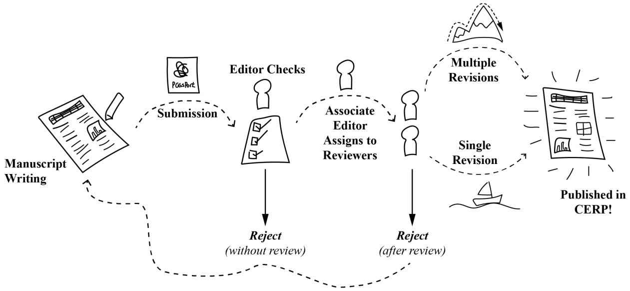
A Manuscript's Journey: writing, submission and publication in CERP!



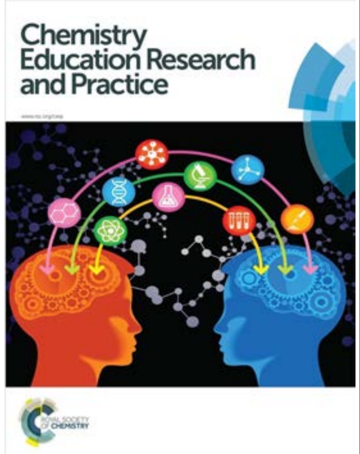
1

Our Journal!

Chemistry Education Research and Practice (CERP) is the journal for teachers, researchers and other practitioners at all levels of chemistry education. It is published free of charge, electronically, four times a year; coverage includes the following.

- *Research, and reviews of research, in chemistry education*
- *Evaluations of effective innovative practice in the teaching of chemistry*
- *In-depth analyses of issues of direct relevance to chemistry education*

Impact factor: 2.959*
Publishing frequency: 4 issues per year
Indexed in Scopus and Web of Science



2

CERP Editorial Team



Editor:
Prof Gwen Lawrie (University of Queensland)

Associate Editors:
A/Prof Nicole Graulich (Justus-Liebig Universität Gießen)
A/Prof Ajda Kahveci (Fort Hays State University)
A/Prof Scott Lewis (University of South Florida)
A/Prof James Nyachwaya (North Dakota State University)

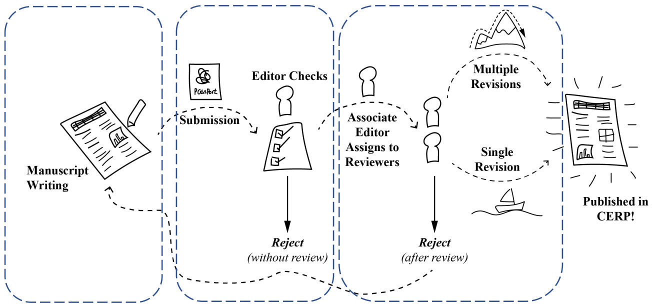

3

Today's workshop …

- First impressions & the review journey: A brief landscape view of the scope, aims, structure of articles sought for CERP and insights into the manuscript review process.
- What counts as a research article in CERP? We will share what the editorial team and reviewers look for in research and evaluative studies across different education contexts (secondary, tertiary, pre-service teacher development and outreach engagement).
- Writing a methodology & including ethical considerations: Participants will be guided in communicating their own research methods and statements of ethical considerations.
- Data display: a picture or table paints a thousand words! We will consider examples of how to convert lengthy written 'results' sections into a variety of representations that enable readers to better access and appraise research findings.
- Making '*Recommendations for Practice*' practical: tips on how to avoid generalized recommendations for practice that need revisions

4

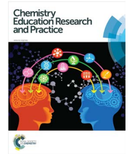
A manuscript's Journey … 3 stages



Seery, M. K., Kahveci, A., Lawrie, G. A., & Lewis, S. E. (2019). Evaluating articles submitted for publication in Chemistry Education Research and Practice. Chemistry Education Research and Practice, 20(2), 335-339.

5

CERP has three objectives …



1. Provide researchers a means to **publish high quality, fully peer reviewed, educational research reports** in the special domain of chemistry education. The studies must be:
   - *original and previously unpublished*
   - *theory based*
   - *supported by empirical data*
   - *of generalisable character.*

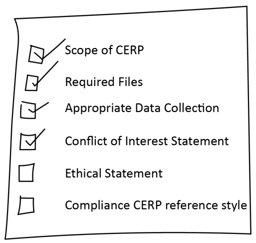
   Generalisable means that the studies **should have an interest for and an impact on the global practice of chemistry, and not be simply of a regional character**. Contributions must include a **review of the research literature relevant to the topic**, and state clearly the way(s) the study contributes to our knowledge base. Last but not least, they **should conclude with implications for other research and/or the practice of chemistry teaching.**
2. Offer practitioners (teachers of chemistry at all levels) a place where they can share **effective ideas and methods for the teaching and learning of chemistry**. Effectiveness is **the demonstration that the approach described is successful**. Contributions are particularly welcome if the subject matter can be applied widely and is concerned with encouraging active, independent or cooperative learning. Such contributions should be demonstrably based, wherever possible, on **established educational theory and results**.
3. Help to **bridge the gap between educational researchers and practitioners** by providing a single platform where both groups can publish high-quality papers with the realistic hope that researchers will find their results seen by those who could benefit from using them.

6

What is your teaching and/or research context (Poll)?

- Primary School Students
- High School Students
- Upper-Level Tertiary Chemistry Students
- General Chemistry (1st year) Tertiary Students
- Cognitive Science Research
- Teaching Assistant (Tutor) Training
- In-Service Teacher Professional Development
- Public Engagement & Outreach
- Pre-service Teacher Preparation

7



Article types frequently 'desk-rejected':

- Bench research … no mention of students or learning
- Collateral studies … learning in contexts where chemistry students happen to be
- New experiments or activities with no evidence of implementation
- Position papers with no link to teaching (e.g. defining chemistry concepts)
- Stand-alone studies with no reference to prior work
- Implementation of known practice in a new context but no new insights reported

8

Table 3 Typical structure for research article in CERP and guidance for what should be included in each section

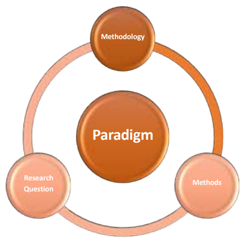
Section	Guidance for content
Abstract	Summary of article, research approach taken, data obtained, findings observed, headline conclusions.
Introduction	Overview of context of research, reporting work from broad domain to specific context. Overview of theoretical framework(s) and relationship to study. Research questions to identify clearly purpose of current research.
Methodology/methods	Justification of methodology in the context of theoretical framework(s). Methods used, with as much pertinent detail as possible. Confirmation of ethical approval, and additional considerations in conducting research within ethical guidelines.
Results	Data obtained. Data should be presented succinctly without omitting detail. Highlighted data to align with arguments in main text, with supplementary data added to Appendix as necessary.
Discussion	Discussion of data obtained considering overview context and theoretical framework. Explicit answering of research questions posed in introduction. Limitations of work.
Implications	Implications for research – how does this work add to the field. Implications for practice – what can practitioners take from this work. If teaching materials or other outputs are available to share, include them in the Appendix.
Conclusions	Report of main findings from work and what is now known as a result of this work.
Appendix	Materials supplementary to the article that will be of use to readers.

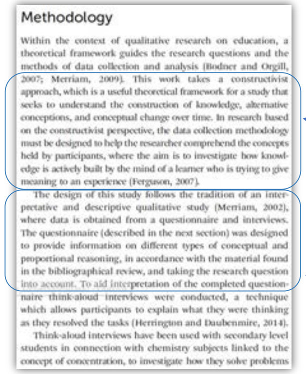
Seery, M. K., Kahveci, A., Lawrie, G. A., & Lewis, S. E. (2019). **Evaluating articles submitted for publication in Chemistry Education Research and Practice**. Chemistry Education Research and Practice, 20(2), 335-339.

9

Paradigms, methodologies, methods …

- Research paradigm: belief system or worldview that drives researchers in their choice of methods (Guba & Lincoln, 1994)
  - e.g. positivism, postpositivism, constructivism





Methodology

Within the context of qualitative research on education, a theoretical framework guides the research questions and the methods of data collection and analysis (Bodner and Orgill, 2007; Merriam, 2009). This work takes a constructivist approach, which is a useful theoretical framework for a study that seeks to understand the construction of knowledge, alternative conceptions, and conceptual change over time. In research based on the constructivist perspective, the data collection methodology must be designed to help the researcher comprehend the concepts held by participants, where the aim is to investigate how knowledge is actively built by the mind of a learner who is trying to give meaning to an experience (Ferguson, 2007).

The design of this study follows the tradition of an interpretative and descriptive qualitative study (Merriam, 2002), where data is obtained from a questionnaire and interviews. The questionnaire (described in the next section) was designed to provide information on different types of conceptual and proportional reasoning, in accordance with the material found in the bibliographical review, and taking the research question into account. To aid interpretation of the completed questionnaire think-aloud interviews were conducted, a technique which allows participants to explain what they were thinking as they resolved the tasks (Herrington and Daubenmire, 2014).

Think-aloud interviews have been used with secondary level students in connection with chemistry subjects linked to the concept of concentration, to investigate how they solve problems

The research paradigm and the following methodology-methods need to be well-described.

Guba, Y.G. & Lincoln, Y.S. (1994). Competing paradigms in qualitative research. In N.K. Denzin & Y.S. Lincoln (Eds.), Handbook of Qualitative Research (pp. 105-117). Thousand Oaks, CA: Sage.
Raviolo, A., Farré, A.S., Schroh, N.T. (2021). Students' understanding of molar concentration. Chemistry Education Research and Practice, 22, 486-497.

10

Writing a methods/ology … where to start? (4 squares activity)

'My research methodology (following the … paradigm) is…. The types of data that I collected are…'

'The participants of my study include …'

'I collected the data by (*process*)…'

'My data analysis is informed by the *known* method of …'

11

Ethical Statements:

Ethical practice involves a human subject's right to autonomy and the ability to make an independent decision, without coercion, involving informed consent and privacy

Does your study have approval from your institutional human research ethics committee?

Yes → A statement confirming either IRB or HREC approval with details of how participants were recruited (informed consent and their ability to opt out of the study at any time).

No → Do you have a waiver, exemption or local procedures in place?

- Yes → A statement of waiver, exemption, gatekeeper's consent and how participants were recruited involving informed consent (confirming their ability to opt out of the study at any time).
- No → Include a brief statement outlining the consideration of the question of any possibility of physical or psychological harm coming to the participants as a result of the study, along with an explanation of the ethical safeguards that were in place

Lawrie, G. A., Graulich, N., Kahveci, A., & Lewis, S. E. (2021). Ethical statements: a refresher of the minimum requirements for publication of chemistry education research and practice articles. Chemistry Education Research and Practice, 22(2), 234-236.

12

Ethical statement example from a study that is not required to have an official IRB approval:

Participants

The participants were 27 students from grade 10–11 (age 16–17 years) from several Dutch secondary schools from different areas in the Netherlands. The group consisted of 12 girls and 15 boys. We selected this group of students, because in the Dutch chemistry curriculum, sustainability and polymer chemistry are taught in the 10th and 11th grade. The students came from three educational levels. The students were approached by their own teacher who knew about the research through the network of the researcher. The students volunteered after they were told that the activity was about a sustainability issue and they were aware that the activity had data collection as a purpose. They were told that their opinion and knowledge were of interest and that there were no wrong answers. The study was conducted in compliance with the faculty's ethical standards. All the participants gave their informed consent, following the considerations advocated by Taber (2014). The average score of the students on chemistry

If local procedures are followed, this should be clearly explained.

de Waard, E.F., Prins, G.T. & van Joolingen, W.R. (2020). Pre-university students' perceptions about the life cycle of bioplastics and fossil-based plastics. Chemistry Education Research and Practice, 21, 908-921.

13

Example of a qualitative research methods (1) …

Ethical Statement and Recruitment

Participants

Participation in this research was voluntary and all students were informed of their rights prior to their involvement in the research. All data was obtained and handled in accordance with the Institutional Review Board. At the end of the first semester of OCLUE, all students were offered an additional homework credit if they wanted to complete an extra homework assignment or participate in an interview for a research project which was outlined to them in an email. Of the students who expressed their interest to be interviewed, nine students were subsequently invited to be interviewed following a random selection of three students from high, mid and lower performing groups from the OCLUE midterm exams respectively. The

Clearly stating how participants were recruited

Coding approaches

The principal researcher transcribed the interviews and analyzed the data in accordance with the *procedures and canons of constructivist grounded theory research* set out by Charmaz (2014). An open coding process *identified a series of codes which served to categorically break down the data*. These codes included students' perceptions of the structure of scientific knowledge, developing scientific knowledge, learning science at university and learning in OCLUE. A process of focused coding then took place. Here, the coding process *moved from identifying codes to generating abstract themes which were deemed to be more reflective of the actual experiences and perceptions of the students within each code* (Charmaz, 1996, 2000, 2014).

Foundation for data analysis

Stating the steps of coding data

Flaherty, A. A. (2020). Investigating perceptions of the structure and development of scientific knowledge in the context of a transformed organic chemistry lecture course. Chemistry Education Research and Practice, 21(2), 570-581.

For further info:
Charmaz, K. (2006). Constructing grounded theory: A practical guide through qualitative analysis. London: Sage Publications.
Saldana, J. (2016). The Coding Manual for Qualitative Researchers (3 ed.). Los Angeles: Sage Publishing.

14

Example of a qualitative research methods (2) …

Sampling

Sampling

Each interviewed student was a volunteer with a successful background in chemistry. Our intention, especially in the first part of the study, was to test for any weaknesses of a novel teaching model (Joki *et al.*, 2015). To this end, we designed our sampling to provide rich data, and we intentionally chose talented students with good grades in chemistry. Information for data set 1 was collected during May 2014, when the chemistry course had ended at the lower-secondary school. During the 2014–2015 school year, the students were invited back to their former lower-secondary school for follow-up interviews after finishing their first chemistry course at the upper-secondary level. The students were asked to identify their chemistry teachers in the first year of upper-secondary school, and these teachers were invited to be interviewed. Participation was strictly voluntary, and three of the five teachers accepted the invitation.

Pre-conditions (e.g. background, prior knowledge)

Grounded theory-based analysis of data and interpretation was completed iteratively by analyzing the different data in order to reach convergence. A sufficient number of excerpts from the transcribed interview data and the analysis are provided as examples so that reliability can be evaluated. The interviews were carried out and transcribed in Finnish, and the excerpts presented here have been translated into English. We selected three excerpts arbitrarily and these excerpts were back-translated into Finnish and compared with the original transcripts by a researcher not involved with this project, for trustworthiness of translation.

The validity of the research was increased by careful sampling. We consciously selected motivated and talented students for interview so that we could test our teaching model and perceive possible incoherence within it. With these students, we obtained very rich material. We carefully planned the interview questions and asked the more-open questions first, followed by more-specific questions. The interviewer (the first author) did not guide the students or teachers toward expected answers.

Data analysis and approaches for reliability

Establishing trustworthiness of translations

Decisions made in the process of sampling

Interview process

Joki, J., & Aksela, M. (2018). The challenges of learning and teaching chemical bonding at different school levels using electrostatic interactions instead of the octet rule as a teaching model. Chemistry Education Research and Practice, 19(3), 932-953

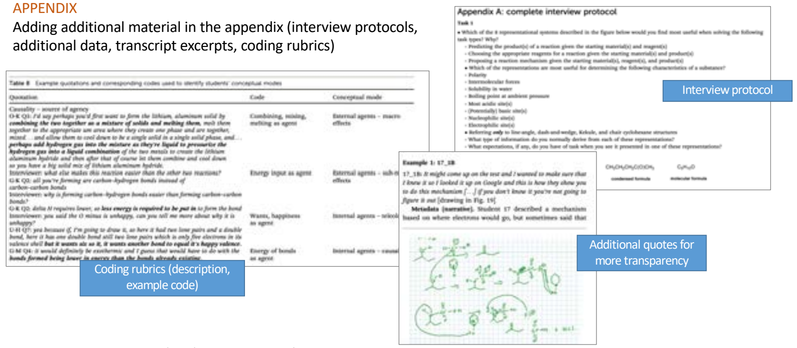
Information for establishing reliability: Watts, F. M., & Finkenstaedt-Quinn, S. A. (2021). The current state of methods for establishing reliability in qualitative chemistry education research articles. *Chemistry Education Research and Practice, 22*(3), 565-578.

15

Example of a qualitative research methods (3) …

APPENDIX

Adding additional material in the appendix (interview protocols, additional data, transcript excerpts, coding rubrics)



Weinrich, M. L., & Talanquer, V. (2015). Mapping students' conceptual modes when thinking about chemical reactions used to make a desired product. Chem. Educ. Res. Pract., 16, 561-577.
DeCocq, V., & Bhattacharyya, G. (2019). TMI (Too much information)! Effects of given information on organic chemistry students' approaches to solving mechanism tasks. Chemistry Education Research and Practice, 20(1).

16

An example of a quantitative research methods (1) …

This convenience sample of instructors were known to the authors and selected based on the size and type of course they taught. The recruitment sample consisted of students enrolled in undergraduate chemistry courses at two Northwestern universities, one Southwestern university, and one Midwestern university, selected through convenience sampling. To sample a range of student levels (*e.g.*, by major and year in degree), the selected courses included organic and general chemistry targeted toward science majors. A total of 855 organic and 1311 general chemistry students were recruited for participation in the study. Demographics collected included age, race/ethnicity, and gender. Students were offered a small amount of extra credit at the discretion of the instructor for participation in the surveys.

Descriptive statistics and response patterns. Student responses to time 1 and time 2 measures were examined between wording and course types. Descriptive statistics including mean, standard deviation, median, range, skew, and kurtosis were computed. Acceptable skew and kurtosis values were between −1 and 1 (Huck, 2012). All descriptive statistics were computed using the statistical software R (Version 3.4.4).

Reliability. Single-administration reliability is commonly reported using the statistic alpha. While this may be appropriate for certain types of data, omega is more appropriate to report when describing models with unequal item error variances and unequal factor loadings, known as congeneric models (Komperda *et al.*, 2018a, 2018b). All models within this study were evaluated as congeneric models and therefore omega was used to provide a reliability estimate. Omega, like alpha, requires that a scale is unidimensional, therefore it was only calculated for an individual scale if evidence of adequate one-factor CFA data-model fit was obtained. Omega values mirror alpha values in their range from 0 to 1 with higher values indicating higher reliability. When latent variables are included in SEM, it is recommended that their reliability estimates fall above 0.7 (Hancock and Mueller,

Think carefully about how you 'use' alpha

Hosbein, K. N., & Barbera, J. (2020). Development and evaluation of novel science and chemistry identity measures. Chemistry Education Research and Practice, 21(3), 852-877.

17

An example of a quantitative research methods (2) …

Instrument

Academic Motivation Scale-Chemistry (AMS-Chemistry) (Liu *et al.*, 2017) was used to measure student motivation toward taking an organic chemistry course in this study. Sample items for each scale are displayed in Table 1. Students responded to 28 possible reasons for being enrolled in the target chemistry course. A five-point Likert scale ranging from "1" (not at all) to "5" (exactly) was used to show the degree of agreement with each reason.

Exam 1 was used as the first achievement measure. Exam 4 was used as the second achievement measure. The two exams were out of 100 points. In addition, Final Exam (cumulative and out of 150 points) and Final Score (the final course grade in percentages) were used to examine if motivation is associated with students' overall academic achievement.

Data collection and participants

The AMS-Chemistry was administered as paper-and-pencil test in the target organic chemistry courses. The students were given 10 minutes during lecture to complete the survey. Students received a small amount of bonus points towards their final exam score for participating in the study; these points amount to less than 0.25% of the student's final course grade. We acknowledge that such a reward system may amplify

Table 1 Sample items of AMS-chemistry

Subscales	Sample item
Amotivation	I don't know; I can't understand what I am doing taking chemistry courses.
External regulation	Because without having taking chemistry I would not find a high-paying job later on.
Introjected regulation	To prove to myself that I am capable of succeeding in chemistry.
Identified regulation	Because taking chemistry will enable me to enter a job market in a field that I like.
To experience	For the enjoyment I experience when I think about the world in terms of atoms and molecules.
To accomplish	For the satisfaction I feel when I work toward an understanding of chemistry.
To know	Because study chemistry allows me to continue to learn about many things that interest me.

Data analysis

Collected data for this study were analyzed using different statistical analyses. First, the scores of the AMS-Chemistry from Pre1, Post1, Pre2, and Post2 were analyzed to evaluate the internal structure validity of the instrument through confirmatory factor analysis (CFA) in Mplus 5.2. A Comparative Fit Index (CFI) greater than 0.90 is considered as an acceptable fit (Cheng and Chan, 2003). A Root Mean Square Error of Approximation (RMSEA) smaller than 0.08 is considered as a reasonable fit (Browne and Cudeck, 1992; MacCallum *et al.*, 1996). A standardized root mean squared residual (SRMR) smaller than 0.10 is considered as an acceptable fit to the data (Hu and Bentler, 1995). In summary, we used the following cut-off values as an evaluation of a reasonable model fit beyond the chi-square test statistic: RMSEA < 0.08, SRMR < 0.10, CFI > 0.90.

Liu, Y., Raker, J. R., & Lewis, J. E. (2018). Evaluating student motivation in organic chemistry courses: moving from a lecture-based to a flipped approach with peer-led team learning. Chemistry Education Research and Practice, 19(1), 251-264

18

An example of a quantitative research methods (3) …

(Yıldırım and Şimşek, 2013). As an example, these categories were explained by taking students responses into consideration to the question of "Think of a mother bear and her cub, how big do you think the amounts of their temperatures are? Which bear has the higher body temperature? Why?" For the Correct Understanding (CU) category, the students were expected to provide a scientifically correct answer to the question for their responses to fall in this category. For instance, responses such as "The mother bear's body heat is higher because she is bigger than her cub, and she has a thicker fat layer and skin" classified under the CC category. For the Partially Correct Understanding (PCU) category, the responses were scientifically correct answers but had some deficiencies. For instance, student responses such as "The mother bear's body heat is higher because her fat layer is more developed and she has more skin" were categorized under the PCU category. For the Understanding with Alternative Concepts (UAC) category, the responses were incorrect and contradicted with the scientific facts. For instance, responses such as "The bear cub's body heat is higher because it is a newborn and it is small" were put into the understanding with alternative concepts category. In other words, it was used to categorize incorrectly explained expressions.

The process for turning written responses into codes needs to be well described

Baydere, F.K. (2021) Effects of a context-based-approach with prediction-observation-explanation on conceptual understanding of the states of matter, heat and temperature. Chemistry Education Research and Practice, 22, 640-652.

19

An example of a quantitative research methods (4) …

Table 13 Predictors of visual model comprehension: results of multiple regression analyses

	OVC1		OVC2		OVC3	
	β	p	β	p	β	p
CCK	0.305	<0.001	0.442	<0.001	0.403	<0.001
VER	0.228	<0.001	0.220	<0.001	*0.120*	*0.054*
FIR	0.178	<0.001	0.208	<0.001	0.229	<0.001
SPA	0.132	<0.05	0.145	<0.05	0.166	<0.05
MAA	0.144	<0.05				
GEN	0.137	<0.05			0.184	<0.05
R^2	0.482	0.519	0.611			
N	250	230	131			

Note: OVC1–OVC3 = overall visual model comprehension at measuring points 1–3; CCK = chemistry-related content knowledge (overall score); VER = verbal reasoning; FIR = figural reasoning; SPA = spatial ability; GEN = gender; GPA = grade point average; MAA = mathematical ability.

Regression models can be described as theory testing or exploratory (theory building). Theory testing should have a theoretical justification for each independent variable

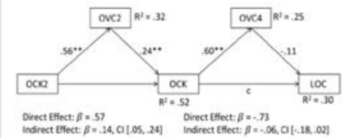


Fig. 3 Mediation analyses for the relation between chemistry-related content knowledge and lecture exam grades in introductory chemistry mediated by visual model comprehension (N = 131 & N = 86, ** $p < 0.001$, * $p < 0.05$). Note: OVC2–OVC3 = overall visual model comprehension at measuring points 2 and 3; OCK 2–3 = organic chemistry content knowledge at measuring points 2 and 3; LOC = lecture exam organic chemistry at measuring point 3.

Multiple related variables may be more clearly analyzed using structural equation models

Dickmann, T., Opfermann, M., Dammann, E., Lang, M., & Rumann, S. (2019) What you see is what you learn? The role of visual model comprehension for academic success in chemistry. Chemistry Education Research and Practice, 20, 804-820.

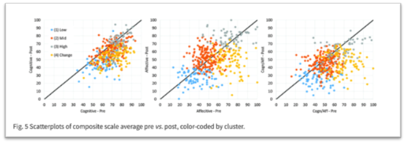
20

Data Display … A picture paints a thousand words!

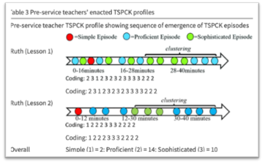
Table 6 Univariate analysis of main effect of pedagogical approach on seven motivation subscales of AMS-Chemistry

Dependent variables	$F(1,359)$	p	Partial η^2
Amotivation	11.735	0.001	0.032
External regulation	4.884	0.028	0.013
Introjected regulation	3.81	0.052	0.011
Identified regulation	0.06	0.806	<0.001
To experience	3.195	0.075	0.009
To accomplish	0.564	0.453	0.002
To know	0.085	0.771	<0.001

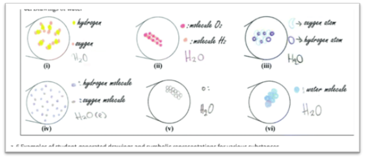
Tables enable comparison of data to find patterns
(Liu, Raker & Lewis, 2018)



Graphs reveal correlations between variables
(Galloway & Bretz, 2015)



Graphics organize information
(Akinyemi & Mavhunga, 2020)



Participant drawings support analysis
(Gkitzia, Salta & Tzougrakia, 2020)

… look through CERP articles for good examples like these!

21

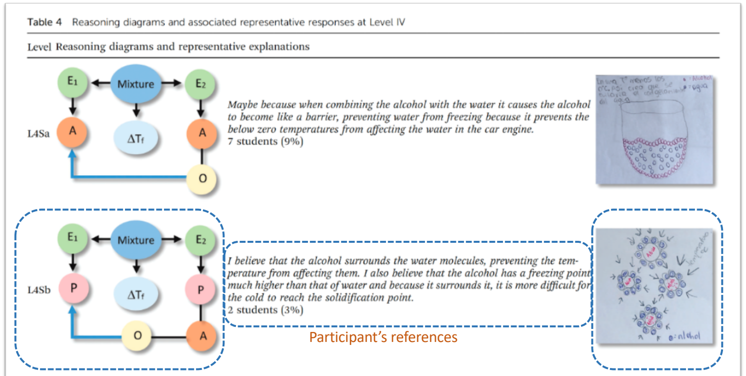
Providing examples of coded data … enables others to apply frameworks

Table 3. Open-ended response examples sorted into each group based on specified grouping criteria. The highlighted segments contain coded content referencing origins of chemistry intelligence. The colors are to differentiate between portions of text which met different criteria within the same response.

Mindset Group	Open-ended response	Grouping criteria met
Fixed	"I'm not sure. I think that people who are chemistry thinkers are a whole different breed of people. There are people who love chemistry and hate chemistry. There has to be some sort of predisposition toward the subject in order for the person to thrive at it and enjoy it at the same time. I think that chemistry intelligence is not as abstract as other intelligences, but more concrete and factual, as most sciences are."	• Some people have it and others do not • Natural inclination
Middle	"Chemistry intelligence is to be able to understand chemistry. Some people can understand more easily than others because it's a complex subject. However, with time, practice, and effort, anyone can increase their chemistry intelligence even if it's just a little. But it's different for everyone because it may take more	• Both growth and fixed statements together

Santos, D. L., Gallo, H. W., Barbera, J., & Mooring, S. R. (2021). Student perspectives on chemistry intelligence and their implications for measuring chemistry-specific mindset. *Chemistry Education Research and Practice*

22



Moreira, P., Marzabal, A., & Talanquer, V. (2019). Using a mechanistic framework to characterise chemistry students' reasoning in written explanations. *Chemistry Education Research and Practice*, *20*(1), 120-131.

23

General Q's

Statistical Analysis Q's

Mixed Methods Q's

Classroom Practice Q's

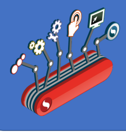
Qualitative Analysis Q's

'Ask an editor' … Breakout Rooms!

24

Tips on Making 'Recommendations for Practice' practical…

Avoid global 'hand-waving' statements such as 'The findings of this research are useful for all teachers of organic chemistry' and 'The findings can inform the development of new resources'.



Include specific examples of how your study's findings might be translated into pedagogical practice and/or translate into other contexts.

Refer to related published examples of practice to suggest how your work enables adaptation or extension supported by the evidence of effectiveness of the intervention.

Finally … recognize & acknowledge the limitations of your study, it helps readers!

25

ROYAL SOCIETY OF **CHEMISTRY**

Acknowledgements

- RSC Publishing teams for their endless support
- Paul MacLellan, our Managing Editor (RSC Education Publishing)
- RSC Education Division for sponsoring CERP to enable free access for readers
- Our Readers!
- CERP's Reviewers who maintain the quality of the articles we publish
- Our Authors for choosing to send their work to our journal

26