Appendix A – Example of a practical lesson lab sheet

Note: Only Part A was observed during the study as Part B was postponed due to issues with the gas.

LE CHÂTELIER'S PRINCIPLE

Aim
Study equilibrium systems and their responses to stress as described by Le Châtelier's principle.

Theory
Many chemical reactions are "one way" reactions. They proceed in one direction only. Many other reactions do not go to completion. Rather, the products of these reactions remain in contact with each other and react to re-form the original reactants. Such reactions are said to be **reversible**. In a reversible reaction, the forward and reverse reactions proceed at the same time. When the rates of the two reactions are equal, a state of **chemical equilibrium** is said to exist.

If the conditions (such as temperature, pressure, or the concentration of the species involved) under which equilibrium is established are changed, the rates of the forward and reverse reactions will no longer be equal. As a result the equilibrium is disturbed and the concentrations of the species will change until this equilibrium condition is once established. We can qualitatively predict the effects of changes on a system at equilibrium by using **Le Châtelier's Principle**, which states that **if a change is imposed on a system at equilibrium the position of the equilibrium will shift in a direction that tends to reduce that change**."

In this experiment, we will study two equilibrium systems.

Safety
Use extreme care when handling the acids in this experiment. Both acids are concentrated and therefore very corrosive.
It is worth noting that Co^{2+} is poisonous. Since the solution contains ethanol, any heating should be carried out in a water bath.
Avoid breathing in any nitrogen dioxide that is evolved while you are collecting the gas.
Prepare the gas in the fume cupboard. Wear a lab apron and safety goggles.

Chemicals
Solution no.I: cobalt (II) chloride in ethanol (1g cobalt (II) chloride in 50 cm^3 ethanol)
Solution no.II: cobalt (II) chloride in water (1g cobalt (II) chloride in 50 cm^3 water)
Hydrochloric acid concentrated.
Nitric acid concentrated
Copper metal

Procedure

Part A: Cobalt (II) chloride

What's the colour of solution no.I? _____
This colour is due to the presence of the anionic species $[CoCl_4]^{2-}$.

What's the colour of solution no.II? _____
This colour is due to the presence of the hydrated cation $[Co(H_2O)_6]^{2+}$.

1. Measure out 2-3 ml of **solution I** into a small test tube.
2. Add water, drop by drop to the solution in the test tube until a colour change occurs.
3. Divide the solution equally into two test tubes, labelled A respectively B.
4. Add drop by drop concentrated hydrochloric acid into test tube A, until a colour change occurs.
5. Repeat step 2 and 4.
6. Record your observations. _____

_____

7. Place test tube B into a beaker with boiling water.
8. Place test tube B into ice water.

9. Record your observations. _____

_____

10. Write the equilibrium equation for the reaction that takes place in test tube A.

_____

11. Write the equilibrium equation for the reaction that takes place in test tube B. State if it is an endothermic or exothermic reaction.

_____

_____

12. What would the effect on the direction of equilibrium be (i.e., would it shift to the left, right, or not at all) if following changes are made to the system?

a HCl is added _____

b H_2O is added _____

c the system is heated _____

d the system is cooled _____

Part B: Nitrogen dioxide

1. Preparation of NO_2: To be done in the fume cupboard. Transfer 1-2 ml of concentrated nitric acid into a test tube. Add a piece of copper metal to this solution.
2. Record your observation. _____

_____

What's the colour of NO_2? _____

3 Place a plastic dropper pipette at the top of the test tube and collect the produced gas by pressing the pipette several times.
4 Place the end of the pipette into the Bunsen flame until it starts to melt. Then press the end with a forceps, so the gas is enclosed in the pipette.
5 Place the pipette into a beaker with boiling water
6 Place the pipette into ice water.
7 Record your observations. _____

_____

8 The colourless gas is N_2O_4.
9 Write the equilibrium equation for the reaction that takes place in the pipette. State if it is an endothermic or exothermic reaction.

_____

_____

10 What would the effect on the direction of equilibrium (i.e., would it shift to the left, right, or not at all) if following changes are made to the system?

a. the system is heated _____

b. the system is cooled _____

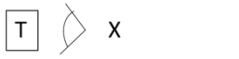
Appendix B – Example of an early descriptive transcript with notes

This appendix shows an original early transcript, to give readers an idea of the data analysis prior to process coding. The printed symbols in the transcript are common to conversation analytic research, and were developed by Gail Jefferson (2004). The hand-drawn symbols are my own and represents non-verbal interactions observed in the video. An overview of the symbols used in the transcript is given below (note that the transcript shown is a work in progress and is therefore not completely finished):

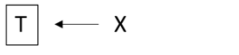
(0.3)	The number in brackets represent a pause in conversation, in tenths of a second.
(.)	A pause in conversation less than two tenths of a second.
=	The equals sign can indicate either (a) sentences from different speakers 'latching on' to each other – that is, proceeding with no pause – or (b) the continuation of a speaker's turn or action across lines.
[ ]	Square brackets mark the beginning and end of overlapping talk.
.hh	Speaker in-breath. The length of breath is indicated by the number of hs.
hh	Speaker out-breath. The length of breath is indicated by the number of hs.
(( ))	Double brackets are used to describe non-verbal actions such as sounds, or transcriber's comments.
wor-	A dash indicates that the word is cut short.
wo::rd	A colon indicates that the sound represented by the letter previous to the colon is extended. The length of the extension is indicated by number of colons.
(word)	A word in parentheses represents the transcriber's best guess at what is being said.
word.	A full stop indicates a falling tone.
word?	A question mark indicates rising intonation.
word,	A comma indicates that the speaker's tone indicates a continuation.
#	Croaky pronunciation of the word that follows.
↑↓	A rise or fall in pitch of the word that follows
wo:rd	A smaller fall in pitch after the underlined sound
wo:rd	A smaller rise in pitch after the underlined colon
word	Speaker emphasis of the word
°word°	The speech inside the degree signs is quieter than surrounding talk

Below is an explanation of the hand-written symbols, created by the author for the purpose of tracking non-verbal interactions:

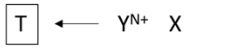
All comments refer to actions related to the transcript line below (and to the person speaking, even if not stated)



Person X looks at the board. Additional information indicates exact direction of gaze.

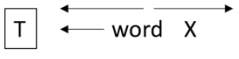


Person X points at the board.



Person X points at a chemical symbol on the board.

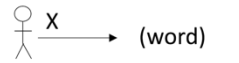
Person X points to a section of the board, described by the word.



Person X makes a sweeping gesture across a section of the board, described by the word.


Shakes tube or microplate


Points at tube or microplate



Person X walks in the (on-screen) direction of the arrow. The direction can also be desribed by a word.


The line indicates that the gesture, gase or other action, occurs alongside the speech indicated by the line. If the action extends across the entire transcript line without ending, the action is marked to the left of the transcript number instead.

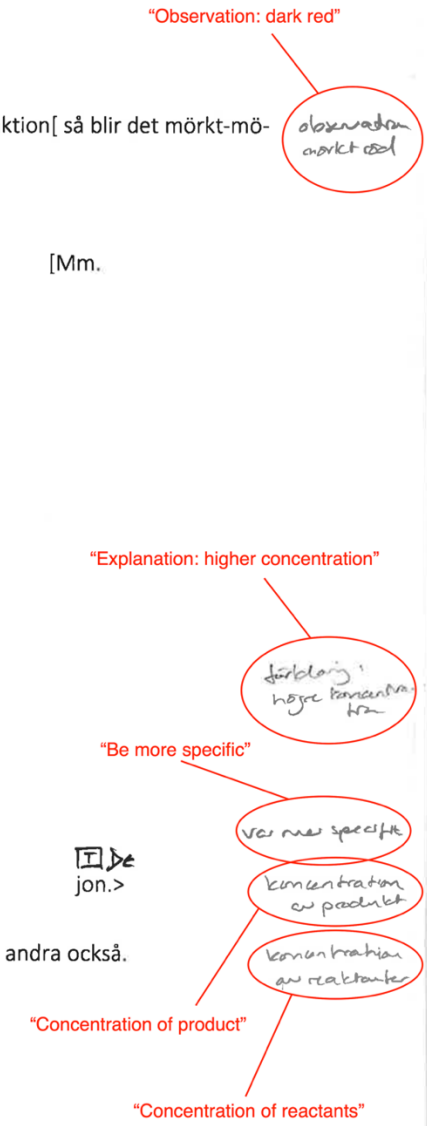
Jefferson, G. (2004). Glossary of transcript symbols with an introduction. In G. H. Lerner (Ed.), *Conversation analysis – Studies from the first generation* (pp. 13–31). John Benjamins Publishing Company.

Lektion 2 Fallstudie 1

Sekvens 1

Transkript börjar 00:25:19 MVI_0075. L1 = Lärare 1, E14/E7 = Elev 14/Elev 7

1	L1	.hhh Hur går det, killar? Hhh
2	E7:	(Vi fick sam[ma ämne)
3	E14:	[Vi fick e::h (att)
4		(2.2)
5	E14:	När vi har lagt samma [ämne som e::h redan finns i reaktion[så blir det mörkt-mö-
6		[((bankande ljud))
7	L1:	[Mm.
8		Det har blivit (.) mörkar:e dä:r
9	E14:	M:m
10	E7:	[[Mm
11	L1:	[[Varf- Varför då?
12		(0.5)
13	E14:	För koncentrationen blir ju högr:e
14		(0.4)
15	L1:	[A:v
16	E7:	[Alltså koncentratio[nen av (0.3) <järntiocyana::t jon.>
17	E14:	[Av e:::::h järn och den andra också.
18	L1:	M:m=
19	E7:	=M:m=



20 L1: =[[Det blir högre ja. Varför då?

21 E7: [[(Att det blir högre)

22 (0.7)

23 E7: För den e::h

24 E14: För dom an- nu vi vi har lagt samma ämn:e så ö::h d:et (k-) (0.4) alltså: reaktionen

25 sker snabbar:e då.

26 E7: Asså [den andra

27 L1: [Ja (.) ja:: [det gör det ju, för det finns- för]det finns mer.

28 E14: [A det finns samma (0.4) s a m m a egenskaper]

29 Ja mer=

30 L1: =(ja) mer [↑jah

31 E14: [(man kan göra) koncentration=

32 E7: =finns mer av den, asså e::h vad hetterom (0.5) reaktanterna [(.) s]om behövs=

33 L1: [Mm]

34 E7: =för att (.) reducera den där.

35 L1: M:m

36 E7: Den fanns me i:eh (0.8) i[lösningen, så därför.

37 L1: [Mm °#mm° tch.hh men om det bildas

38 sånt, går inte den till ↓vänster (.) snabbare ocks:å då

39 (0.5)

40 E14: Jo (1.3) [(ah) måste den göra.

"More substance - more reaction"

"More reactants give more product"

"(Wrong: not a reduction; a complex ion is formed)"

"Leading question: Equilibrium gives a reaction to both right/ left"

41 E7: [(Då hadde man) n å t t jämvikt.=

42 L1: =Den har nått jäm↓vikt varför rö- varför blir det rödare då, det är ju jämvikt hela

43 tiden. Varför har det blivit röda:re då?

44 E7: För de finns högre konc- för de finns hög koncentration av:: den där.

45 (0.9)

46 L1: °Mm° (0.8) m:m

47 E7: Ja

48 L1: Men:: dom andra då?

49 (0.7)

50 E7: (Ja) dom andra=

51 E14: =jag tror det ö::h (ad) för de fanns inte samma:: (0.7) egenska- asså

52 samma ämne (.) s- så blev kon- koncentrationen inte

53 [:: °högre° å då å då kan det ske:: (.) på nåt annat sätt tror jag.

54 L1: [Mm. Vad har hänt då?

55 E7: De- Den reagerade me: (0.5)

56 E14: Me $Ag°NO_3°$=

57 E7: =E:::h asså för jag satte f- i början (.) e::h (.) 0,01 Fe alltså järn (0.8) NO=

58 L1: [(°Mm°) Mm

59 E7: =så den här har reagerat med den istället för att bilda den där.

60 L1: Tch-oke:j [(.) ja::

61 E14: [(°Mm°)

"If the reaction occurs in both directions, why is there more product?"

Om man skriver åt båda hållen, varför syns mer produkt?

Förklarar med observation av produkt

"Explains using observation of product"

"Explain the other trials"

Förklara de andra försöken

"Other substance - something else occurs"

Annat ämne - något annat sker

"Describes what was there from the start"

"The other substance"

Det andra ämnet

Beskriver vad som fanns från början

Reaktanter som stördes: andra reaktanter reagerar och då kan $FeSCN^{2+}$ inte bildas

"The reaction that happened: Other reactants react and then FeSCN2+ cannot be formed"

62 E7: Så då bildade (.) asså=

63 L1: =Så då- å då försvann även det som var i börja:n e[ller?

64 E14: [Bli- blir det inte så F[e(N)-

65 L1: [Varf-

66 varför blev det helt avfärgat för det had- fanns ju lite sånt i börj↓°an°

67 (0.7)

68 E7: Jamen (0.4) det e inte lik:a (.) assåö (0.3) substansmängd, det e mycket mindre.

69 (0.5)

70 L1: #A::ah ((tveksam ton)) men den försvann ju he:lt eller?

71 (1.2)

72 L1: Si[lverjonerna reagera me det och dåh (0.4) men de försvann det fanns ju=

73 E7: [jamen då d å (bild)- ja

74 L1: =redan.

75 E7: Ah

76 (1.0)

77 L1: Varför har det °förs↑vunnit ↑då°

78 (0.4)

79 E7: För den reagerade <me> silver.

80 L1: Ja men dom reagerar ju inte med ↓silver[joner, de var bara den.

81 E14: [nej

82 E7: [nej

"But what happened with FeSCN2+ (the product) that was there from the beginning?"

Men vad hände med $FeSCN^{2+}$ (produkten) som fanns från början

"It could not be seen"

Det syntes inte

"Some was seen"

Lite syntes

Bekräftar reaktionen, samt att $FeSCN^{2+}$ också försvann

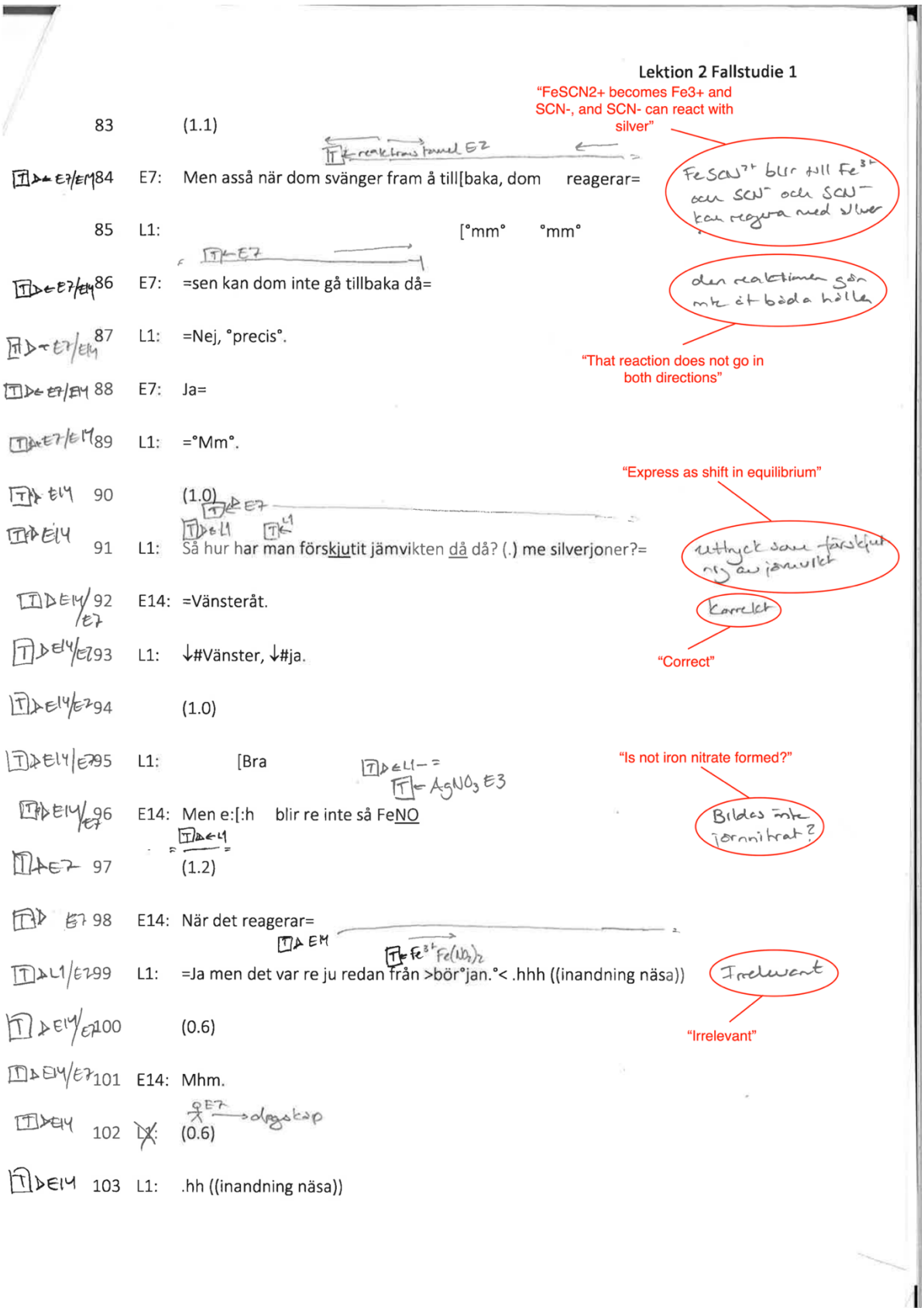
"Confirms the reaction, and that FeSCN2+ also disappeared"

"FeSCN2+ (?) reacted with silver"

$FeSCN^{2+}$(?) reagerade med silver

Nej

"No"


Lektion 2 Fallstudie 1
"FeSCN2+ becomes Fe3+ and SCN-, and SCN- can react with silver"
83 (1.1)
84 E7: Men asså när dom svänger fram å till[baka, dom reagerar=
85 L1: [°mm° °mm°
86 E7: =sen kan dom inte gå tillbaka då=
87 L1: =Nej, °precis°.
88 E7: Ja=
89 L1: =°Mm°.
"That reaction does not go in both directions"
90 (1.0)
91 L1: Så hur har man förskjutit jämvikten då då? (.) me silverjoner?=
"Express as shift in equilibrium"
92 E14: =Vänsteråt.
93 L1: ↓#Vänster, ↓#ja.
"Correct"
94 (1.0)
95 L1: [Bra
96 E14: Men e:[:h blir re inte så FeNO
97 (1.2)
"Is not iron nitrate formed?"
98 E14: När det reagerar=
99 L1: =Ja men det var re ju redan från >bör°jan.°< .hhh ((inandning näsa))
100 (0.6)
"Irrelevant"
101 E14: Mhm.
102 (0.6)
103 L1: .hh ((inandning näsa))

~~104 E7: [((E7 går tillbaka till dragskåpet.))~~

105 [(2.3)

106 E14: Å sen Ag reagerar me::

107 L1: °Mm° (0.5) Ag reagerar <meh> (0.3) me den[↑va (0.6) .hh (0.3) ↓Å ↓bildar ↓en=

108 E14: [just ja

109 L1: =↓fällning.

110 E14: Mmhm=

111 L1: =°Mm° (0.6) M:m

"What does silver react with again?"

Vad reagerar silver med igen?

Silver reagerar med SCN-

"Silver reacts with SCN-"

~~Fällning~~ observeras

"A precipitate is observed"

Appendix C – Expanded description of the dialogic structure analysis

This appendix provides an expanded description of the dialogic structure analysis, exemplified by Anna's conversation.

The overall structure of the sensemaking dialogues is shown in Table 1 and exemplified below. Some of the 46 film clips initially identified as containing a sensemaking component were discarded as the student full participation could not be confirmed, and others were identified as belonging to the same conversation taking place over a longer stretch of time. Overall, 41 conversations were analysed.

Table 1 The overall structure of the sensemaking dialogues in the data. Capital letters represent sections that occurred in all or almost all (in the case of A) conversations. Lower-case letters represent parts of the conversation that could occur either in alternation or in combination (not necessarily in the order stated), as long as at least one sensemaking element was retained. Sections A and D could be non-verbal (for example, a student raising his or her hand for A, teacher nodding for D). Sections B and C were in some conversations repeated if further clarifications were needed for the students (for instance, a conversation could have the structure A, Ba, Ca, Bb, Cb, D). Sensemaking dialogues are defined here as dialogues containing elements of sensemaking (that is, connecting an observation or an experience to theory in the student's own words in order to resolve a gap in knowledge; 'student's own words' in a teacher–student dialogue could be concepts known to the student – concepts previously covered in class that the students had available to them to use for sensemaking as evidenced by the interaction in the dialogue and teacher interviews). Numbers given in parentheses represent the frequency distribution expressed as occurrence within a conversation/total number of conversations.

A	Initiation of conversation (by teacher or student) could sometimes be skipped if the teacher overheard student sensemaking and entered into the dialogue straight away, or if the students framed their sensemaking as a question to the teacher (combining A and B) (90 per cent)
B	a. Student attempt at making sense of phenomena in their own words (initiated by teacher or student) (71 per cent) b. Student asking for explanation/clarification (59 per cent)
C	a. Teacher–student sensemaking (80 per cent) b. Teacher explanation/clarification (93 per cent)
D	Closing of conversation (by teacher or student) (100 per cent)

The conversation structure is exemplified below in an expanded analysis of Anna's conversation, which can also be found in the paper.

Anna 5, 01:42–02:15

A: Intiation of conversation

1 A: Får ni rätt på re, er ha ja inte pratat nåt me
Did you figure it out, I have not spoken with you

Ba: Student attempt at making sense of phenomena in their own words, initiated by student

2 S1: N:äeh vi har lite- vi tänker att dom två ((points at tubes)) beror på
*No we have some- we think that **those** two depend on*
3 koncentration:en,
the concentration
4 A: Jaa? B-
Yes? B-
5 S1: De e ju båda ämnen som <finns> i re- asså i lösningen från början.
They are after all both substances that are present alr- I mean in the solution from the start.
6 A: Ja
Yes
7 S1: Å den här ((points at tube)) s- tänker vi att där så reagerar silverjonerna ((points at
*And **this** one s- we think that **there**, silver ions react*
8 instruction)) med tiocyanatjoner ((points at instruction)) istället för att järnet gör det.

with thiocyanate ions ***instead*** *of the iron doing so.*

9 (0.6)

Ca: Teacher-student sensemaking

10 A: .tch ja[a ? Så skulle man ju kunna säga men vad får de för eff↑ekt då=
yes? That's one way of putting it of course but what kind of effect does it have then

11 S1: [typ
kinda

12 =eftersom de bildar ett svårlösligt salt ((points at instruction))
since they form a sparingly soluble ***salt***

Anna 5, 02:15–02:39

13 (1.7)

14 S1: °↑↑M:m° ((tilts head, looks at instruction))

15 A: Va beror reaktionen på, vi sa att vi ska ha gynnsamma kollisioner, eller hur
What does the ***reaction depend*** *on, we said that we should have* ***favourable collisions****, right*

16 S1: Mm
Mm hmm

17 A: Hur gynnsamt tror ni de blir om man ha re som i en fällning
How favourable do you think it ***becomes*** *if you have it as in a* ***precipitate***

18 (0.9)

19 S1: Ej [så gynnsamt
Not so favourable

20 S2: [Inte så gynnsamhmhmt=
Not so favourable ((laughs))

21 A: =De betyder att dom <här ((points at instruction)) blir ju faktiskt> uppbundna i
That means that these ones actually become ***bound up*** *in*

22 ett svårlösligt salt, så de- de ju på sam- om- så hur kommer koncentrationen av
a sparingly soluble ***salt****, so they- it is after all in the same- if- so how will the concentration of*

23 löst tiocyanat att påverkas.
dissolved *thiocyanate be affected.*

Anna, 02:39-03:09

24 S2: Den kommer gå:: ↓ner.
It will go down.

25 A: Den kommer ju gå ner ja.
It will go ***down*** *yes.*

26 S1: Vänta nu va sa ni nu säg re en gång till.
Wait what did you say say it one more time.

27 A: Jo eftersom tiocyanatjonerna binds upp i det svårlösliga saltet
Well since the thiocyanate ions are bound up into the sparingly soluble salt

28 S1: Mm
Mm hmm

29 A: å då frågade ja hur kommer de då påverka <koncentrationen> av tiocyanatjoner
And then I asked how will ***that*** *then affect the concentration of thiocyanate ions*

30 i <lösning>.
in ***solution****.*

31 (0.5)

32 S1: De blir ↓mindre ↓ja. ((nods))=
It becomes less yes.

33 A: =De blir mindre ja.=
It becomes ***less*** *yes.*

34 S1: =Eftersom att resten e där. ((points at instruction))
Since the rest is there.

35 A: Precis å om du tittar på reaktionen (d)är ((indicates with her hand to the equilibrium
Precisely *and if you look at the reaction there*

36 equation on the whiteboard; the students look up)) om den ((points to $FeSCN^{2+}$
if that

37 and makes a circle with her hand in the air)) <minskar>,
lessens,

38 S1: Så minskar [ju också] koncentrationen av den å då=
Then of course the concentration of that also lessens and then
39 S3: [a h a : :]
Aha
40 S1: =minsk[ar färgen
the colour lessens
41 S2: [Ja å då #m-
Yes and then l-
42 (1.5)
43 A: Mm:

Anna 5, 03:09–03:42
44 S1: Eller?
Or?
45 S2: ↓↓#Mm: (1.5) >ere inte att< eller
is it not that or
46 (1.2)
47 A: Kommer ni ihåg när vi tittad på reaktionshastigheter, hur vare me koncentration i
*Do you remember when we looked at **reaction** rates, what was it with **concentration** and*
48 reaktionshastigheter
reaction rates
49 S1: De e ju samma hela tiden.
They are the same all the time.
50 S2: #M[m
51 A: [<Nej> s- vi sa ju att koncentrationerna- vi tittade ju på va är re som <gynnar>
No s- we said that the concentrations- we looked at what is it that favours
52 e:::h kollisioner [#å reaktioner va sa vi om koncentrationer rå=
collisions and reactions what did we say of concentrations then
53 S2: [Mm ja
Mm hmm yes
54 S1: =°hmm°=
55 A: =Vi under[sökte de.
We examined it.
56 S2: [(jö) ju högre koncentration desto mer gynnsamma kollisioner.
the the higher the concentration the more favourable collisions.
57 A: Ju högre koncentration desto mer gynnsamma e:::h kollisioner desto högre
*The higher the concentration the more **favourable** collisions the higher the*
58 reaktions[hastighe[t.
***reaction** rate.*
59 S2: [ja
yes
60 S1: [°mm°

Anna 5, 03:42–04:17
61 A: Å ((indicates with hand at the chemical equation on the whiteboard)) i de fallet så
And in that case one
62 kan man ju säga att om du minskar då e::h tiocyanatjonerna som ni konstaterar för
*can then **say** that if you **lessen** then the thiocyanate ions that you **ascertain** because*
63 att ni ((picks away something invisible from instruction)) tar bort dom [ur=
*you take them **away** from*
64 S2: [Ja
Yes
65 =lösningen. Då kommer ju reaktionshastighet:en ((indicating from left to right on
*the solution. Then the **reaction** rate will*
66 A: the chemical equation on the board))
67 (0.8)
68 S2: Saktas ned.

Be slowed down.

69 A: Ja. Åt ((indicating from left to right on the chemical equation on the board)) alltså
Yes. ***To*** *then*
70 åt e::h höger.=
to ehm the right.
71 S2: =Ja å då ere (vart) lika. [Ja (de är)
Yes and then it is the same. *Yes they are*

Cb: Teacher explanation/clarification

72 A: [Å då ere ju helt plötsligt ((indicating from right to left
And then it is all of a sudden
73 on the chemical equation on the board)) den andra reaktionen som e kvar i sina
the ***other*** *reaction that is* ***left*** *in its*
74 [eh
ehm
75 S2: [a:::h
ah
76 S1: [((leans back and looks away from the conversation towards the board, 76-82))
77 A: Är du #m::e=
Are you with me
78 S2: =ja nu fattar ja=
Yes now I understand
79 A: =j:a, vilket innebär att o:: då kommer den tillfälligt åtm[instone .h vara lite=
Yes which means that oh then it will ***temporarily*** *at least be a little*
80 S2: [ja
yes
81 A: =snabbare tills dom ((hands, palms down, moving towards each other on a vertical
faster ***until*** *they*
82 line and stopping)) saktar in igen.
slow down again.
83 S2: (okej ja)
okay yes

Ca: Teacher-student sensemaking

Anna 5, 04:17–04:32

84 A: Å va får ru för effekt ((indicating with hand towards chemical equation, then from
And what kind of effect do you get
85 right to left)) om den andra då är lite snabbare [om den åt e-hö-=
if the ***other*** *one is a little* ***faster*** *if the one to the ri-*
86 S1: [((fiddles with protective=
87 =glasses, lines 82-90))
88 A: =vänster ((indicating with hand to the left across the chemical equation)) är lite
left *is a little*
89 snabbare än den åt höger ((indicating with hand to the right across the chemical
faster *than the one to the* ***right***
90 equation)) vad borde hända med färgen,
what should happen with the ***colour****,*
91 S2: Den borde gå tillbaks ((indicating with hand to the left across the chemical
It should go back
92 equation)) till de som va.
to what it was.
93 A: Precis, den borde ju bli mindre ((indicating with hand to the left across the chemical
Precisely*, it should of course become less*
94 equation)) röd.
red.

Anna 5, 04:32-04:56

95 S1: [((looks away from conversation towards whiteboard again))
96 [(1.6)
97 A: ((bending forward, smiling to S1)) ↓hö:h:
98 S1: J::a lång [↑lång ↑förkla- lång förklar:ing (0.9) ↓.tch-mkej.
Yes long long explan- long explanation okay.
99 S2: [hehöh heh heh
100 (0.4)

D: Closing of conversation (by teacher)

101 A: Vi kommer säga re me enklare ord men nu [just nu vill] ja ju bara att ni=
We will say it with simpler ***words*** *but now right now I just want you to*
102 S1: [mm heheh]
mm hmm ((laughs))
103 A: =<pratar> kring va va hur kan man resonera sig fram till det på[ett] logiskt=
talk *about what what how you can* ***reason*** *it out in a logical*
104 S2: [mm]
mm hmm
105 A: =resonemang,
reasoning,
106 S1: Ja
Yes
107 A: Å ni e inne på rätt spår [så]ja hjälper er lite på traven
And you are ***on*** *the right track so I am helping you a little along the way*
108 S1: [#ja]
yes
109 (0.7)
110 S2: #heh
111 (0.5)
112 A: ((smiling, to S1)) [[Du får liksom smälta re.
You have to kind of digest it.
113 S1: [[ehehehe[heheheheheh
114 S2: [.hhh heh
115 S1: Okej (0.3) silverjonen ((the teacher goes away, no more sound))
Okay the silver ion

Appendix D

This appendix provides an extended analysis of the excerpts used in the article.

1. Cecilia's conversation with S4

Cecilia 4, 02:26–02:57

1	S4:	Cecilia? Som förklaring ( ) ska vi utveckla lite mer, skriva formeln och sånt?
		Cecilia? As explanation shall we elaborate a bit more, write the formula and such?
2	C:	Ja, varför har du en ökad- varför ökar den ((points to the chemical equation in the
		Yes, why do you have an increased- why does that increase
3		instruction)) när du tillsätter den ((points again))?
		when you add that?
4	(7.0)	((S4 looks at the chemical equation on the whiteboard))
5	S4:	Men alltså det, det finns mer järn och krocka med tiocyanatjon så det eh
		But like there, there is more iron to collide with thiocyanate ion so it ehm
6		reaktionen åt det hållet ((indicating from left to right in terms of the chemical
		the reaction in that direction
7		equation)) blir liksom större.
		becomes kind of larger.

Student S4 initiates the conversation through a question about what to write on his lab sheet (Line 1). Cecilia responds by using the chemical equation as a reference (Lines 2–3) to connect back to a student's previous experience with solutions during the practical lesson. The student accepts this reference point by incorporating it into the conversation, changes focus to the whiteboard chemical equation, and then uses it as a link to theory in Lines 4–7, displaying the double nature of its communicative utility – that is, as both an experiential and a conceptual referent in *linking experience to theory* (Grosholtz and Hoffmann, 2000). The long pause produced in Line 4 is likely due to a knowledge gap being discovered and overcome by the student as he looks at the chemical equation and, seemingly, uses it to think before continuing with sensemaking in his own words.

2. Erik's conversation with S6 and S7

The students have initiated the conversation through expressing a confusion about the species interacting as they have observed a colour change due to a change in temperature.

Erik 2, 02:53–03:25

1	E:	=Yeah, so what what kind of reaction did you have
2	(2.5)	
3	E:	What happened when you did ((points to instruction)) <u>that</u> reaction?
4	S6:	Changed to one colour and then it changed back ((smiles))
5	S7:	.hhhh [((looks up))
6	E:	[heh yeaheh
7	S7:	.hheh=
8	S6:	=I don't know what that means
9	(4.0)	
10	E:	Look, so ((points to instruction)) here we're saying we're having the <u>for</u>ward reaction=
11	S6:	=yeah
12	E:	So you're meaning that it started with that one ((points to instruction)) and ended up

13 there ((points to instruction))=
14 S6: =yeah=
15 S7: =Mm hmm
16 E: (But) what happened there ((slides finger from right to left across the instruction))
17 (1.2)
18 S7: It went back t-
19 E: Yeah.

Erik responds to the students' request for help by asking them to express sensemaking in their own words (Lines 1 and 3), which S6 does in response to Erik's second attempt (Line 4), although she humorously acknowledges that she finds the sensemaking challenging through smiling, which is likely an attempt at using humour to save face (see Kangasharju and Nikko, 2009). By responding through laughter, Erik is likely participating in this remedial work in Line 6. Then, in response to S6's display of ignorance in Line 8, and possibly after considering how to formulate himself in response to her sensemaking (pause, Line 9), Erik connects the chemical equation (as a reaction) to the students' observation on Line 3 (*connecting observation to theory*). He then uses it to illustrate the equilibrium shift on Lines 10, 12–13 and 16 through pointing and indicating the direction of the shift. Note that Erik first uses inclusive pronouns (referring to a joint community of practice; see Bills, 2000) and reformulates the students' statement of not knowing into a statement of knowing (Lines 10–13), which S6 confirms in both cases (Lines 11 and 14). Erik then uses the chemical equation and a gesture to hint about the direction of the shift at the same time as asking the question of 'what happened' in Line 16. Thereby, the students are invited to participate in his explanation of events, and also to remain competent contributors in the interaction.

3. Lars' conversation with S10

Lars 2, 16:50–17:15

1 S10: Ökar reaktionen. Ja och om K ökar så skjuts det åt höger. ((faces chemical equation
The reaction increases. Yes and if K increases then it shifts to the right.
2 on the whiteboard, hand indicates to the right))=
3 L: =°Mm°
4 (1.2)
5 S10: (Ökar[det åt)
Does it increase to
6 L: [N e j ((looks at chemical equation on the whiteboard))
No
7 S10: >går re inte åt<vänster om K ö[kar ((indicates to the left))
*Doesn't it go to the **left** if K increases*
8 L: [°Mm° den blir ju mer ofärgad .hhh=
Mm hmm it becomes more transparent
9 S10: =>Varför det< (när) man skjuter åt väns- ju högre K är, desto mer r[ea-
*Why is that when one **shifts** to the **lef-** the higher K is, the more rea-*
10 L: [Men
But
11 frågan e, frågan e ändrar du K vad du gör är ju att du ändrar
the question is, the question is do you change K what you do is that you change
12 koncentrationskvoten.
the reaction quotient.
13 (0.9)

14 S10: Aa:
Ah

15 L1: Mm
Mm hmm

In the above excerpt, S11's incorrect utterance in Line 1 is followed in Lines 3–4 by a hesitant 'mm' by the teacher as well as a pause (indicating a dispreferred response; see Pomerantz, 1984), which invites the student to modify his statement (withheld evaluation; see Gardner, 2012). In Line 5, S10 then gives a modified answer, again incorrect, to which Lars responds with a direct correction ('Nej' *[No]*), whereby the student expresses confusion in Line 7. The overlapping speech in Lines 7–8 and 9–10 shows fast responses in the explanation (*observation* in Line 8 is *connected to theory* in Lines 10-11, and to the *alternative concept* of change in reaction quotient, Line 12) given by the teacher. Hence, there are no pauses (or further tension) between the turns of the dialogue. In Line 8, Lars responds to the correct aspect of the student statement in Line 7 (the reaction 'goes to the left'), agreeing that the solution will become more transparent (partial, or weak agreement; see Pomerantz, 1984), which prompts S10 to express his knowledge gap openly in his own words in Line 9 (not connecting the proposed observation with his assumption that K, a constant not changeable under the conditions of this experiment, has changed). In response to Lars' connection to the *alternative concept* in Lines 10-12, S10 appears to think (pause, Line 13) and then signals understanding ('Aa' *[Aah]*) in Line 14. Generally, confirming and accepting assessments of the other's statements are shown through turns of talk with no delay (Pomerantz and Heritage, 2012), which can be clearly seen is this sequence. Therefore, it is reasonable to assume that, after being forced to directly correct his student, the teacher minimised further negative assessments of the student's knowledge gap in the interaction.

4. Cecilia's conversation with S11

Cecilia 3, 29:57–31:12

1 C: ((Cecilia points at whiteboard)) Det var ju den <järntiocyanatjonen>, va Det är <u>den</u>
It was the iron thiocyanate ion, right It's ***that one***

2 som är mörkröd.
that's dark red.

3 S11: Ah, så den ökades
Ah, so that increased

4 C: Varför gör den de?
Why does it do that?

5 S11: Därför att e:h mer lösa joner i den antar jag
Because of ehm more loose ions in it I suppose

6 C: Mer lösa vadå för nåt?
More loose what?

7 S11: Järnjoner.
Iron ions.

8 C: Å då:: blir- bildas det mer
And then it becomes- more are formed

9 S11: Ja. ((nods))
Yes

10 C: Varför rå?
Why is that?

11 S11: Varför rå den e ((shakes head a little)) alkan, och den är ((shakes head a little)) mer
Why is that it is alkane, and it is more
12 reaktiv än ((sniffs)) tiocyanatjonen, ((shrugs)) >jag vet inte<
reactive than the thiocyanate ion I don't know
13 C: Ah, okej. Näeh, tiocyanatjonen ((looks at whiteboard, Lines 13-14)) måste väl också
Ah, okay. No, the thiocyanate ion must also be
14 vara reaktiv, annars hade re ju aldrig bildats järntiocyanat, eller?
reactive right, otherwise iron thiocyanate would not have been formed, would it?
15 S11: ((looks at whiteboard)) ↓Ja ↓vete ↓fan, men sen fyran iallafall
Yeah hell if I know, but then four anyways
16 C: a:h=
uh-huh
17 S11: =då ser man klart å tydligt att det bildas e- silver, silver[fällning
then you see clearly and plainly that it forms silver, a silver precipitate
18 C: [S::ilverfällning bildas det väl
Surely a silver precipitate is not
19 inte [((shakes microplate))
formed
20 S11: =Sil-[Jo
Sil- Yes
21 C: Det blir väl inte metall? ((hands over microplate))
Surely it doesn't become a metal?
22 (0.7) ((S11 inspects microplate))
23 S11: Det ser man ju. Eller- okej, det blir en ((looks towards ceiling)) heterogen ((looks at
You can see it. Or- okay, it becomes a ***heterogenous***
24 Cecilia))
25 C: ((sniffs)) °Mm°
Mm hmm
26 S11: som syns [klart och tydligt
that is visible plain and clear
27 C: [mm ja, precis det bildas en fällning och vad består fällningen utav?
yes, precisely a precipitate is formed and what does the precipitate consist of?
28 S11: E:::h (1.0) äh du ((looks down))
ah well
29 C: Vad står det i pappret. ((looks over to their lab sheet, on a bench opposite the fume
What does it say in the sheet.
30 hood))
31 S11: Jag har inte läst pappret. ((S11 walks over to bench, S12 and Cecilia follow))
I haven't read the sheet.
32 C: Tch-°Nej°
No
33 (2.0) ((S11 picks up lab sheet))
34 S11: Det är ju det jag vill att ni förklarar, ni ska beskriva och förklara varför saker sker.
This is what I want you to explain, you should describe and explain why things happen.
35 S11: .hhh Ah oj, va st- här står ju allting
Ah ooh, what does- this says it all

In response to the S11's so far decontextualised reasoning, Cecilia explicitly points out the reaction being studied in Line 1, *connecting experience to theory*, possibly trying again to

prompt the student toward sensemaking that is more contextually relevant. However, S11 responds by talking about reactivity instead of chemical equilibrium (Lines 11–12), which Cecilia responds to with a correction, whereby S11 then changes the conversation topic to a different experiment (Line 15). Here, he proposes the precipitation of silver, which Cecilia again corrects (Lines 17-21). In response to S11's reformulation of the precipitate as heterogenous in Line 23, Cecilia sniffs and expresses a raised pitch 'mm-hm', indicating reluctancy with regard to S11's statement (Pomerantz, 1984), whereby S11 confirms his newly proposed sensemaking in Line 26 through connecting his proposed theory to his observations. Cecilia indicates a partial agreement through agreeing with that 'a precipitate has been formed' (weakened agreement; see Pomerantz, 1984), and then asks what the precipitate consists of (Line 27), whereby the student gives up ('äh du' *[ah well]*, Line 28). There is no tension management noted in this conversation; rather, Cecilia then asks the student what the instruction says (Lines 29-33), which he admits not having read (Line 31). In response to this, Cecilia confirms having noted that this is the case (Line 32), and then clarifies her expectations for what type of explanation she expects as an enactment of the context of the practical lesson ('det är ju de jag vill att ni förklarar' *[It is after all that I want you to explain]*, Line 34). This is in line with sensemaking needing to proceed within a predefined context (Weick, 1995), in this case framed by the information given in the instruction. Executing a chemistry practical lesson without reading the instructions could be regarded as breaking the rules of engagement, or the frame within which sensemaking could take place (Persson, 2018; Odden and Russ, 2019a). According to Weick (1995, p. 51), the frame, or the structure of the context within which sensemaking takes place, is vital for how sensemaking proceeds as the context provides the cues from which sensemaking can arise. Hence, chastising the student and displaying his actions as less competent could be regarded as a corrective action to re-establish the social order (Persson, 2018, p. 71) and the context for sensemaking (Weick, 1995). With the context under threat, the creation of tension by the teacher would be required to enforce correction and the reestablishment of an environment supportive of sensemaking.