

Supporting Information to Aakre (2026): “As close as it gets to the truth”:

University students’ views on science and scientific models of chemical bonding

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Supporting Information A: Survey questions

The survey was given to the students in Norwegian and was translated into English for this article. Table A shows the full text of the relevant survey questions in the original Norwegian and English translated versions.

Table A. Relevant survey questions in Norwegian and English.

Question	Norwegian (original)	English (translated)
Q1: multiple select	Under vises 8 ulike måter å se for seg hydrogenmolekylet på. Hvilke av disse representasjonene har du sett før? Sett kryss hvis du tror du har sett en lignende figur tidligere <input type="checkbox"/> Figur 1 <input type="checkbox"/> Figur 2 <input type="checkbox"/> Figur 3 <input type="checkbox"/> Figur 4 <input type="checkbox"/> Figur 5 <input type="checkbox"/> Figur 6 <input type="checkbox"/> Figur 7 <input type="checkbox"/> Figur 8	Below are 8 different ways to visualize the hydrogen molecule. Which of these representations have you seen before? Check the box if you think you have seen a similar figure before <input type="checkbox"/> Figure 1 <input type="checkbox"/> Figure 2 <input type="checkbox"/> Figure 3 <input type="checkbox"/> Figure 4 <input type="checkbox"/> Figure 5 <input type="checkbox"/> Figure 6 <input type="checkbox"/> Figure 7 <input type="checkbox"/> Figure 8
Q2: Likert scale	Figuren under viser en representasjon av hydrogenmolekylet H ₂ . I hvor stor grad mener du at denne representasjonen er vitenskapelig? <input type="radio"/> i veldig liten grad <input type="radio"/> i ganske liten grad <input type="radio"/> nøytral <input type="radio"/> i ganske stor grad <input type="radio"/> i veldig stor grad	The figure below shows a representation of the hydrogen molecule H ₂ . To what extent do you find this representation scientific? <input type="radio"/> a very small extent <input type="radio"/> a rather small extent <input type="radio"/> neutral <input type="radio"/> a rather large extent <input type="radio"/> a very large extent)
Q3: text box	Hva vil det si for deg at en representasjon er vitenskapelig?	What does it mean to you that a representation is scientific?

Supporting Information B: List of textbooks

A total of 22 textbooks were included in the study. The lists below sort the textbooks by course. The textbooks for natural science (grade 8-10) are published as sets of three textbooks, one for each year of lower secondary school (Norwegian *ungdomsskole*), and the list sorts these textbooks by name of the set.

Natural science textbooks, grade 8-10

Eureka!

- Frøyland, M., Hannisdal, M., Haugan, J., & Nyberg, J. (2006). *Eureka!: Naturfag for ungdomstrinnet: Grunnbok 8*. Gyldendal undervisning. https://urn.nb.no/URN:NBN:no-nb_digibok_2014110448148
- Hannisdal, M., Haugan, J., & Munkvik, M. (2007). *Eureka!: Naturfag for ungdomstrinnet: Grunnbok 9*. Gyldendal undervisning. https://urn.nb.no/URN:NBN:no-nb_digibok_2011032106093
- Hannisdal, A., Hannisdal, M., Haugan, J., & Synnes, K. (2008). *Eureka!: Naturfag for ungdomstrinnet: Grunnbok 10*. Gyldendal undervisning. https://urn.nb.no/URN:NBN:no-nb_digibok_2009100104029

Nova

- Steineger, E., & Wahl, A. (2013). *Nova 8-10: Naturfag for ungdomstrinnet: [Elevbok] 8*. Cappelen Damm. https://urn.nb.no/URN:NBN:no-nb_digibok_2021010807545
- Steineger, E., & Wahl, A. (2014). *Nova 8-10: Naturfag for ungdomstrinnet: [Elevbok] 9*. Cappelen Damm. https://urn.nb.no/URN:NBN:no-nb_digibok_2020112407037
- Steineger, E., & Wahl, A. (2015). *Nova 8-10: Naturfag for ungdomstrinnet: [Elevbok] 10*. Cappelen Damm. https://urn.nb.no/URN:NBN:no-nb_digibok_2020030607032

Tellus

- Ekeland, P. R. (2006). *Tellus: Naturfag for ungdomstrinnet: 8 [Grunnbok]*. Aschehoug. https://urn.nb.no/URN:NBN:no-nb_digibok_2013070305058
- Ekeland, P. R. (2007). *Tellus: Naturfag for ungdomstrinnet: 9 [Grunnbok]*. Aschehoug. https://urn.nb.no/URN:NBN:no-nb_digibok_2011070505007
- Ekeland, P. R. (2008). *Tellus: Naturfag for ungdomstrinnet: 10 [Grunnbok]*. Aschehoug. https://urn.nb.no/URN:NBN:no-nb_digibok_2011083106167

Trigger

- Finstad, H. S., Kolderup, J., & Jørgensen, E. C. (2006). *Trigger: Elevbok naturfag 8. Klasse*. N.W. Damm & Søn AS. https://urn.nb.no/URN:NBN:no-nb_digibok_2011072808054
- Finstad, H. S., & Kolderup, J. (2007). *Trigger: Elevbok naturfag 9. Trinn*. N.W. Damm & Søn AS. https://urn.nb.no/URN:NBN:no-nb_digibok_2012082938018
- Finstad, H. S., & Kolderup, J. (2008). *Trigger: Elevbok naturfag 10. Trinn*. Cappelen Damm AS. https://urn.nb.no/URN:NBN:no-nb_digibok_2014070907047

Natural science textbooks, grade 11

- Brandt, H., Fonstad, T., Hushovd, O. T., & Tellefsen, C. W. (2006). *Naturfag 5: Grunnbok: studieforbereidende utdanningsprogram*. Aschehoug. https://urn.nb.no/URN:NBN:no-nb_digibok_2020111907570
- Ekeland, P. R. (2006). *Nexus: Naturfag 5*. Aschehoug. https://urn.nb.no/URN:NBN:no-nb_digibok_2012072006097
- Heskestad, P. A. (2013). *Kosmos SF: Naturfag for studieforbereidende utdanningsprogram: lærebok*. Cappelen Damm. https://urn.nb.no/URN:NBN:no-nb_digibok_2018073148134
- Marion, P. van. (2006). *Senit: Naturfag vg 1: studieforbereidende*. Gyldendal undervisning. https://urn.nb.no/URN:NBN:no-nb_digibok_2011032206017

Chemistry 1 textbooks

- Brandt, H., & Hushovd, O. T. (2010). *Kjemi 1: Studiespesialiserende utdanningsprogram*. Aschehoug. https://urn.nb.no/URN:NBN:no-nb_digibok_2018060648072
- Knutsen, H., Tveit, S., & Vestli, K. (2018). *Kjemien stemmer 1: Grunnbok: kjemi 1*. Cappelen Damm. https://urn.nb.no/URN:NBN:no-nb_digibok_2022082448063
- Steen, B. G., Fimland, N., & Juel, L. A. (2010). *Aqua 1: Kjemi 1: grunnbok*. Gyldendal undervisning. https://urn.nb.no/URN:NBN:no-nb_digibok_2015112708118

Chemistry 2 textbooks

- Brandt, H., & Hushovd, O. T. (2011). *Kjemi 2: Studiespesialiserende utdanningsprogram*. Aschehoug. https://urn.nb.no/URN:NBN:no-nb_digibok_2013071708146
- Knutsen, H., Tveit, S., Vestli, K., & Edvardsen, H. (2019). *Kjemien stemmer 2: Grunnbok: kjemi 2*. Cappelen Damm.
- Steen, B. G., Fimland, N., & Juel, L. A. (2011). *Aqua 2: Kjemi 2: grunnbok*. Gyldendal undervisning. https://urn.nb.no/URN:NBN:no-nb_digibok_2015120908133

Supporting Information C: Statistical data

Table B gives the number of respondents (N), mean values of the responses to the Likert scale question “To what extent do you find this representation scientific?”, and consensus values (Cns) for the data. The means are calculated by giving the response “a very small extent” the value -2 , “a rather small extent” the value -1 , “neutral” the value 0 , “a rather large extent” the value $+1$ and “a very large extent” the value $+2$. A positive mean indicates that students, on average, find the model to be scientific to a large extent.

A consensus value of 0 means that there is perfect disagreement between the respondents, while a consensus value of 1 is perfect agreement. All calculated consensus values are in the range 0.59 – 0.80 .

Table B. Statistical data for the Likert scale question “To what extent do you find this representation scientific?” (Q2): number of students (N) answering the question for this model, mean values, and consensus values (Cns). The mean is calculated by setting “a very small extent” = -2 , “a rather small extent” = -1 , “neutral” = 0 , “a rather large extent” = $+1$ and “a very large extent” = $+2$.

MODEL	First-year			Second-year			Third-year		
	N	Mean	Cns	N	Mean	Cns	N	Mean	Cns
Lewis structure (model 1)	202	-0.22	0.69	100	-0.30	0.67	84	-0.43	0.59
Ball-and-spring model (model 2)	200	-0.26	0.72	70	-0.11	0.78	13	-0.08	0.75
Octet model (model 3)	202	0.65	0.74	99	0.28	0.65	85	0.15	0.66
MO diagram (model 4)	200	0.85	0.73	101	1.35	0.79	85	1.46	0.80
Ball-and-stick-model (model 5)	272	-0.36	0.68	66	-0.23	0.64	29	-0.41	0.68
Space-filling model (model 6)	273	-0.04	0.75	67	0.15	0.73	29	0.28	0.78
Overlap model (model 7)	272	0.38	0.76	67	0.84	0.76	29	0.66	0.73
Potential energy graph (model 8)	273	0.96	0.77	66	1.23	0.75	29	1.21	0.76

Supporting Information D: Student answers

Table C gives the example student answers from the thematic analysis in English and Norwegian. The Norwegian versions are unedited from the student answers, and the English translations are uncut.

Table C. Selected student answers to the question "What does it mean to you that a representation is scientific?", in Norwegian and English.

Student answer in Norwegian (original)	Student answer in English (translated)
At den til en grad viser hva som faktisk skjer i virkeligheten	That it to some extent shows what actually happens in reality.
Jeg har ikke mye erfaring med vitenskap, men for å svare på spørsmålet vil jeg si at det er noe som er fullstendig eller så nærme det kommer sannhet. Noe som man kan bruke som et grunnlag for videre nysgjerrighet	I do not have much experience with science, but to answer the question, I would say that it is something that is entirely or as close as it gets to the truth. Something one can use as a basis for further curiosity
Personlig ikke så mye, men det er enklere å stole på informasjonen når den er vitenskapelig.	Personally, not much, but it is easier to trust the information when it is scientific.
At den bygger på noe som er basert på forskning og ikke synsing.	That it is built on something that is based on research and not on speculations.
At forskere bruker det	That scientists use it