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# Rutherford visits middle school: a case study on how teachers direct attention to the nature of science through a storytelling approach

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**Abstract**

It has long been argued that nature of science (NOS) is an important part of science teaching. In the literature, many different approaches to NOS have been suggested. This article focuses on a storytelling approach, and builds on data from audio recordings from three middle-school (school year 6) classrooms. The three science classes are run by three science teachers who have been introduced to NOS and storytelling during a one-day workshop. These three teachers chose to tell the students a story about Ernest Rutherford. The stories told by the teachers, as well as the whole-class discussions afterwards, are analysed with respect to what NOS aspects were communicated. The results show that many different NOS aspects, such as the tentative nature of scientific models, empirical aspects of the scientific knowledge process, as well as human aspects of science, emerge in the context of the story about Rutherford and his work on the atomic model. The results indicate promising possibilities for storytelling as an approach to NOS teaching.

## Introduction

*Can scientific knowledge change? How can the relation between scientific models and Nature be described? What is the role of experiments? Is research a totally objective and rational process or are there also subjective, socio-cultural and creative elements?* Such issues and many more, are aspects of 'nature of science' (NOS).



Research shows that students often describe scientific research in simplistic ways, and that stereotypical images and myths about science are frequent (McComas 1998, Allchin 2003). Such myths include that one specific research method—'the scientific method'—is always used in scientific research, and that creativity, subjective and socio-cultural elements are absent from the research process. Research is then instead viewed as an entirely objective and universal enterprise. These kinds of myths are reproduced in various situations, for example in science textbooks, during science classes, and in media. The myths are not challenged if the science teaching only focuses on scientific concepts and models. Instead NOS has to be explicitly discussed (e.g. Lederman (2007) and Khishfe and Abd-el-Khalick (2002)).

Many different approaches to the teaching of NOS have been suggested in the literature. Some of these approaches directly couples NOS to specific science content and the 'ordinary' science teaching (Hansson and Leden 2016). In this article we focus on StoryTelling as an approach to teaching NOS. Although arguments for the inclusion of NOS are old, and NOS is specified as part of the curriculum in many countries, a tradition for working with NOS in schools is often lacking. In this article we look into how a storytelling approach could help teachers direct the attention to NOS in a middle-school science context.

Storytelling has been recommended in the field of science education since the 1990s (Kubli 1996). This approach received more attention and was used in several approaches (Allchin 2012, Clough 2011, Kokkotas and Kokkotas 2014), particularly with the increasing interest in enabling students to develop a better understanding of the nature of science (NOS). Moreover, several authors provide materials that can be used in such an approach (e.g. Hadzigeorgiou (2006)), however there is little empirical evidence with respect to storytelling in science education. One exception is the study by Hadzigeorgiou et al (2012), who found that students who learned about the personal aspects of Teslas work were more motivated to learn about the science content.

This approach has also been discussed in detail from a theoretical perspective that includes both educational and linguistic perspectives (Klassen and Froese Klassen 2014). It is crucial in this respect that the story contains both science content and a historical figure which is the protagonist of the story, and that some NOS content is addressed.

A significant number of primary, but also some middle schools use a storytelling approach, where the pupils learn to tell creative stories, as a way to develop their oral communication skills (see e.g. Hübsch and Wardetzky (2017)). In these approaches, science is only rarely a relevant topic (for an exception see https://storytellingschools.com/). In our StoryTelling approach used in our work, the teacher tells the story in the classroom and addresses a historical figure (Heering 2016; https://www.uni-flensburg.de/en/project-storytelling/). This is slightly different from for example the North American approaches, where, the story is read by the teacher in front of class, or read by the students themselves[4]. We believe that telling the story has several advantages: First and foremost, the material has some flexibility with respect to the emphasis that is placed on certain aspects in the story. It is then easy for the teacher to adapt the narration to the needs in class. A second advantage is that the narration allows more interaction between the teacher and the students, since there is a direct connection between a person telling a story and the audience. Consequently, the teacher can respond immediately to details that seem to cause irritation or when students show a lack of understanding. In addition, telling a story is of cultural value, and we take it to be useful to have such cultural activities in the science classroom.

This article presents results from classroom observations. Empirical studies on the use of this kind of storytelling in science education are scarce. A primary aim of the article is to illustrate what NOS aspects were addressed when teachers used this StoryTelling approach.

The story in focus in this article tells about Ernest Rutherford and the formulation of the atomic nucleus in the collaboration with Hans Geiger and Ernest Marsden. It has previously been found that investigations related to the experiments performed by Rutherford can lead to a deeper understanding of NOS aspects (Abd-El-Khalick 2002). In the literature, there are many suggestions of activities demonstrating important features of scattering experiments also for pupils in the 10–12 age group. These activities involve scattering of balls or marbles to explore a hidden structure illustrating how

[4] We use the term StoryTelling in order to distinguish our approach from the other ones.

information about the object can be inferred from the scattered particles (e.g. Contemporary Physics Education Project at http://www.cpep-physics.org, Chapon *et al* (2015), Cunningham (2017) and Abd-El-Khalick (2002)). The StoryTelling approach in this article shifts the focus to the story about the person Ernest Rutherford and his struggles to make sense of observations that seemed to contradict the present understanding of the structure of the atom.

## Design of the study

### *Context*

We focus on three Swedish middle-school classrooms[5] (teaching students aged 10–12). In Swedish middle school all pupils take the same science course. NOS is part of the curriculum, but there is no tradition of teaching NOS. Concerning the science content relevant for the Rutherford story, a core content in the Swedish science curriculum, years 4–6, is a 'simple particle model to describe and explain the structure, recycling and indestructibility of matter' (Swedish National Agency for Education 2011). In Swedish middle school science textbooks, an atomic model (the Bohr model) is often described very briefly, and in some of the books also a historical background is mentioned. However, in most cases, Rutherford and Thomson are not mentioned.

### *The teachers*

In preparing teachers to use the StoryTelling approach, they participated in a one-day teacher training that addressed both methodological issues of StoryTelling as well as NOS issues. We also introduced them to the teaching materials available at the webpage (https://www.uni-flensburg.de/en/project-storytelling/). As examples we told the teachers three different stories to inspire them: about Otto von Guericke, Augustin Bernhard Mouchot and Archimedes. The teachers were also introduced to a number of other stories that are part of the StoryTelling material. They were asked to choose a story to focus on and later use in their science teaching. Among the stories chosen by the teachers was the story on Ernest Rutherford's work on the atomic model. During the workshop teachers formed groups by what scientist they had chosen to tell a story about. Teachers were provided with a biography, a historical background and a story about their scientist translated to Swedish (www.fysik.org/fysikhistoria) from the StoryTelling material (https://www.uni-flensburg.de/en/project-storytelling/) that should be adapted to suit their pupils. During the group work, the teachers discussed what NOS issues should be in focus in the story and prepared what to include and how to tell the story.

### *Data and analysis*

The article builds on an analysis of audio-recordings from the lessons when the teachers told the story of Rutherford to their pupils, and of the whole-class discussion following the StoryTelling[6]. The researchers provided a student activity (with a number of different NOS statements to be discussed in small groups).This was used to different extent by the teachers. Some of these small-group discussions were also audio taped, as were the follow-up discussions in the three classrooms.

The teachers who had tested the StoryTelling approach in their classes were invited to a second workshop. During this day, they got feedback, from colleagues, from us, and from a professional drama teacher. During this second workshop teachers also shared their experiences from using the StoryTelling approach in their own classes. The teachers expressed being positively surprised about the quality of the classroom discussions about NOS.

The transcripts from the classrooms were analysed, searching for moments when different types of NOS issues were addressed explicitly in relation to the Rutherford story. In a first step, the moments that were identified were grouped in to three broad categories: *Characteristics of Scientific knowledge*, *Tools and processes of Science,* and *Human elements of Science*. These were adapted from the three categories used by McComas (2017): Science knowledge and its limits, Tools and products of Science, and Human

[5] In one of the classrooms two teachers were involved. One of the teachers told the story, and the other led the discussions afterwards. In the article we do not differentiate between these two teachers.

[6] All relevant permits were obtained from teachers, pupils and parents.

elements of Science[7]. As In a second step an empirically grounded analysis was performed, resulting in categories describing the different NOS themes mentioned during the lessons.

## Results

### *Characteristics of scientific knowledge*

*Scientific knowledge as tentative.* In the three classrooms, the tentativeness of scientific knowledge was communicated during the storytelling by the teachers and/or during the classroom discussions after the story was told. In classroom C the teacher, taking the role as Rutherford, told the students about his work on the development of the atomic model:

> Rutherford [Teacher C]: During my research, I discovered that my results did not quite agree with what we knew about the atom. What we knew about the atom was that it looked something like my cake here, like a dough of positive particles and negative particles in a complete mess. But my observations and experiments did not agree with this. I realized that it must be in a different way. There must be a positive nucleus within the atom.

Here, the story highlights that the knowledge about atoms has developed over time, and also the importance of experimental results for this development, as the results did not match earlier models. Thus, in this example the development of the model is said to be due to new experimental results, which is something that was communicated in all three classrooms in the context of the story about Rutherford.

In one of the classrooms (A) the teacher, in addition, explicitly directed attention to different reasons why scientific knowledge changes:

> Teacher A: And why do you think this is not the final model?
> Pupil 1: Hard to say
> Pupil 2: Because there may be smarter people ...
> Teacher A: Yes. And what could make you change the views of things? You get smarter - but what else?
> Pupil 3(?): There are better research alternatives
> Teacher A: Like for example what, do you think?
> Pupil 3: Well, there is more to learn.
> Teacher A: Mm. We have talked about space research. How did we learn more about space? Thanks to ...?
> Pupil: Thanks to GPS and researchers?
> Teacher A: Yes, they have built new things. Mmm, technology.
> Pupil: Science

In addition to the role of the experimental observations by Rutherford and his coworkers, other reasons for past and future development of the atomic model were discussed, including people being smarter, and technical and scientific developments.

*About scientific models.* In all the classrooms, attention was directed to the possibility of more than one scientific model describing the same thing—there have been different atomic models that have been discussed in relation to each other. Sometimes, the teacher (in the role of Rutherford) made it a direct question of right and wrong:

> Rutherford [Teacher A]: And I realized that this [the Thomson model] cannot be right. He [Thomson] must be wrong. After that, I started to think about it, and together with my friends, I arrived at a new model[8].

On other occasions, a more complex image emerges. In classroom C the models by Rutherford and Bohr were discussed, starting from a discussion of how we view the atom today:

> Teacher C: But it [the Bohr model] is still a model that works very well. But it doesn't quite agree with how we view it today.

[7] The changes of McComas' categories are the following: Limits of science was not discussed in the story and thus the first broad category was adapted to 'Characteristics of Scientific knowledge'. This category also, in our use, includes how scientific models are viewed upon (Hansson *et al*, submitted). As a consequence the second category which we call 'Tools and processes of science' does not, for us, include the 'products of science' (e.g. distinctions between models and laws which McComas includes here). Instead our second category focus on processes of science, that is how scientific knowledge is developed. The third category is not changed in relation to McComas (2017).

[8] Even though this may appear problematic in terms of NOS, this is very much the way scientists talk over coffee.

But Ernest said something when he was here: That there is like a cloud of electrons around the nucleus. In the Bohr model, the electrons have special orbits, like this. And this is very good for thinking about how atoms work. But it doesn't agree as well with reality as a cloud of electrons. So Ernest may have been right from the beginning. But when Bohr developed the model about how to think about it, it got to look a bit different.

In this example the notion of right and wrong models is somehow problematized. One model could better serve some needs than another model, which may have other strengths.

### Tools and processes of science

*Tools.* Not many tools used by Rutherford were mentioned during the storytelling or the discussions afterwards. Except for the gold foil and the alpha particles, the experimental equipment was not described or discussed during the lessons. One tool (of a very different kind) was the plum pudding that played a significant role in the teachers' story of Rutherford's development of the atomic model. In addition, in two of the classrooms there was a short and more general discussion on how new tools can influence the revisions of models:

Pupil: /…/ one gets new resources, that can help
/…/
Teacher: What kind of resources are you thinking of?
Pupil: I don't know. You get better laboratories…/…/

Here attention is directed to the technical development, and thus how new tools influence the research.

*Empirical work.* In all three classrooms attention was directed towards the importance of observations during the experimental work for realizing the shortcomings of Thomson's model. In one of the classrooms, the experiment was described like this:

Rutherford [Teacher A]: And together we made an experiment during several years. It was alpha particles. This sounds really difficult. They are helium nuclei. If we shot them onto a piece of very thin gold foil, they scattered.

Another teacher explicitly, in her role as Rutherford, discussed the observations in relation to the atomic model

Rutherford [Teacher B]: Well. And there I continued my research about the atom. And my results, yes, now they did't quite agree with how we all knew the atom was built. You know about atoms, don't you?
Pupil: Yes.
Rutherford [Teacher B]: Everything consists of atoms. Yes. I thought and I wondered. We had an atomic model that worked. It, yes, it, it ... It looked like this. A nucleus with positive and negative … Or particles inside. Exactly, like this cake in a dough. No it can't be right. It can't be right, my observations ... no it doesn't work. When I shot particles ... No, it doesn't work, it can't be right. It must be like this. /…/ The atom. The atom must consist of a positive nucleus with positive particles surrounded by electrons like a cloud around it.

No detailed description was given of the experiment itself or in which manner the observations were incompatible with Thomson's model.

Still, the teacher addressed other aspects of experimental knowledge production. The class discussed that many experiments were performed. During this discussion, the teacher coupled the need to repeat experiments to students' experiences from lab work in science class:

Teacher B: What is required by scientists, physicist and chemists? What is required to work and struggle like this? Do you do it, just like that? So "Yes, now I have discovered something?"
/…/
Pupil: To do a lot of research. So that you have 30 different things, and then you will find something that works.
Teacher B: yes, you have to try and try and try
/…/
Teacher B: Yes, did you [...] try the experiment only once? [relating to an electrostatic

experiment done by the class during and earlier science lesson]
Pupil: NO.
Teacher B: No
Pupil: Many.
Teacher B: Many times, you have to try it many, many, many times. Because there was one group that thought they saw a small flash there, a discharge.
Pupil: Yes
Teacher B: ... and then there were more groups and you tried, and tried and tried.

Here the teacher also highlights that possible results by one group could motivate other groups to reproduce (or challenge) the result and continue the investigations.

Thus, the importance of experiments and observations was communicated in all three classrooms, both during the storytelling itself and during classroom discussions after the story was told. The teachers emphasized the importance of the experiment performed by Rutherford and his colleagues to enable the development of a new atomic model. However, no closer description of the experiment and the observations was presented, nor was it pinpointed in what way the observations made Rutherford conclude that Thomson's model was in need of a revision.

This omission of experimental details led one of the students to ask 'How did he [Rutherford] do it [the experiment]'? as part of the follow-up discussions about the role of observations[9]. This shows that the story can contribute to the development of an intrinsic motivation to understand Rutherford's experiment—an effect that clearly is beneficial to understanding science content. It also may serve as an indication of the interest of the students created by the story.

*Rational and intuitive work.* When telling the story, and during the discussions afterwards, more diffuse reasons were sometimes presented to describe why Rutherford constructed the new atomic model. In classroom A, the teacher stated:

Teacher A: Well, it looked a bit strange that ... The first model... His wife made that plum pudding, which looks like that one [pointing to an image]. Yes. He did think it looked wrong, didn't he?
Pupils: Yes.
Teacher A: Yes, because ... Maybe he had a feeling that "No, this does not agree". Maybe he thought "I have to make this right, to make it agree". [Pupil X raises a hand]
Pupil: And then he made a model of his own.
Teacher A: Yes he did, indeed.

Here an almost intuitive feeling is described as a driving force for Rutherford, without references to what aspects of the observations contributed to his impression of the model being wrong. In classroom C the teacher directed the attention to how Rutherford started to think in a different way:

Teacher C: But until then, when Rutherford started to think in a different way after eating from his wife's cake, one [scientists] thought that the atom looked like this. And when scientists instead started to think that it looked like this, it had lots of effects. Then, since you had come up with a new thought, you could start to think in a different way, draw new conclusions and understand everything much better. Exciting!

Here the thinking is emphasized, as a complement to the importance of observations and empirical work discussed above.

*Observation-inferences.* In all three classrooms it was also communicated (at least implicitly) that the observations from the experiments did not lead directly, or in a straightforward way, to the new model. Instead, time passed between the experiments and Rutherford's formulation of the new model. In classroom C the teacher taking the role of Rutherford described it like this:

Rutherford [Teacher C]: During my research, I discovered that my results did not quite agree with what we knew about the atom. What we knew about the atom was that it looked something like my cake

[9] During the workshop afterwards, the teacher described this question from a student as a difficulty that had occurred during the lesson. He did not feel comfortable describing the experiment in more detail. However, he promised to return to the question in a later lesson.

> here, like a dough of positive particles and negative particles in a complete mess. But my observations and experiments did not agree with this. I realized that it must be in a different way. There must be a positive nucleus within the atom.

Here the empirical observations in combination with Rutherfords' thinking, inspired by the plum pudding, is described as important for the development of the model. It becomes clear in this excerpt that the experimental observations are not the same thing as the conclusions or the formulation of the model. It also becomes clear that the scientific process could not be well described as following a strict, rational 'scientific method', but is instead complex and fuzzy and involves also human elements such as being inspired by a plum pudding at a Christmas dinner with friends.

### Human elements of science

*Creativity.* Creativity as an important aspect of Rutherford's work became apparent in the classrooms. All teachers include the importance of the plum pudding (see figure 1 showing one of the teachers, in the role of Rutherford, showing the plum pudding) as inspiration for Rutherford when he realized what the problem with Thomson's model was:

> Rutherford [Teacher C]: Based on that experiment, and actually a rather remarkable event. My wife .. Yes, we finally did get married. She had to wait quite a few years, but finally we got married and had a daughter. She had her annual Christmas dinner and we ate together with our friends, this Christmas dinner, and for desert we had Christmas pudding. Plum pudding. And when I ate it, I recognized something. It resembled something—it looked like a JJ Thomson model. Now I call it the plum pudding model. And I realized that this cannot be right. He must be wrong. After that I started to think about it, and together with my friends, I arrived at a new model.

Here it becomes obvious how creativity is involved in the construction of scientific models. In another example (from the whole-class discussions in class C, following the small-group discussions on NOS statements) a student, commented on the need for imagination as a scientist:

> Pupil: We thought ... yes, because if you hadn't had imagination, you couldn't have thought outside the box. ... E.g. This thing about the atoms, you couldn't have thought "It might be in a different way, it might be in a different way". And they concluded that it was in a different way. And then you think a bit outside perhaps
> Teacher C: Yes, that is wise. And, eh, that was partly, that was partly what the Ernest-drama showed.

The teacher then elicited a response from another group, that agreed:

> Pupil: It might require creativity to come up with new thoughts and ideas and ... and experiments

*Cooperation.* In two of the classrooms, cooperation between scientists was communicated in the context of the story of Rutherford. In classroom A, the teacher taking the role as Rutherford, tells the students about how the experiments were conducted, not by him alone, but together with colleagues.

> Rutherford [Teacher A]: There were people I thought were the best to work with and I had two colleagues I collaborated well with. One of them was Hans Geiger and the other was Ernest Marsden. Together we made an experiment that lasted for many years.

In classroom B the colleagues were not mentioned, giving the impression that Rutherford had performed the experiments by himself.

In classroom C it was communicated that Rutherford was part of a research community, with colleagues who collaborated and built on each other's work:

> Teacher C: Yes, there was a lot of work involved for Ernest to prove it. And then there was another guy, Bohr, Niels Bohr, who believed him. And Niels Bohr, he is the one who came up with ... This is his atomic model, how it could really look. So, Rutherford had the idea and then there were several colleagues collaborating to develop

the idea, the thought. And then it turns into the Bohr atomic model.

*Subjective/socio-cultural aspects (mostly inside science).* In all classrooms, throughout the story, it was communicated that Rutherford depended on a scholarship. Unless he had got this, he would not have been able to do research, but instead continued working on the potato field:

Rutherford [Teacher B]: Then one day, my mother came running over the field, crying: “Ernest, Ernest, you have got a scholarship. You can go anywhere in the world and work as a researcher.” I thought “Wow, now I have planted my last potato”, and I am off. Then I went to Montreal. I was 24 years old, and went to Montreal in Canada. And there I tried to do research about the different parts of the atom.

In some of the classrooms the teacher was directing attention to the difficulties Rutherford encountered trying to convince other scientists on the value of his model:

I would like you to think about it individually at first, then you can discuss it. Do you think that everyone believed him directly and said “Oh, we believe this model. No, no, we don’t believe that famous professor.” Like that?

Here it is communicated that status could be an issue also in the research community, and that it could be hard to convince others about a model that contradicts established models supported by famous scientists. The teacher closes this discussion by coming back to the empirical results, and the need to repeat experiments. However, to some extent, this hides the messy research process, which also includes interpretations—sometimes different and even contradicting.

*Characteristics of scientists and personal background.* During the story and the whole-class discussions different characteristics of Rutherford as a scientist were communicated, e.g. that he was ‘very smart and clever’, ‘fearless’, ‘stubborn’ and ‘curious’.

It was also communicated that he was born in New Zeeland. His parents cultured potatoes and also Ernest Rutherford was working at the potato field before he got the scholarship. His mother was a teacher, and teacher A described how this helped Rutherford. The family moved around a lot because of his father’s work (he was a mechanic). In one of the stories (classroom A) this was described as a reason as to why he became fearless and inventive.

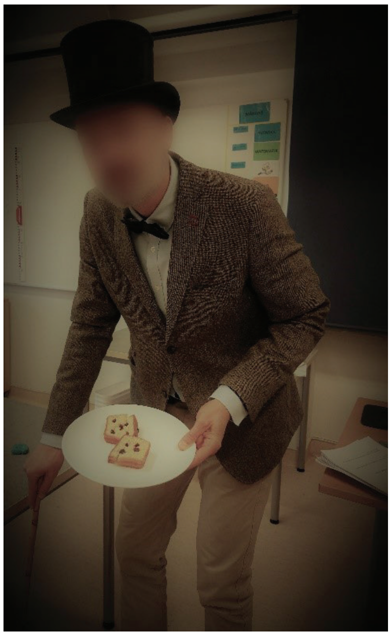

**Figure 1.** One of the teachers in the role of Rutherford.

All three teachers described that Rutherford got a physics book when he was a child, and that this was really important for him in developing an interest for physics:

Rutherford [Teacher B]: When I was ten years old, I got something fantastic. I got my first physics book. It was the most exciting thing I got in my whole life. I just wanted to read and read and read. But I couldn’t, because I had to work at the farm. In those days we children worked at the farm. Well, I helped, I worked at the farm, but when I got older I started to study. I read, I read a bit ... or actually quite a lot. I read languages, I studied Latin, I studied French and I studied English. Then I studied mathematics, and more mathematics and got even better at it. Then I studied physics. I read and read and read. It was fantastic to have a chance to get educated and learn more and more.

Education was described as something joyful and desirable for Rutherford in the stories told. All teachers also told about Rutherford trying to get a position as a teacher but failed:

> Rutherford: I applied for a job, thinking, I have to make a living. I applied to be a teacher - but do you think I got it?
> Pupil?: NO
>
> Rutherford: No, I didn't get a job as a teacher. I think you have to be very smart to be a teacher. You have to know a lot. All my education within mathematics and physics was not enough. So, I had to return to my parents and work on the potato fields, which is what I did.

Thus, during the lessons taking a starting point in the story about Rutherford, some stereotypical images of the scientist were communicated (he was very smart and clever) and somewhat a hero in succeeding to develop a new atomic model and convince others about the strengths of this model compared to the Thomson model. On the other hand also images were communicated somehow problematizing this image—picturing Rutherford as having a rather normal background (cultivating potatoes).

## Discussion and conclusion

NOS can be taught through using contextualized as well as decontextualized approaches. There is an ongoing discussion in the NOS literature on pros and cons with these different approaches (Allchin *et al* 2014, Clough 2006). Worries have been raised that teachers might think that contextualized approaches are too demanding, whereas approaches that decouple NOS from science content can lead students to view NOS as something that is irrelevant for the concept and models taught (see e.g. Clough (2006)).

This article describes examples from science classrooms where teachers use the StoryTelling approach to NOS, which is a highly contextualized approach. In line with previous studies on teachers' views on the StoryTelling approach (Blum and Heering 2014), the teachers in this study clearly consider the approach to be beneficial for their science teaching. With this as a background, it is particularly interesting that the results presented in this article show that teachers address a number of NOS aspects explicitly, and in context of the story told. Worth noting are the many human aspects of science that are highlighted in the context of the story. The teachers highlight the person Rutherford, but at the same time NOS aspects, for example creativity as important for scientific research, come to the forefront. However, focusing on a single historical scientist can run the risk of positioning him or her as a hero. In this study we have seen example of stereotypical images of the scientist being communicated (e.g. very smart and clever, and somewhat of a hero), but also instances where these images are at least somewhat problematized (picturing Rutherford as having a rather normal background). Humanizing science through highlighting the people that have been involved in the history of science, as well as scientists of today, will possibly make science less hard and more human. As a consequence, students may find it easier to identify with science (on the relevance of role models and interest in science see Hannover and Kessels (2004) and Taconis and Kessels (2009)). In this study, we have seen that aspects of NOS concerned with the characteristics of scientific knowledge as well as the processes of science, and human elements of science were all discussed in the classrooms. Thus, in the classrooms studied, the high level of contextualization (through the story of Rutherford's work on the atomic model) did not hide the NOS.

It is also obvious that NOS really is addressed in context of the Rutherford story and that also science content come to the forefront during the lessons. In comparison with the classical teaching of atomic models, but also with other NOS-oriented approaches to teach Rutherford's model (Abd-El-Khalick 2002), there is a substantial amount of science content included in the teaching sequence. However, in the StoryTelling approach, this content is also contextualized historically. It is interesting to notice that pupils ask for clarifications concerning the experiment performed by Rutherford, as well as concerning the relation between the plum pudding and the Thomson atomic model. Thus, there are indications that students could ask for and support an increased level of contextualization of NOS during the StoryTelling lesson. Thus, the StoryTelling approach seems to enable teachers and students to focus both on different NOS aspects, and on the specific science content.

In this study we have seen teachers who are able to adopt the StoryTelling approach successfully after a shorter (one-day) introduction, and that the approach may enable teachers to address NOS-aspects in classroom. This is interesting and promising due to teachers' need of support with respect to NOS teaching. Further classroom studies on how teachers use different stories, in different contexts, to direct attention to NOS, would be valuable, as would studies addressing pupils' developing an understanding of NOS when taught with the StoryTelling approach.

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