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Teaching Graduate Attributes along with subject content: Perspectives from Science Teacher Educators

Abstract
This study explored the extent to which science teacher educators in Norway introduce, teach, and assess graduate attributes (GA), a range of qualities, skills or competences considered vital for one's survival and thriving in a complex world. A qualitative analysis of views from a sample of science teacher educators revealed majorly an implicit approach to the teaching and assessment of graduate attributes along with the main teaching subjects. Moreover, the lack of a graduate attributes profile for science teachers is impeding the teaching and assessment of these attributes. The findings raise important questions to science educators and policy makers regarding how to best address graduate attributes in science teacher education.

INTRODUCTION

Learning institutions across all levels world-wide have as their main obligation to equip citizens with knowledge, skills, practices, and experiences relevant for survival and participation in society. As groups or individuals living in today's society, we have come to accept in the recent years that the required forms of knowledge and competences for active and productive participation in society are increasingly changing, owing to the increasing threat to the environment, coupled with remarkable global social, political, and economic challenges. The demand for new knowledge forms and innovations to ensure the sustainability of both today and tomorrow's society is thus inevitable (Ludvigsen et al., 2015). New requirements for knowledge to tackle societal problems not only concern the canonical- subject specific knowledge and technical skills, but also include the requirement to attain a range of other abilities and skills considered as *subject content or technical-knowledge application enablers*. There is thus the increased pressure and demand for especially higher learning institutions to ensure that the training of other skills, abilities or a different kind of knowledge not directly tied to subject-content is formally considered as part of the productive development of graduates for the dynamics of the current working life and its demands (Barrie, 2007; Bath et al., 2004; Buzdar et al., 2018; Hager & Holland, 2006).

A combination of different adjectives and nouns have been employed in research when describing what constitutes a range of abilities, skills, or a kind of knowledge which is not directly tied to subject content, but relevant for an individual's participation and survival in society. Commonly employed terms include, "generic skills", "transferrable skills", "life-long learning", "enterprise skills", "soft skills", "key attributes or skills", "graduate attributes", and or "employability skills (Barbara et al., 2018; Barrie, 2006; France et al., 2016; Sumsion & Goodfellow, 2004). In this study, I use the term "graduate attributes" as a coining term for the range of abilities, skills, and knowledge that are not directly tied to subject content, that which graduates of any training program are expected to have acquired during their training, and which they continue to develop and improve long after their graduate training. Moreover, for a working definition, I adopt Barrie's (2006) understandings, where the author describes graduate attributes to constitute "the skills, knowledge, and abilities of university graduates beyond disciplinary content knowledge, which are applicable in a range of contexts and are acquired as a result of completing any undergraduate degree."(p. 217). Examples of the different constituents of graduate attributes considered in earlier research include critical thinking, intellectual curiosity, problem-solving, logical and independent thought, communication and information management skills, intellectual rigor, creativity and imagination, ethical practice, integrity and tolerance (Barbara et al., 2018; Bath et al., 2004; Stracke & Kumar, 2014).

Graduate attributes as key enablers of productive participation in society

About over two decades ago (as of October 2022), life-long learning as well as graduate employability were key driving factors for inclusion of graduate attributes in higher education. The overall goal was to ensure graduates with the ability to re-learn at workplaces, able to synthesize, and apply both existing and emerging general and subject-specific knowledge and technical skills in desired ways (Barnett, 2012; Headrick, 2001; Knight & Yorke, 2004; Windsor et al., 2014). Though the focus on graduate employability has not changed and employers continue to demand these attributes of their prospective employees (Headrick, 2001), graduate attributes are increasingly considered as enablers of productive participation in society as a whole (Bond et al., 2017; Ludvigsen et al., 2015). This worldwide acknowledgement of the importance of graduate attributes has seen an ostensible inclusion of graduate attributes in curricula as evident in various graduate programs at different higher learning institutions (Barbara et al., 2018; George et al., 2013; Hill et al., 2019). An overview of the major driving factors behind such a movement is given by Bond et al. (2017) in their review of literature on the topic. According to the authors, interest in increased accountability, increased productivity at workplaces, as well as the increasing demand for a learning society that is ready to meet the increasingly changing societal demands, are key factors behind the restructuring and alignment that has been ongoing since the early 2000s in higher learning institutions in Europe, USA, UK and Australia (Bond et al., 2017).

Considering the Norwegian context (the focus of this paper), development of generic skills and competences is underscored as an important part of the relevant training both current and future Norwegian citizens would require in the next 20 to 30 years. These skills are perceived as enablers of productive participation in society, with which individuals in addition to having area-specialized knowledge and technical skills, will be able to deal with the current and future societal and global challenges (Ludvigsen et al., 2015). In its policy document; "The school of the future – renewal of subjects and competences" (Ludvigsen et al., 2015), the Norwegian government reiterates that both primary and secondary education in Norway "shall contribute to developing the knowledge and competences of pupils so they may become active participants in an increasingly knowledge-intensive society." (Ludvigsen et al., 2015, p. 7). The targeted competence areas include; (i) subject-specific competence, (ii) competence in learning, (iii) competence in communicating, interacting and participating, and (iv) the competence in exploring and creating (pp. 8-9). All the above four government targeted competence areas, three of which form a set of examples of core (generic) skills or graduate attributes, have a bearing on how higher learning institutions should be structured not only today but also in the years to come.

Moreover, graduate attributes are a central component of what constitutes high quality training in higher education institutions in Norway. With a full understanding that the ongoing transition from a resource-based economy to a more knowledge-based one, demands a highly qualified work force capable of responding to rapidly changing world demands, the Norwegian government in its white paper – Meld. St. 16 (2016–2017) (Kunnskapsdepartementet, 2017), underscores the need for higher education graduates to attain generic skills. Among it's laid-out objectives and expectations for higher education institutions, the government expects that graduates will develop and acquire useful knowledge, skills, and all-round competence, rooted in current international research. Such training is not limited to students acquiring only subject-specific knowledge and skills, but includes development of more generic skills, including "the ability to apply critical thinking, analytical evaluation and continuous learning." (Kunnskapsdepartementet, 2017, p. 16).

The requirement to support students' attainment of graduate attributes is also central in the Norwegian teacher education. Teacher education in Norway comprises four main teacher education programmes, two 5-year integrated primary and lower secondary (PLS) master's programmes (PLS 1–7 and PLS 5–10), a 5-year integrated "lector" programme (8–13), and a 1-year "practical" teacher programme (5–13). Moreover, there is also a programme for kindergarten teachers, and as well as multiple programmes for school-based-teachers (see a report by the Advisory-Panel-for-Teacher-Education, 2020). For each of the above four main teacher education programmes, the Norwegian government developed a national framework document stipulating a set of regulations aimed at ensuring that teacher education institutions offer an integrated, professionally oriented and research-based teacher training to trainees in those programmes (Kunnskapsdepartementet, 2020). In each respective framework document, a three-dimensional learning-outcomes strategy is presented, comprising the teacher-knowledge dimension, the skills dimension, and the general competences dimension (Kunnskapsdepartementet, 2020).

The teacher-knowledge dimension comprises a set of the teachers' knowledge for teaching, including the mastery of the specific subject content knowledge for the selected teaching subjects, and the pedagogy and didactics for teaching those subjects (the broad knowledge of the teaching profession, research about teaching, learning processes and theories). The skills and general competences dimensions on the other hand, comprise the other abilities or knowledge not directly tied to subject-content, with which the graduate will be able to transfer, apply or use the attained learning outcomes in the teacher-knowledge dimension. For instance, teacher graduates are expected to have the ability to provide a teaching rooted in research and experience-based knowledge, either independently or in collaboration with others. Moreover, they should be able to analyze, adapt and use relevant curricula, and be ready to make timely decisions to ensure productive learning. Graduate teachers are also expected to be creative, reflective and critical thinkers with good communication skills (verbal, non-verbal and written skills), and who can critically evaluate and use national and international research in their teaching. In addition, they should be able to use and train digital skills to their students, have the ability to execute judgement professionally with a self-awareness of personal prejudice. It is also expected that teacher graduates will be able to use their learned skills and knowledge to reinforce international and multicultural perspectives at both their workplaces and in society in general (Kunnskapsdepartementet, 2020).

Graduate attributes for science teacher graduates

Several attempts have been made in educational research to identify and describe a graduate-attributes profile for teachers generally (e.g.; Ayres et al., 2000; Berliner, 2004; Ngang et al., 2015; Schleicher, 2016). The list of attributes considered in literature includes a range of personal competences such as good communication skills, self-management, organizational skills, classroom management, problem-solving, teamwork, research competences, and the ability to relate to individual students (Ayres et al., 2000; Berliner, 2004), critical thinking and analysis, lifelong learning, entrepreneurship skills, ethical and professional moral skills (Jones, 2009; Ngang et al., 2015), self-efficacy, decision making and motivation (Kunter et al., 2013; Schleicher, 2016).

While the listed attributes are generally viewed as transcending disciplinary knowledge, some research studies have showed that such attributes are context-dependent, and that variations in epistemologies of different disciplines would result in different ways of conceptualizing, and teaching graduate attributes. Moreover, the differences in tasks and assignments associated with different professions are a clear indication of the contextual dependence of graduate attributes. For example, as they execute their job assignments, chemists are expected to be able to communicate, collaborate, organize, problem solve, and think critically (Headrick, 2001). The same is expected of a teacher graduate, a doctor, or a nurse. However, each profession has a different role in the same society, and thus the nature and connotations attached to the communication competence for the chemist, is not that which is implied when it comes to the teacher. This argument is supported by among others, Jones' (2009) study where the teaching of generic attributes in physics, history, economics, medicine and law, were examined. The author reported that skills such as critical thinking, analysis, problem-solving and communication, were conceptualized and taught differently in the respective disciplines.

In consideration of the context-dependence and as well as the disciplinary epistemological connotations regarding the conceptualization of graduate attributes, a different list of graduate attributes unique to only science teacher graduates cannot be expected. Rather, what is expected is an understanding of the difference that lies in the role, conceptualization and application of graduate attributes in different disciplines, professions and settings. Having said that, the uniqueness of the nature of science has a substantial influence on its teaching and learning. In learning science, both teachers and students need to understand the nature of scientific knowledge and how this knowledge is developed. For example, the process through which scientific knowledge is generated is underpinned by the ability to think critically, inductively and deductively, being creative, making careful and critical observations, making logical decisions, etc. (Anwar, 2014; Harefa & Suyanti, 2019; Hewitt et al., 2014; Murti et al., 2018). Such generic skills are important for both learners and teachers to be able to follow and understand science and the processes for its development.

The goal of the present study

This study sought to explore the extent to which science teacher educators in Norway introduce, teach, develop, and assess teacher trainees' graduate attributes. The need for and hence the relevance of this study was premised on the understanding that, despite the already existing large body of research literature on graduate attributes, the teaching and assessment practices of graduate attributes as reported from other countries do not necessarily represent the practice in the Norwegian context. Given that developing students' graduate attributes (soft skills, key skills or generic skills) is a central component of the curricula at the different levels of education in Norway, it is equally important that processes through which these attributes and skills are developed and assessed at the teaching level, are considered and formalized. The study was guided by the following research question; *To what extent do science teacher educators introduce, teach, develop and assess science teacher trainees' graduate attributes along with the usual teaching subjects (content knowledge (CK) and pedagogical content knowledge (PCK)?*

METHOD

Data collection and Participants

This qualitative – exploratory study (Pamela, 2011; Saunders et al., 2009) was underpinned by an interpretive-constructionism perspective (Cohen et al., 2018, p. 23). Exploratory research aims either to establish the current state of knowledge, practice or situation, screen alternatives, or to discover new ideas by assessing phenomena for new emerging perspectives (Elman et al., 2020; Makri & Neely, 2021; Saunders et al., 2009). This study is characteristically exploratory in that, it sought to explore and establish the educators' current practice with regards to teaching and assessing graduate attributes. On the other hand, an interpretive -constructionism perspective is a philosophical positioning that I advance as a researcher, to make clear the distinction between what the subjects of the study present as views reflecting their understanding or practice (constructionism), and the meanings that the researcher constructs from those views through an interpretation process. In other words, drawing on constructivists' understandings, people act deliberately and creatively, thereby making meanings in and through their activities (Blumer, 1986; Matthews, 1993), they are able to interpret events, contexts and situations, and proceed to make decisions, or act based on those events (Danczak et al., 2017; Morrison, 1998). However, the researcher analyzing these people's views does not have direct access to the meanings implied in these views, and hence he/she must construct a personal understanding of what is implied in the provided views. This is where an interpretive-constructionism perspective comes into form.

Based on the above understandings, an online open-ended survey was used to collect qualitative data from a group of science-teacher educators from different teacher education institutions in Norway. The use of open-ended questions as a data collection tool in exploratory studies enables participants to express their honest opinions, describe their experiences, and thereby reveal their knowledge (Jackson & Trochim, 2002; Miles & Huberman, 1994). Target participants were science educators who are members of the National Network for Science Education (NNN) (Naturfagsenteret, 2021). The NNN – network brings together mainly teacher educators in science, working at different teacher education institutions in Norway, and as well as other members from publishers, Magazines, teaching aid companies, museums and the school system. The network's aims include among other things, creating opportunities to share experiences between teacher educators in science, as well as promoting research in science didactics (Naturfagsenteret, 2021). By the time of data collection (December 2018), a total of 136 members subscribed to the network, and it was possible to contact all these members via the network's "natural-nett" yahoo email list. Of this total, only members working in teacher education, and actively involved in the teaching or training of science teachers (trainees) were invited to participate in the survey, with multiple reminders sent via the "natural-nett" yahoo email list.

A total of 51 teacher educators out of the 136 NNN-network members responded to the survey. In Table 1, a summary of the participants' training profile is given. The survey was launched in the second week of December 2018 through a "SelectSurvey" system managed by the faculty of Social and Educational Sciences, Norwegian University of Science and Technology. The administered online survey, which was accessible to the target participants for 24 weeks (from the second week of December 2018 until the second week of June 2019), comprised two parts. Part one invited participants to provide some information about their gender, education, and teaching experiences, whereas the second part consisted of three open-ended questions that invited participants to (i) discuss whether or not they teach graduate attributes during their formal classroom teaching, and to give some examples of how the teaching of graduate attributes along with the formal science or didactics subjects is realized in actual teaching situations, (ii) share their views regarding embedding and teaching graduate attributes along with formal science subjects or subject didactics, and (iii) discuss or share their views about how they assess students' attainment of the desired graduate attributes. The filled surveys were transformed into excel files and exported to a local computer where they were qualitatively studied and analyzed.

Table 1 Participants' qualification profile

Education and training	Number of Participants
Ph.D. in chemistry didactics	2
Ph.D. in physics didactics	3
Ph.D. in science (physics, chemistry or biology) and a course in pedagogy	16
5 -year integrated master's in science teacher education	2
Master of science + 1 year teacher training	6
Other unspecified training	22
	(Total = 51 respondents)

All the 51 participants answered the questions in the second part of the survey. However, as showed in Table 1, some participants (43 %) did not disclose information regarding their education and training. Consequently, when synthesizing the results of the study, the discussion avoids making direct associations between the results and the educators' training. Moreover, I avoid making conclusions about what is good practice and what is not, in order to allow for a wider understanding and the opportunity for the reader to consider the results in an unbiased state.

Data analysis

The analysis and interpretation of the educators' views were guided by an interpretive phenomenological analysis perspective (Creswell & Poth, 2016; Dean et al., 2006; Smith et al., 1999). The analysis process involves studying participants' lived experiences (data accounts) and developing a personal interpretation of these experiences. The iterative process involved (i) reading and re-reading individual responses to open-ended questions, (ii) identifying important and interesting or unique aspects, (iii) organizing identified aspects, and developing meanings and claims about the identified aspects, and comparing these across all data accounts, and (iv) verifying and aligning claims with evidence from data.

ANALYSIS RESULTS/FINDINGS

The practice of teaching and assessing graduate attributes: How science teacher educators think about and describe their practice

The analysis revealed four main understandings regarding how science educators consider and work with developing (teaching) and assessing their trainees' graduate attributes,

(i) the understanding that students develop graduate attributes indirectly or implicitly as they take part in formal science teaching and learning process
(ii) the understanding that it is difficult to embed and teach graduate attributes,
(iii) the understanding that it is not the science educator's obligation/responsibility to teach graduate attributes to teacher trainees
(iv) the conception that the attainment of graduate attributes is also assessed when assessing students' attainment of canonical or didactic science knowledge and skills by the already existing assessment frameworks and tools

These four main analysis findings are respectively elaborated in the subsequent subsections below.

Students develop graduate attributes indirectly or implicitly as they take part in formal science teaching and learning process

The majority (47/51), while considering graduate attributes a relevant component of the teacher trainees' training, exhibited the understanding that teacher trainees develop relevant graduate attributes indirectly or implicitly as they take part in the formal teaching. Examples pointed out include, during classroom discussions, when answering oral questions perceived to elicit higher-order thinking, and during school practicum where management skills are practiced.

By claiming that development of graduate attributes happens indirectly or implicitly, the educators did not seem to imply that they completely do not take up graduate attributes in their teaching. Rather, as in the two examples below, the educators claim to present teaching contexts, situations or activities when teaching science or science didactics, which indirectly serve to develop trainees' graduate attributes.

> TR3F (TR = teacher educator, F/M =gender): "students acquire these attributes or skills during their teacher training. That's part of it (teacher training). They are interwoven in the learning activities. For example, opportunities to be creative are provided (by the teacher), which some students use more than others."

> TR14F: “graduate attributes are important and a part of the teacher-trainees education as a whole; these attributes are relevant for any subject matter, including science as a subject. I believe that students receive training in those attributes as a part of training not only in science but in other subjects as well”

It is difficult to embed and teach graduate attributes

12 out of 51 educators expressed that embedding graduate attributes and teaching them along with the canonical or subject didactics was (is) difficult. Three reasons were advanced by the individual educators for the above position. First, five (05) educators expressed that they lacked the relevant competence or experience to enable them include and teach graduate attributes. As an example, educator TR1M expressed that, “teaching graduate attributes along with the subject content would require substantial strengthening of the skills of science faculty since traditional training within science does not cover them well.”, while educator TR22F expressed that, «I think it is very difficult for me to teach graduate attributes as I have no experience.”.

As a second reason, five (05) educators expressed that it was more demanding and time consuming to teach graduate attributes. That is, “it is very demanding, as it takes a lot of time to develop (plan) content knowledge and very often we get too little time for these other important aspects as graduate attributes.” (Educator TR6F). Moreover, two of these five (2/5) educators who claimed that teaching graduate attributes was more demanding and time consuming, also added that teaching graduate attributes demanded both a change in the teaching structure as well as additional resources. That is,

> “If the attributes were to be taken literally (and taught along with the subject content), it would require a much more systematic approach and be backed up by the necessary resources. E.g., ethical reflection and critical thinking need to be addressed as such and will not develop as a by-product of the rather technical training in the sciences.” (Educator TR2M).

The third reason or justification given by two (02) educators concerns the unclarity of what constitutes graduate attributes. Two educators expressed that it was difficult for them to teach these attributes since they did not have a clear picture about the relevant attributes that should be taken up in science education. That is,

> TR20M: “The skills (graduate attributes) are good but can be a bit unclear how they should be applied in the courses and there is maybe a bit many of them. A simpler and more concrete list would be nice, and how it should be applied into the science education courses. There is normally “to much” we try to put into the courses...”

A similar claim was mad by educator TR13M who expressed that “these so-called attributes have to be made explicit, then we can talk about teaching them.”. Table 2 below shows a distribution of the 12 educators with respect to the three different reasons given to justify the understanding (perception) that it is difficult to embed and teach graduate attributes.

Table 2: A distribution of how many educators share the same reason for why is difficult to embed and teach graduate attributes

12/51 – Educators: TR1M, TR2M, TR3F, TR4M, TR6F, TR7F, TR13M, TR17M, TR20M, TR24F, TR23F, TR22F	Reasons for why it's hard to embed and teach GA
5/12 – educators: TR1M, TR4M, TR7F, TR22F, TR23F	Lack of competence, skills or experience
5/12 – educators: TR2M, TR3F, TR6F, TR17M, and TR24F 2/5 – educators: TR2M, TR24F	More demanding and time consuming to include and teach graduate attributes Teaching GA requires a change in the current teaching structure
2/12 – educators TR13M, TR20M	There is no clear or defined graduate profile for teachers

It is not the science educator's obligation/responsibility to teach graduate attributes to teacher trainees

Four educators explicitly argued that while graduate attributes were an important component of teacher training, it (is) was not their responsibility to develop or teach graduate attributes. The two educators' argument is that, as science teacher educators, they are more occupied with teaching subject content and or the didactics components of it.

> TR4M: "I believe students obtain or develop graduate attributes during their teacher training, so our focus here at the college (science education department) should be turned more towards subject matter, didactic skills and competences"
> TR23F: "graduate attributes are not my responsibility. However, to work as a teacher means that different forms of knowledge is meshed and need to be handled as part of a complex practice."
> TR24F: "graduate attributes are important, but I don't think that we are able to cover or teach graduate attributes during the science courses, I feel that the general pedagogy courses deal with these attributes."
> TR11M: "The science teacher education (her at the department) must focus on natural sciences (biology, physics, chemistry ...) and as well as the focus be on science didactics, biology didactics, physics didactics ... and then general education has or can focus on these other aspects (such as graduate attributes) relevant to the profession. I believe that there is far too little focus on the education of the professional science teacher, that is, training in the natural science subjects, science didactics, biology didactics seen in a context and in relation to the teaching profession one educates."

The attainment of graduate attributes is also assessed when assessing students' attainment of canonical or didactic science knowledge and skills by the already existing assessment frameworks and tools

The majority (47/51) educators expressed that there were already in place several strategies being used to assess the attainment of graduate attributes. Examples given include oral and written examinations and presentations – targeting argumentation skills, reasoning and critical thinking competences, reflection questions and other open-ended oral classroom questions, individual oral feedback and classroom discussions. Moreover, one educator argued that "it is impossible to pass an exam without having a high degree of problem-solving abilities and a display of creative and critical thinking", implying that when students pass their written or an oral exam, it is indication that they have already attained the relevant attributes. A similar understanding was shared by other educators. For example, educator TR11F expressed that; "such reflections (implying a focus on attainment of graduate attributes) are always part of the assessment, either as specific questions on for example writing skills or as a requirement for the level of thinking reflected in the answer from the students."

Important to recognize here however is the consistency maintained by the four educators who claimed not to own the responsibility of teaching graduate attributes. When asked about assessing graduate attributes, these educators while acknowledging the implicit assessment of the attributes in the commonly used assessment strategies, expressed that there was no requirement set in place for assessing the attainment of graduate attributes, a statement consistent with their original understanding of their role with regards to teaching graduate attributes. That is,

> "I have not assessed the attainment of these attributes, if done right, then they could be assessed, but this has to be written in the course description (for the assessment) to be allowed" (educator, TR4M).

This submission by educator TR4M does not imply that the educator considers graduate attributes not to be reflected in the existing assessment strategies at his teacher education institute, rather, for him, assessment of graduate attributes' attainment is not the primary focus for the educator. Indeed, the educator affirms to his position by adding that, "graduate attributes have a natural place in teacher education and there is no need to offer it too much energy during science (and subject didactics) teaching."

DISCUSSION AND IMPLICATIONS

The teaching and assessment of graduate attributes in science teacher education: the Norwegian context

An overall picture from the analysis indicates that the teaching of and hence development of graduate attributes is an expected component of teacher trainees' attained competences. Indeed, graduate attributes occupy a substantial part in curricula documents at all levels of education in Norway and are considered important achievement targets for students in addition to canonical and technical knowledge and skills (Isnes, 2005; Kolstø, 2009; Ludvigsen et al., 2015). This component of training, however, does not have a separate teaching space or time, and the teaching of these attributes is expected to proceed along with the teaching of the subject matter. In otherwards, teachers and teacher educators are expected to plan their teaching, also ensuring that their students acquire the relevant graduate attributes in addition to the canonical subjects.

The educators' expression of implicitly teaching graduate attributes is not only unique to the Norwegian context. Earlier research reports about embedding graduate attributes into curricula have also indicated a broadly shared belief about graduate attributes being inherent to all the teaching and learning that goes on (e.g.; Hughes & Barrie, 2010). Teachers are reported in earlier research as relying on the assumption that students will automatically master the skills and attributes throughout their course program (George et al., 2013; Stewart et al., 2016). Barbara and Christina (2012) also reported that the academic staff in their study showed greater willingness and confidence regarding the importance of graduate attributes and their inclusion in the curricula, but the same was not observed when it came to the teaching and assessing graduate attributes in practice.

While claims of implicit (or indirect) teaching and assessment of graduate attributes are also reported in studies from other contexts, the difference inherent in the educators' practice as reported in this study is made known when what is implied in the educators' use of the terms "implicit" or "indirect", is carefully and contextually examined. A superficial consideration of the claim of an implicit or indirect teaching and assessment of graduate attributes does not provide information regarding the role played by the educators, or the amount of planning invested. Moreover, no concrete evidence emerges from the analysis that shows any of the educators as having a formal awareness or pre-planned working framework for including graduate attributes as part of the intended teaching goals. What is evident in the results on the other hand, is that the educators easily mention that students develop skills such as communication, argumentation, reflection, critical thinking, etc., either while in class where students take part in a discussion or when completing assignments and exams.

In other words, while data from this study alone may not be sufficient to make such a bold claim, the analysis results are indicative of a lack of a conscious effort by the educators, where a formal pre (intentional) planning for the claimed implicit teaching and assessment of graduate attributes is visible. Implicit actions can either be consciously or unconsciously executed, they could be intentional or unintentional, they could also start with being explicit actions that transform into implicit, such as a teacher learning to pose higher order thinking questions. Being a conscious or deliberate practice also implies that the executor exhibits some kind of planning or working framework that inform the practice. The overall evidence presented in the present study does not provide for making a conclusion that the educators deliberately set out to teach and assess graduate attributes. It rather points to a general belief or understanding among participating educators that the existing practice will most likely lead students to attain the relevant attributes at the end of their studies.

Going over to why educators consider (teach) graduate attributes implicitly, there are possible reasons that could underly the reported practice. The lack of a knowledge of the relevant attributes that could be reinforced for teachers is one possible reason. Earlier studies have reported about teachers forgetting to take up the most relevant attributes (e.g.; George et al., 2013). Moreover, in some cases, educators might deliberately choose to prioritize the available time to teach other things, provided there is no motivation for teaching graduate attributes. Taking TR4M as an example, he expressed that he does not assess graduate attributes since this was "not written in the course description". While this statement was expressed by only one educator, it could be a general understanding held by the majority educators in this study, that students obtain these attributes as they take part in ordinary training, and hence there is no need for making the teaching of graduate attributes explicit.

The implication here is that, while there is already a vast amount of literature documenting feasible strategies and frameworks for teaching and assessing graduate attributes (e.g.; Barbara et al., 2018; Bond et al., 2017; Green et al., 2009; Radloff et al., 2008), the process starts with having the correct reasons and the motivation. Consequently, questions such as "do we need to change the status quo regarding how graduate attributes are taught and assessed and why?" will need to be addressed for the Norwegian context as it has been done in other contexts where there has been a realization of a formal structure for teaching and assessing graduate attributes. Further still, conceptual problems raised by educators in this study pertaining the need to map out a graduate attributes profile for specific disciplines, have also consistently appeared in several research reports (e.g.; Badcock et al., 2010; Barbara et al., 2009; Barbara et al., 2018; Barrie, 2006; Campbell et al., 2009; Knewstubb & Ruth, 2015). Having in place a graduates attributes profile defined for a given profession is an important prerequisite to the success of any intervention efforts targeting the teaching and assessment of the desired attributes.

Whose responsibility it is to teach, develop and assess the attainment of graduate attributes in teacher education?

The claim by the four educators where they argue that it's not their responsibility to teach graduate attributes, arouses the interest to consider and discuss what could be the possible reasons behind this claim. First, research has documented that, individual educators hold different beliefs about graduate attributes, which impact on the teaching and assessment of these (e.g.; Bond et al., 2017; George et al., 2013; Green et al., 2009; Radloff et al., 2008; Åkerlind, 2004). This earlier research claim comes to light in this study when individual educators' submissions are analyzed in light of their individual training backgrounds. Please note that only 29 out 51 participants disclosed their education background (refer to Table 1). Of the 29 educators, 16 educators hold doctoral training in natural sciences (either in physics, chemistry, or biology). Accordingly, the 16 educators undertook a course in pedagogy following their employment in teacher education (Table 1). Looking at the background qualifications of these 16 educators, these educators mainly, and if not, only teach subject content to teacher-trainees at their respective job placements. It would thus seem reasonable when the educators claim to prioritize the teaching of canonical subject content, or when some claim that it is not their responsibility to teach graduate attributes. However, the fact that these are employed in teacher education, their job expectations cannot be any different from those originally qualified as teacher educators.

Second, denying a teaching responsibility for graduate attributes can also be linked to a lack of ownership and a shared understanding of how to teach and assess graduate attributes as reported in earlier research (Green et al., 2009; Radloff et al., 2008). This argument is indeed supported by the fact that some educators explicitly expressed that they lacked the relevant knowledge and competences to be able to teach and assess graduate attributes.

Consequently, it is possible that an individual's training background could result in the possible perceptual differences in how different educators conceptualize their teaching roles. It should however be noted that these conceptual differences are not permanent and are subject to change especially when the educators begin to accept (understand and conceive) that the teaching in teacher education (and in other fields as well) broadly covers more than a focus on only canonical content knowledge. Moreover, just like some of the educators in the present study argued, the requirement for a formal structure for teaching and assessing graduate attributes should also include a needs assessment for teachers, and as well an equivalent response to the identified teacher needs.

Study limitations

This study has a limitation that only 51 science educators responded to the survey. This number is very small compared to the total number of science teacher educators working at different higher learning institutions in Norway. It is therefore not possible to conclude that the findings reported in the study are a representation of the views of the entire fraternity of science teacher educators in Norway. However, the findings and discussions made in the present paper could initiate a formal discussion regarding the questions about how best science teacher trainees' graduate attributes could be developed in the Norwegian context. Moreover, the fact that some of the claims made by the educators have been also reported elsewhere provides for an exploration of what appropriate steps have been adopted by others to improve on how they work with graduate attributes. It should also be recognized that there are not any known studies that have reported that the lack of a formal or explicit training of graduate attributes to science teachers has in any way affected the way teachers are doing their work of teaching, for those already in the field. As such, it is also possible that the current implicit teaching of graduate attributes in teacher education is sufficient and hence no needed structural changes.

Regardless of whether a move towards explicit teaching of graduate attributes is considered or not, teachers including those in higher education, are expected to support their learners in acquiring a graduate attributes profile with which they are able to operationalize the knowledge and other subject specific skills at their workplaces after school. Consequently, the findings and discussions in this study bear important implications to consider, and which have a bearing on the future teaching and assessment of graduate attributes in learning institutions in Norway.

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