argue that the students in the CS/IT programme, [...] only take toolbox courses in the first three years and that they get exposed to broader ways of experiencing participation in later years [22]. This study suggests that introducing broader aspects later in the curriculum is not an alternative. [...] The predominance of participation [in computing] as creating and problem solving has implications for what it entails to fit in and be seen as competent. The students adapt their behaviour and learning activities accordingly. The absence of broader experiences of participation appears to be a breeding ground for dualistic constructions of computing as technical problem solving. When students are recognised for their technical competences, they may perform a technical computing identity rejecting broader ways of engaging in computing when those are introduced [...].

Thus, the earlier in their studies that students in computing

are, the less narrow their view of how they may participate in the discipline is likely to be. We have discussed elsewhere [18] that we need to understand the potential of role models considering how engagement in engineering is constructed in social interaction. Not all role models have the same level of influence over students. These role models can be peers, teachers and other stakeholders in engineering education.

III. APPROACH

In this paper we look for philosophical theories that can be used to analyze the ethics of teaching as a role model in engineering education. We use these theories to find themes in the interview transcripts from our previous study in computing teachers’ experiences as role models for their students.

A. The Theories

On character building and ethics in education, subjects close to role modeling, Aristotle’s virtue ethics was a natural starting point. Interest in knowledge and gaining knowledge through education leads us from Aristotle’s notion of practical wisdom, *phronesis*, to a contemporary philosopher of education Gert Biesta. Biesta uses *phronesis*, practical judgments, and a pragmatic view of knowledge when discussing education from an ethical standpoint. The later Wittgenstein, a philosopher of knowledge and language often referred to as having a pragmatic stance, is connected to the two above with his holistic understanding of knowledge gain. We describe this work and its connection to role modeling in section IV.

B. Study of Teachers as Role Models for Their Students

In this paper we re-analyze the data from an interview study that the first author is conducting, where teachers in a Swedish and in a Taiwanese university discuss their experiences as role models for their students.

The participating teachers had diverse backgrounds and teaching experience. In Sweden they were both from within and out the country, while in Taiwan all the teachers were locals. The two locations for the study are chosen due to their very different cultures. The participants’ age ranged from late twenties to close to retirement, and there was diversity in gender as well. For some it was their first years teaching while others had been educators for decades. The interviewees were specialized in different research areas of computing in the departments where they teach. There are nine semi-structured interviews of 30-70 minutes. The participants agreed to the use of quotes from their interview with fake names to ensure anonymity¹. For Sweden, five interviews were transcribed and analyzed using a phenomenographic approach, which resulted in an outcome space of different understandings of role modeling as a teacher (see [16]). For Taiwan, four interviews were transcribed. For both settings, the interviewer inquired about the participant’s own definition of role modeling, whether they had reflected on their potential role as such for their

¹We have tried to avoid using names that belong to other people in the departments. If there is any match, it is the result of a coincidence and not a real match

students, how this role may have potentially limited their behavior and in what ways, and whether they considered that they were providing their students with role models other than the teachers themselves. Notice that all these areas of inquiry relate to how the teachers experience role modeling in general terms, as this was the original research question for that study. There is no specific mention of the ethical aspects of the phenomenon as part of the questions. However, this does not mean that they were not mentioned during the interviews.

In section V we present the themes identified after using deductive thematic coding analysis [23] with the interview data described but focusing this time on the theories described in section IV. This method was chosen because there was already a prediction of what themes would emerge based on the theory selected. The authors discussed the themes and looked for an agreement when there was a conflict in the classification. The results were later discussed with colleagues. In the quotes the original text in English is kept, despite some grammatical errors (that are due to the participant's mother tongue being one other than English), to avoid adding alternative meanings.

IV. ETHICS IN TEACHING IN CONNECTION WITH ROLE MODELING

We begin by discussing Aristotle's virtue ethics and then proceed to the later Wittgenstein's texts regarding knowledge. In order to link these theories to education and ethics, we add perspectives from educational philosophy with references to Gert Biesta's views.

A. Aristotle

One way of understanding ethics and role modeling in education is through Aristotle's account of virtue ethics. Aristotle argues for building your character through your life, aiming at cultivating desirable virtues such as truthfulness [24]. He has been used in character-education embracing role modeling as a way of teaching values [25].

Kristján Kristjánsson discusses emulation and the use of role models from an Aristotelian perspective. Aristotle describes emulation as "distress at the apparent presence among others [...] of things honoured and possible for a person to acquire" [26, p. 161] as both a felt lack of something and also an awareness of something desirable for oneself. The concept of emulation has relevance for role modeling in education even though this is not explicitly stated by Aristotle. Kristján Kristjánsson argues that the present (in 2006) trend in character-education underuses the Aristotelian virtue ethics. To emulate values through role modeling should be more than to follow an example. It is not the whole person that should be copied but only the virtues; the student must learn to distinguish character traits from role model [25]:

If, however, we want to fully understand the nature of the good life and the role of the particular virtues in such a life, we need objective, exemplar-independent standards to help us grasp that truth. Merely pointing to role models or other good examples is not enough. The Aristotelian educator

would bring this fact home to learners, even before they were capable of understanding such exemplar independent standards themselves, by constantly referring to moral reasons rather than merely good examples. This is precisely what is meant by taking account of the cognitive element of emulation. [25, p. 48]

In Aristotelian ethics, the young learner starts to cultivate their virtues by copying from examples such as a role model [24]. But for the student to "mature" and to distinguish what to copy, a teacher must point to why these character traits are desirable. This process of maturing is also accompanied with the ability to form judgments about example-independent standards [25].

B. Wittgenstein

In regards of the issue of acquiring knowledge through examples the philosopher Ludwig Wittgenstein states in "On Certainty":

(paragraph 141) When we first begin to believe anything, what we believe is not a single proposition, it is a whole system of propositions. (Light dawns gradually over the whole.) [27, p. 21e].

(paragraph 232) "We could doubt every single one of these facts, but we could not doubt them all." Wouldn't it be more correct to say: "we do not doubt them all". Our not doubting them all is simply our manner of judging, and therefore of acting. [27, p. 30e].

Wittgenstein's reflection on language and propositions is akin to learning virtues through role models. First the student believes in the example as a whole. As the student matures (and through guidance), they start to doubt one thing at a time. This "doubting" we compare to making critical judgments and being able to discern between traits that should or should not be copied.

We draw on statements from Wittgenstein that declare how he understands how people come to know:

(paragraph 160) The child learns by believing the adult. Doubt comes after belief. [27, p. 23e].

We interpret an educational setting as concerning the student and role modeling. The student ("child") believes someone (the "adult") as a whole before being able to question certain aspects. This whole can be viewed as a system of beliefs that are acquired in clusters.

(paragraph 279) This system is something that a human being acquires by means of observation and instruction. I intentionally do not say 'learns'. [27, p. 36e].

Given that *believing in something/someone as a whole* is a necessary start in understanding a subject, the teacher's aim could be to lead the process of being able to doubt. The teacher could first accept that the student will believe and "follow" the whole - the role model, the teacher's example - not expecting the student to be able to distinguish what to copy. Part of

the teaching could subsequently be directed at making doubt possible.

C. Biesta

According to Gert Biesta, active in the field of philosophy of education, the ethical dimension of education is fundamental. He builds on Dewey [28] in arguing that the purpose of education is an ethical question. One cannot disconnect questions of how to effectively teach a subject, from questions of why this content and to what purpose. According to both Biesta and Dewey, knowledge and content are always connected to values. Knowledge and values are perceived as an integrated whole from the perspective of the student.

Biesta, just like Kristjánsson, points to the importance of ethical judgments. He focuses on ethics and the teacher's judgments. The teacher makes didactical decisions using their professional judgments while considering three purposes of education. The ability to do so is fundamentally ethical.

Biesta [29] argues that all education has three purposes: qualification, socialization, and subjectification. These three purposes (or functions of education) are intertwined during the practice of education, but can be separated to better analyze and understand an educational setting.

Qualification is to be able to practice a profession or be ready for the next educational step. To qualify in the subject computer science is for example to be able to solve a problem through programming. If the program does what it is supposed to do, the student has been taught the right things. Included in qualification is the ability to form ethical judgments, according to Biesta [30]. The purpose of qualification can be expressed in terms of knowledge, skills, and judgments. Qualification is the most important of the purposes of education, as the student needs to qualify in the profession - and also to be a citizen.

Socialization is about (actively) being a part of communities. The student becomes a part of an already existing order (e.g. a social or political order). Individuals become socialized to different ways of doing and being. It could be traditions or norms for society, but also specific norms for a particular profession. All education has socializing effects even if that is not a declared aim, cf. the hidden curriculum [29]. Education plays a part in preserving cultures and traditions.

Although the subjectification aspect of education is often dismissed or not noticed, it is of special importance to Biesta. It can be described as the possibility to be your own unique self in an educational setting, to be able to think and act more autonomously. Biesta describes subjectification as the opposite to socialization. The education should incorporate possibilities for individual interpretation of the socialization process. This gives possibilities for something new to emerge into the world. The purpose of an education is not only reproduction (socialization), but also aiming at change, development, and uniqueness [31]. Biesta is interested in creating a way of talking about education that captures how the subject exists in this setting.

Biesta is critical of the (over) use of the word "learning". The teacher makes situated judgments where the three pur-

poses of education are balanced against each other. These judgments become hidden in the discourse of "learning".

Both Biesta and Kristjánsson connect Aristotle's virtue with the development of practical ethical wisdom, named by Aristotle the *phronesis* [32] [33]. Aristotle believes that this knowledge is developed through experience, but good examples are necessary in this regard, and role models in education have a particularly important role. Biesta connects the development of *phronesis* with the subjectification aspect of education [33]. The teacher's judgment in balancing between the socialization and the subjectification aspects is crucial for the students' opportunity to develop *phronesis*, both in general and in the subject discipline.

V. TEACHERS' PERSPECTIVES ON ROLE MODELING AND ETHICS: THEMATIC CODING ANALYSIS

Teachers participating in the study about their role modeling for their students described in section II-A had different understandings of what it meant to be a role model: in particular, of what should be modeled. We looked through their reflections to find examples of virtue ethics, Wittgenstein's philosophy and Biesta's purposes of education. The quotes presented here show teachers who seem to agree or disagree, depending on each case, with the philosophers' theories discussed in this paper. Our aim with these quotes is to give concrete examples from computing education settings that relate to the theory and can serve as a starting point for reflection for the reader in engineering education.

A. Virtue Ethics in Connection to Role Modeling

The teachers reflected on what virtues they aim to model for their students. For example, Emil in Sweden talks about fairness:

Emil: 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, things like that. So I behave in a good *makes air quotes* way, in a way which I think can be mimicked if you like.

Yu-Wen in Taiwan makes similar claims as Emil, speaking of fairness, when discussing what she means when she says she must behave like a teacher. In her case, she talks avoiding behavior that would show she does not care about the student's learning experience or that is unfair:

Yu-Wen: But I do sometimes hear from my students saying that they mmmm they, you know, some they have some bad learning experience. For example, [...] some teacher don't care how students learn so they just keep talking [...] and don't care the reaction from the students. That's the thing I avoid doing [...] unfairness, that's also one negative behavior I try to, I well, avoid to happen in my class.

What Emil and Yu-Wen express is in line with Abdul-Samad's [34] recommendations for teacher training in value education leadership (emphasis added):

Positive role modeling requires the leader/teacher to *behave in accordance with his/her innate values. They also need to demonstrate consistently values-based behaviors* (in their words, thoughts, and actions) so that conducive environments are created where learning and creativity can grow and thrive.

Teaching in Taiwan, Yan-Ting talks about examples of role models such as more experienced students. He makes use of them to help new students identify what Yan-Ting believes should be copied by the newcomers and what they should avoid. When asked about using students as negative examples, he says: *We try not to focus on the model himself but on the actions they did.* After a follow-up question on whether this applies to positive examples as well, he agrees and adds:

Yan-Ting: [...] senior students, they also can present very good and also act very good role models for the newcomers. So I can point out some, like, more explicit behavior for newcomers.

Here Yan-Ting emphasizes how in his teaching an important factor for role modeling is to focus on what is to be emulated or avoided, rather than on the person (the positive or negative role model) that is embodying this achievement or aspect. This is very much in line with Kristjánsson's discussions on Aristotle's virtue ethics and that the teacher needs to point out independent standards themselves, by constantly referring to moral reasons rather than merely good examples.

By focusing on their values and how they relate to role modeling, these teachers' reflections are in line with Aristotelian thinking of the cultivation of desirable virtues. However, except for the example given by Yan-Ting, it is not clear whether the role modeling of these teachers is focused on the person (the teacher) rather than on helping the student see the character traits, as Kristjánsson criticizes (see section IV).

B. Wittgenstein in Connection to Role Modeling

What may be lacking in Yan-Ting's approach in the previous quote is a reflection on the process of first believing and then being able to doubt, that the new student may not have the ability to distinguish one quality from another. Now we are drawing on our support of Wittgenstein's description of how one comes to know something.

Joe, a teacher in Sweden, reflects on whether students only copy the good traits of their teachers:

Joe: I mean [role models] are someone who are setting an example whether that's an example that you feel that you should follow that could be the deciding factor whether they are a role model... *long pause* yeah we [teachers] are all putting ourselves out there in our behaviors... observed and judged and... by the students... adapted or adopted whether we behave poorly or... otherwise, well...

Since this "poor behavior" may be copied regardless of the teacher's intention, Joe seems to indicate that he does not perceive the students (or at least all of them) to be able to distinguish between desirable and poor behavior in their

teachers. He then gives an example of such attitudes for a new student:

Joe: I remember, 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", just start doing the same thing. So the people who were being aggressive, they were role models whether they wanted to be it or not, they were bad examples of how you should behave.

He also gives an example of (according to him) a behavior that should not have been copied but was adopted anyway. Joe perceived this as due to the student not being able to tell that aggressiveness was not a necessary characteristic of being a researcher. This fits the connection of role models first seen as a whole, as presented in section IV on Wittgenstein's work.

Consider the differences between Yu-Wen's (see above) and Joe's examples. Yu-Wen highlights cases of teachers' behaviors that both she and the students have identified as bad in a teacher. It then follows that these behaviors would not be imitated if teaching was the student's goal. In Joe's case, he thinks the researchers being aggressive represent a bad example but that the student does not see that. Instead, the student considers them an example to copy. As described above, this is an example of Wittgenstein's view on how the student copies the whole without doubting when they are new to, in this case, the research context.

It may not be easy for teachers to be available for the students as role models, both for negative and positive aspects. In Sweden, Sara talks about the pressure of showing a side of oneself that may not be perceived as perfect by the students:

Sara: Teaching is dangerous *laugh*. Because you are exposing all of your weaknesses. I mean, if you have a weakness then the students are going to find it *laugh*. [...] all of the spotlight is on you.

Presenting oneself as a teacher, and supporting the students in the process to "mature" to doubt (to start questioning how much they are really able to copy from their teacher), may be a difficult task for the teachers themselves due to the fear of judgement.

C. Biesta's Purposes of Education in Connection to Role Modeling

One of the participating Taiwanese teachers, Hsin-Hung, expresses that others may focus on attitudes and behaviors for their role modeling but he believes programming skills are what he needs to emphasize in his role modeling for his students:

Hsin-Hung: Maybe I think the role model is especially focused on the programming skills. Some definition maybe the role model is involved with some attitude or some personality, something like that, but I agree with this definition but mostly focused on the programming skills.

Hsin-Hung is thus focusing on modeling skills related to being a computer scientist. This is an example of Biesta's qualification. In Sweden Tage talks about students eventually being part of society as professionals in computing, and how that implies having certain skills:

Tage: Most of [the students] will end up out in society in some kind of jobs and of course it is my duty to, mmmm, make sure that they have the necessary skills to do that effectively.

Tage then specifies that these skills, in his case, are related to programming:

Tage: I feel you want the students to see me as a role model, as an academic. Somebody who actually who both knows how to code and to understand the deeper issues behind the design of programming languages and the theory of computing. [...] because I think actually that kind of understanding is what you should have if you have a university degree.

Yu-Wen highlights that teachers in computing not only model subject-related skills and attitudes. In particular, they can be role models of how to be a teacher in computing:

Yu-Wen: I try to be, to become a good example. For example my students would tell me that they like my teaching style very much. If one day they become teachers, they would like to apply a similar field to teach their students.

In other words: teachers may represent aspects or achievements necessary for students to achieve their goals, whether these goals imply being a computer scientist (in industry or academia) and/or the particular case of becoming a teacher in computing.

Yan-Ting sees himself as a role model for his students. But he also makes sure that new students quickly learn how to be part of the student community, by providing them with student role models. This relates to the socialization purpose of education:

Yan-Ting: For example, I'm a role model for them. But probably too far from them. For them. So I always use their... [...] the students who graduated a couple of years ago, as a role model for them. [...] So they can closely look, academic brothers, sisters... We try to create that kind of small laboratory climate for newcomers to join in. And to get to know academic living, studies, and even discussions.

These "academic brothers and sisters" are examples of how to be a student in computing (at least in Yan-Ting's lab). The teacher creates opportunities for discussion, so these attitudes and skills that are promoted as part of the culture seem to not be expected to be assimilated without questioning.

As another example of Biesta's socialization, Kuan-Yu in Taiwan talks about how he transmits to the students that reading research papers is part of being a part of the research community in computing:

Kuan-Yu: I challenge [the students] to read a lot of research papers. That's because I also read a lot

of research papers.[...] So by the time they graduate they also have read a lot of papers, they think reading a lot of papers is not a requirement but is a necessity to do in order to achieve a good research topic.

Notice how Kuan-Yu emphasizes that it is important that he the teacher himself reads papers, but the quote can also be interpreted as an example of qualification: being able to go through the available literature is an essential part of a student's education in computing.

As Kuan-Yu, Yu-Wen talks about how she transmits to the students what they should (not) do to be part of the research community, based on her own view of it:

Yu-Wen: The other thing I can think of [my role modeling] is my... my... research... my attitude for doing research. I tell my students that for researchers we have to do something or... you can't do something [...], I have to tell them a few guidelines, something you can do and something you can't. And that shows my attitude, right?

Here Yu-Wen is referring to socialization in the sense of modeling how to be part of the community but also refers to her own subjectification, as she is aware that this is how she in particular behaves. We can see this quote as an example of balancing socialization and subjectification: how Yu-Wen keeps being herself while belonging to the group.

Alex, another interviewee in Sweden, talks about how role models can help enhance subjectification by being a reflection of each student's goals:

Alex: [...] being a role model is very connected to who would you like to be in the future, so if your role model is a startuper, [...] or if your role model is someone who opened a big foundation, or if your role model is [Edward] Snowden [...] That could be important or relevant, to understand what we are doing here, what kind of people are going out of our courses.

Alex believes that there is a need to reflect on the goals of the students, partly through an analysis of who their chosen role models are and what they represent, in order to inform the teaching at the department, i.e. to help the teacher make situational judgements.

Notice how the same quote may serve to illustrate different points, as we have seen when Yu-Wen talks about showing her attitude and what can(not) be done in research. These examples illustrate that Biesta's purposes of education are presented separately for the sake of discussion but are in practice intertwined.

Both Hsin-Hung and Yu-Wen think of a specific aspect that they want students to pay attention to and emulate. Hsin-Hung is clearly focusing on the qualification aspect of education when he thinks of himself as a role model showing programming skills but does not motivate other ways in which he can be a role model as well. Yu-Wen, on the other hand, is pointing to herself as a role model in teaching being able to

incorporate all of Biesta's purposes of education and enables for a more complex view of what her role modeling could be.

VI. DISCUSSION AND FUTURE WORK

There is no silver bullet to solve the lack of diversity in computing education, where diversity refers not only to social constructs (the most common example in the literature being gender) but also to variety in professional identities and ways of participating in the discipline for all students. The culture needs to change, and one of the strategies contributing to this is role modeling. Effective role modeling is not trivial, though, and there is a need for theory so that teachers can have tools to reflect on their own role modeling for their students. This is important because of the benefits that having a role model has for students, particularly of underrepresented groups, as seen in section I. We have presented different theories and their connection to role modeling, including work in STEM education that emphasizes the importance of teaching scientific virtues through role modeling [20], and how this should be done at all levels of a degree in the area to avoid narrowing the student's view of the field [21].

In summary both Aristotle and Biesta are concerned with the balance between socialization and subjectification in education, although they use different wording. Both emphasize the purpose of education and the aim of developing practical ethical wisdom in making judgments (phronesis). These are aspects to consider teaching and possibly in role modeling. Wittgenstein adds to this that students start by believing in contexts and examples as a whole, and then, by maturing in the situation/subject, get the ability to doubt.

The examples provided of teachers' experiences of role modeling for their students show different understandings of and approaches to not only what aspects and achievements are to be modeled but also the ethics related to the modeling phenomenon. While some teachers may reflect on what values are transmitted to the students, there seems to be little to no reflection on how to explicitly discuss these values and virtues with the students to support them in their "maturing" to doubt. We recommend that teachers use a model for role modeling that includes a tool for reflection on what is being modeled and how, e.g. [17]. This way they can be better equipped to discuss their role modeling with their students, and even ask them to reflect on what they aim to imitate or avoid copying. Notice that the model in [17] includes how role modeling can be both intentional and the opposite, and the role model may sometimes be unaware of their being imitated by others (as Joe's example in section V-A can be interpreted). This makes discussion especially important, to bring awareness of what may not have been noticed by the teacher before.

Teachers may be providing opportunities for qualification by modeling skills, but qualification also involves attitudes. Here we bring attention to how all three purposes of education are intertwined, which contradicts the view of teachers who aim to model subject domain knowledge (e.g. programming skills) but assume their values are not part of their role modeling.

Guiding students in the process of questioning their teachers as role models involves the teachers presenting themselves as imperfect. If we connect this to the point above, this can mean that the teacher explicitly addresses their so-called flaws and has a conversation with the students on pedagogical approaches that are being tried in the classroom, since sometimes this may not be considered a success. Notice, however, that the teacher needs to feel the freedom to make mistakes and not be punished for them. One contradictory approach that some institutions support is the use of student evaluations to judge the performance of their educators, which can turn into one of these punishments.

In an educational setting not all students are the same: they do not have the same goals and, therefore, they will not have the same role models or aspire to copy the same achievements or aspects. Thus, the conversation about what is desirable to copy and what to avoid needs to be based on subjectification, i.e. who the students themselves think they are and who they strive to become while they are also part of the community. It also means that guiding the students to doubt does not mean necessarily that all that is not copied is considered a flaw: it could simply not be part of that student's goals. This difference between flaw and lack of alignment with a particular student's aims for imitation is something that mentors of new or inexperienced teachers may want to highlight when discussing with their mentees. We have described elsewhere [16] that seeing the students as a heterogeneous group in terms of how the teacher has an impact on them from a role modeling perspective is one of the higher levels of understanding of role modeling as a teacher in computing.

It could be interpreted that we have portrayed the students who are new to computing education as individuals who take their teachers as a whole as role models, without questioning at the beginning of their studies. We clarify that we do not mean that students have no agency whatsoever. We bring attention to the fact that students are too new to the field to be able to distinguish what is needed to be considered an engineer and may struggle with comparing their own values and goals to those that seem to be valued by their peers and educators. This has been illustrated by Peters [21] and we have discussed elsewhere the influence that cultures and contexts have on the impact that role models have on students [18].

It is the teacher's responsibility to reflect on how they can be role models for their students and to analyze the situated judgments they make in order to provide the students with balanced opportunities for both socialization and subjectification. Our ongoing work will address theories and examples to support teachers in this process, for both their intentional and unintentional role modeling. We will address questions such as: How can we teach students to be free agents, to be more critical of what to follow as an example? How do we structure the teaching in this way? How do we get the students to identify but also criticize the role models? Awareness of one's own role modeling as a teacher is a starting point for teachers to reflect on these aspects.

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