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ABSTRACT

This paper describes a fictitious scene that could be used to support role-playing activities in the science classroom. The scripted scenes contain interviews with Gabriel Fahrenheit and Anders Celsius regarding the development of their temperature scales. Although the scenes are imagined, the scientific concepts are factual and could be used to teach some aspects of the history of science. (Contains 11 references.) (WRM)

Temperate Facts in Fictitious Time

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This article could be used by teachers for "role-play in the classroom".

Role-playing gives students an opportunity to practice interacting with others in certain settings. It helps students to cultivate imagination by portraying the person they represent in a theatrical set-up. Students can be creative in setting up the surroundings, yet maintain the basic theme. By enacting, students who play the roles and the audience in the class will learn something about the person and their scientific contribution. Role-play is highly motivating, and enables students to put themselves in situations they have never experienced before, and help to develop interpersonal and communication skills. (Ments, 1994).

The following fictitious scenes transport us back in time to conduct an interview with "good ole" Gabriel Fahrenheit. After a brief visit with him, with the help of the mythical time machine the scene fast-forwards and we leap in time to visit with Anders Celsius for a pleasant and informative conversation.

Although scenes depicted here are imaginative, the scientific concepts are factual and could be designed to help teachers teach history of science to students.

An Interview with Gabriel Fahrenheit:

It was already dark when our horse carriage entered the village of Heidelberg (Germany). The severe cold wind along with snow on the ground had made our journey quite exhaustive. It was early in the morning when I left Mrs. Graff's house and headed west to celebrate Christmas Day with the Becker family. It had been almost three years since I last visited them and I thought it would be really fun to celebrate the Christmas of 1713 with them. I was told that if I took a carriage in the morning, I should reach their place by the evening and could join them for the Christmas Eve dinner. However, the gusty wind had made the journey greatly impeded our progress and far more difficult; sooner than I expected, the horseman indicated that the weather condition made almost impossible for the horses to go any further. It came to me as a shock as I did not know the area at all and was quite fearful of spending a bitter cold night inside the carriage. Upon discussing with the horseman we finally agreed to make a stop at the very first house that came on our way. Fortunately, we didn't have to go too far when we noticed a big house; the flickering lamps inside assured use of the presence of someone in the house. We crossed our fingers, hoping that the individual will be kind enough to allow two strangers to make a night stay at his/her place. As we drove the horses closer, we heard the dogs inside barking at their loudest. I was quite fearful to step out and asked the horseman to speak with the owner. As we were talking, we heard some one open the big wooden door in front of us; a tall young man holding a lamp stepped down the front stairs and speaking fluent German, asked, if we are lost or looking for someone? During these years of my stay in Germany, I had well versed myself in German

language so I introduced myself, telling where I came from and the reason for our stoppage. After learning that I was from England and did not know much about this place, the gentlemen allowed my horseman and myself to spend the night at his house. I was very pleased by his offer and thanked him for his kindness. To my astonishment, in clear English he said, " Merry Christmas and welcome to Heidelberg, Dr. Guha. I am Dr. Fahrenheit, a physicist at the Heidelberg University. It is my pleasure to meet an adventurous lady who defied the freezing temperature to enjoy a wonderful Christmas evening with her friends".

Dr. Fahrenheit asked my horseman to keep the horse in the adjacent barn, and I went inside. As it was almost dinnertime, he asked if I would like to join him. I agreed without any hesitation. After our dinner, we spoke for a while and Dr. Fahrenheit asked if I would like to have a freshly brewed cup of tea.

Me: "Dr. Fahrenheit, let me make the tea."

Dr. Fahrenheit: "Thank you young lady, but let me make you a perfect brew of the tea which needs accuracy, precise timing and a great deal of practice. The water for the tea comes from the development of my scientific research."

Being his guest, I felt it impolite to refuse. Nevertheless, I could not resist myself and asked:

Me: "What made you think that I cannot make a perfect brew of tea?"

Dr. Fahrenheit: "Simply because you do not have the **Magic Stick.** You see, the water temperature is important and then you need precise timing to drop tea leaves in the boiling water inside the pot and then brew the tea for 3 minutes."

Me: "Okay, I get your point, but I do not quite understand what has to do with your **Magic Stick**."

Dr. Fahrenheit: "Only when I show you the **Magic Stick**, you will know."

I saw Dr. Fahrenheit taking out a long (about 12 inches) glass stick, with small markings evenly distributed on it's side.

Me: "Wow! pretty fancy stick, seems like a longer version of Cinderella's stelé toes."

Dr. Fahrenheit (laughing): "Looks alike, but this is different. It takes the scientific community a long way, and not our pretty Cinderella to the ball room floor."

Me (laughing): "Sure, but would you mind explaining to me first, how your **Magic Stick** works? Once this unscientific minded, bewildered English lady is convinced by simple explanation

of the scientific theory, only then you can be assured that knowledgeable world will gladly accept your new creation."

Dr. Fahrenheit: See the three big markings - red, yellow and blue; they specify the boiling point, the zero-point and the freezing point of water respectively. The zero-point, which is indicated by a yellow line is the base and based on my system, I found that there are 32 degrees between the zero-point and the freezing point of water; this further indicates that water freezes at 32 degrees of temperature.

Me: Then, how do you know the boiling point of water?

Dr. Fahrenheit: "It's simple, hot is just the opposite of cold. So in this case, boiling point is opposite to the freezing point. If you see the markings carefully, you will see that it shows 32 at one end and 212 at the other."

Me: "Yes, I see that, but why 212? Is there any specific reason?"

Dr. Fahrenheit: " Mathematically speaking, the two most dissimilar points of scale is 180 degrees apart. When I say 180 degrees, I mean the degree of straight angle. For example, if you ask a person to sit at one end of a bench, and then ask another person to sit at the other end, in theory, it means that they are sitting at two opposite ends; a mathematician would view them sitting

180 degrees apart (or totally opposite polarities). From that perspective, if the freezing point of water is 32 degrees, then add 180 to get the boiling point of water, which comes to 212 degrees.

Me: "It is really interesting, but what about the zero-point? How would you explain that?"

Dr. Fahrenheit: "You see, this zero-point is far below the freezing point of water. This is as cold as it can get, even at the north pole. When I use my degree spacing that I fixed between the freezing point of water and the boiling point, I have 32 degrees. Let me show you a simple experiment."

Dr. Fahrenheit puts some ice in a glass, measured its weight and kept it aside. Next, he poured some common salt in another flask, measured it a couple of times and then kept it on the table. Afterward he poured the whole ice-water mixture from the glass into the flask containing the salt. As I was watching Dr. Fahrenheit's, he said "come on, and now see the fun."

Me: "Dr. Fahrenheit, I see the ice melting, so the temperature must be high now."

Dr. Fahrenheit: "Oh no! the temperature is well below the freezing point now."

Me: "But I see the ice melting, so how could it be possible that the temperature is lower? Ice melts only when the temperature gets warmer."

Dr. Fahrenheit: "Compare the temperature level at the graduated yellow mark, and you will see how low it is from the blue mark which is our freezing point. If the temperature had been warmer, the indicator line would have been over the blue mark and moving towards the red mark. This is a common error that people make. In reality, when salt causes the ice to melt, the process absorbs huge amount of heat energy, and the temperature gets down far below freezing. The forced melting of the ice has a cooling effect just like evaporation has a cooling effect."

Me: "Wow! It's a new thing to me."

Dr. Fahrenheit: "That's okay, because that is the most common assumption. But once you understand the principle behind these, you are enlightened."

Me: "Now, I fully understand your reason for zero-point, the 32 degree mark and the 212 degree mark. But, instead of 32 , why didn't you have it as 0 degree and make it the freezing point and then use 180 degree as your boiling point? I think, it would have been simpler to understand 180 for boiling, 0 for freezing, and assign a negative value for anything below freezing"

Dr. Fahrenheit: "I see your point, and I have thought about it. But in general, people get confused when you use a negative value. It is hard to understand how could anything be less than

zero and for all that reason I made the zero-point as the reference, 32 degrees was found to be the freezing point and 212 degrees as the boiling point of water."

Me: "So, do you just say 32 degrees or 212 degrees? People may get confused with mathematical numbers where angular values are denoted as 15 degrees, or 30 degrees..."

Dr. Fahrenheit: "I guess you are right, so why don't I call it degrees Fahrenheit or just "F"."

Me: "Yeah, that's the right choice. Now, my last question - did you establish your system and proved to your scientific community about this?"

Dr. Fahrenheit: "I sure did, and they are reviewing my system and the instrument now. But whatever views they might have, my concept is clear and simple, and they do not have any measurement system better than the one that I just described to you."

Me: "You are a genius!"

Dr. Fahrenheit: "Now, that I have explained this simple theory of temperature measurement to you, I am sure you can make the perfect tea in future. But tonight, let me make it."

Me: "Thank you for being a wonderful host, and I shall remember this evening and the scientific tea session for ever."

The horse carriage came to a sudden jolt and I woke up. I looked at my watch; alas! I slept for almost two hours and in my dream I was reminiscing the wonderful evening I had with "good ole" Fahrenheit in Germany about three decades ago. I still recall my accidental meeting with Prof. Fahrenheit, and of our fascinating discussion about the measurement of temperature.

[With the help of the mythical time machine the scenes are then fast-forwarded]

Next morning, on a sunny day in 1742, I am in Stockholm, on my way to meet Prof. Celsius, who agreed to meet with me for an interview. His recent publication in the Annals of the Royal Swedish Academy of Science has provided an alternative method for measuring temperature. Thirty winters have passed after he reported his new system and many in the scientific community have embraced this new scale.

An Interview with Anders Celsius:

As I entered the main lobby of the research institute where Prof. Celsius has agreed to meet with me, I saw clippings from news papers and other scientific journals covering the entire bulletin board covering almost one third of the back wall. It has been thirty years, still some of the newspaper excerpts are preserved carefully. I am excited to see his laboratory at Uppsala. Now, it is

thirty minutes past in the morning and the laboratory supervisor indicated that Prof. Celsius is ready for the interview.

Prof. Celsius: "Hello friend! Welcome to the land of midnight sun."

Me: "Thank you Sir, I am quite excited about meeting with you and discussing about your new invention."

Prof. Celsius: "You had indicated in your letter that you had met with Dr. Fahrenheit after he invented his scale on temperature measurement. I am also glad to meet with you and tell you about my invention."

Me: "That's why I am excited; Prof. Celsius, first let me ask you, what made you to think about an alternative scale of measurement, when every one was happy to use the Fahrenheit scale?"

Prof. Celsius: "That's the beauty of science; a scientist's mind always try to solve puzzles, construct new model, and improve on existing knowledge."

Me: "So, what did you do, and why?"

Prof. Celsius: "You know, Dr. Fahrenheit's scale was certainly useful and we adopted it quite well in our research experiments and it was widely used by the common people. However, there were certain aspects, which made me curious to design my temperature scale. First, the zero-point was not really a fixed value, and for a common person it is difficult to understand the concept of the 180 degree difference. Lastly, Dr. Fahrenheit overlooked the fact or was unsure that in some countries, the temperature falls below the zero on his scale and they cannot measure the temperature with his scale."

Me: "You are quite right, and it's interesting that I had thought about it before but didn't know the solution to it. Can you please explain a little bit more on this."

Prof. Celsius: "Sure, my friend. First let us talk about the zero-point in Fahrenheit scale. You see, Prof. Fahrenheit arrived at this zero-point when he mixed equal amounts of salt and crushed ice and the temperature then drops far below freezing. It became his zero-point. However, in reality it is not a fixed point and cannot be duplicated around the world. Since, the temperature of ice-salt mixture varies depending on the size of crushed ice and size and type of salt, the zero-point meant different temperatures in different places."

Me: "Well now, I understand when you say that in Fahrenheit scale the zero-point is never a fixed value. But how would you place your temperature scale with respect to that? Would you say that your scale is right and Fahrenheit is wrong."

Prof. Celsius: "No, I wouldn't say that Prof. Fahrenheit is incorrect, but my scale is comparatively convenient to use. I took freezing point of pure water as my reference point; I call my thermometer, the Centigrade thermometer because it showed 100 degrees between freezing and the boiling point.

Me: "Now, what about the boiling point? How would you tell people that boiling point is opposite to the freezing point?"

Prof. Celsius: "For that, I used decimal system so that every one understands. I used 100 degrees between freezing and the boiling points, so my freezing point of water is 100 degrees and the boiling point is 0 degree."

Me: Don't you mean zero for freezing and 100 for boiling"

Prof. Celsius: No, I mean it as I say! (very firmly).

Me: "I read that you found out that Fahrenheit's ice-salt mixture is 18 degrees below 0 in your scale, is that correct?"

Prof. Celsius: "You are absolute right."

Me: "Do you think, now it will set a standard in temperature measurement."

Prof. Celsius: "No, nothing is standard, it depends upon the user and what is appropriate for them. I invented this scale because I felt that Fahrenheit scale had limitations, so I wanted to develop something, which is convenient for me and may be to the others. For the ever changing world, it is hard to set any standard, everything has a relative value and we always compare among things, values... may be a time will come when someone will invent a substance which has more scientific value than water and people will use that as a standard instead of water."

Me: "Prof. Celsius, I thank you very much for this opportunity to discuss with you on your new invention – the "Celsius Degree Scale" and my sincere wishes for your success.

Years after Celsius died, the scale was reversed to use zero degree for freezing and 100 degrees for boiling. This is the system we use today. Later on, the name of the scale was changed from centigrade to Celsius in honor of its inventor.

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