

Appendix 1

Coding Scheme for assessing PCA dimensions

Dimension	Indicators	Anchor examples
Real-life context		
Constructed	Relation between subject knowledge and a very strongly constructed real life context (rather does not correspond to the experiences of the learners, analogies to own experiences are hardly recognizable).	Anne is shopping with her father. In the stationery store, they buy 3 adventure books at €9 each and a box of crayons at €6. How much do they have to pay there? Sample task mathematics, source: own development
Authentic	Relation to real life context, although constructed, makes sense in the context of the task and thus appears authentic (applications of subject knowledge make sense in everyday life or professional life). A context is considered authentic when it is situated within the actual experiences and practices of the students in real life contexts.	5) <i>"My mother wraps cold drinks in a wool blanket to keep them cool in the hot car," Melanie says, and Niko laughs at her for it. What do you think?</i> Sample task physics, source: Pietrzyk Einblicke 7-9 Physik/Chemie - Rheinland-Pfalz 2009, p. 73
Real	Difference in the task between the world of life/school and students' own world of experience is close to zero. Students deal with a problem that actually has to be solved.	<i>You are standing loosely behind a shopping cart and you're only holding it very lightly (or not at all).</i> <i>a) Someone suddenly pushes the cart forward.</i> <i>b) The cart is quickly steered to the right around a shelf.</i> <i>Describe what you feel / what happens to your body</i> . Sample task physics, source: own development
Openness		
Work order	The task comprises an open work assignment and is characterized by the following indicators (at least 1 applicable indicator): - no operator - information about the problem/situation is presented without a clear work assignment. Source: based on Bohl et al. (2013)	Lea wants to have all the walls in her house painted. Sample task mathematics, source: own development
Solution	The task involves a divergent solution and is characterized by the following indicators (at least 1 applicable indicator): - Several solutions are conceivable/correct within the task. - The task description explicitly states that several solutions are conceivable/correct. Source: based on Bohl et al. (2013)	Kai bought juice and lemonade for his birthday party for €20. A bottle costs €1.20. He paid €1 for each bottle of lemonade. a) How many bottles did Kai buy of each type? b) Explain why the corresponding linear equation has only three meaningful solutions. Sample task mathematics, source: Koullen (2015). Mathematik real 9 – Differenzierende Ausgabe – Nordrhein-Westfalen (p. 10/8b). Cornelsen.

Solution path

Several solutions are conceivable/correct within the scope of the task. The task must contain an explicit reference to this.
Source: based on Bohl et al. (2013)

Solve the system of equations.
Choose a suitable method yourself.

a) $5(4x + 3y) + 7 = 42$
 $4(5x + 4y) - 15 = 17$
b) $10(x + y) = 77 - x - y$
 $2(5x - 1) + y = 2(10y + x)$
c) $3(x - 2) + y + 5 = -2$
 $4(x + 3) + 3(y - 1) = 11$
d) $5(x - 2y) + (y + 3) = 32$
 $-(y - 5) - (10 - x) = 0$
e) $4(x + 19) - 3(y - 1) = 0$
 $3(x - 3) - 3(y - 1) = 0$
f) $(x + 4)(y - 7) = xy - 56$
 $7x - 5y = 0$

Sample task mathematics, source: Maroska et al. (2017). Schnittpunkt Mathematik 9, differenzierende Ausgabe Nordrhein-Westfalen ab 2013 (p. 24). Ernst Klett.

Linguistic complexity

Linguistic complexity in terms of content is characterized by the following indicators (at least one applicable indicator):

- The order of sentences/phrases does not directly correspond to the cuts in the editing.
- The task contains information that is irrelevant to solving it.

Source: based on Jordan et al. (2006)

If Peter were five years younger, he would be twice as old as Paul was when he was six years younger, and if Peter were nine years older, he would be three times as old as Paul when he was four years younger.

Sample task mathematics, source: Jordan et al. (2006). Klassifikationsschema für Mathematikaufgaben: Dokumentation der Aufgabenkategorisierung im COACTIV-Projekt. Materialien aus der Bildungsforschung: vol. 81. Max-Planck-Institut für Bildungsforschung

Activating prior knowledge

Activation of prior knowledge is characterized by concrete clues based on the following characteristics (at least 1 applicable indicator):

- Prior knowledge from the everyday lives of 15-year-olds
- Prior knowledge from previous tasks

Source: Müller and Duit (2004)

Based on your prior knowledge, explain what you need to consider when it comes to interest rates and bank accounts.

Sample task mathematics, source: own development

Argumentation

Argumentation is characterized by the following indicators (at least 1 applicable indicator):

- Reproduction/application of routine arguments, e.g., sentences/procedures/derivations
- Giving simple mathematical explanations
- Argumentation using everyday knowledge
- Understanding/explaining/developing manageable multi-step arguments
- Describing/justifying solution methods
- Evaluating results in terms of their application contexts
- Explaining connections/orders/structures
- Using/explaining/developing complex arguments
- Evaluating different arguments
- Asking questions that are characteristic of mathematics
- Expressing well-founded mathematical conjectures
- Argumentative explanations, justifications, proofs of solutions
- Well-founded expression of conjectures

“If the resulting force on a body is zero, then it does not move.”
Comment on this statement.

Sample task physics, source: Mai and Torgau (2018). Universum Physik 9./10. Schuljahr. Gymnasium Sachsen-Anhalt Schülerbuch (p. 29). Cornelsen.

Source: KMK (2004a), Blum et al. (2010).

Possibility to deepen knowledge

The opportunity to explore the topic in greater depth is indicated by a specific reference based on the following characteristic:

- Request to independently explore the topic of the assignment in greater depth while completing the assignment, e.g. through independent research.

Source: Deci and Ryan (1993), Kassira and Rausch (2016)

Discussion/reflexion of solution paths

Communication (discussion/reflexion) within the class is characterized by the following indicator (specific reference needed) :

- Communicative interaction within the class, e.g., through discussion/ reflection within the class

Find out online about the use of the Pythagorean theorem in everyday life.

Sample task mathematics, source: own development

Physicists working in nuclear research are, on the one hand, developers of technologies for energy production and medical applications, but on the other hand, their work involves dealing with risks such as radiation and nuclear waste. Discuss this contradiction in class.

Sample task physics, source: own development

Activating metacognition

Metacognition is characterized by the following specific indicators (at least one applicable indicator):

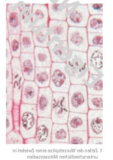
- Reflection on one's own learning goals
- Reflection on one's own learning habits
- Reflection on one's own information processing strategies
- Reflection on one's own problem-solving strategies

Source: Maier et al. (2010)

a) Compare your self-made preparation with image 1. Find similarities and differences and name them.

b) Search for possible errors in the experiment and interpret them.

Sample task biology, source: Günther et al. (2014). PRISMA Biologie 2 Differenzierende Ausgabe Nordrhein-Westfalen ab 2012 Schülerbuch mit Schüler-CD-ROM | Klasse 7-10 (p. 277). Klett.



Mathematics

Modelling

Mathematical modeling is characterized by the following indicators (at least 1 applicable indicator):

- Translation processes between “reality” and mathematics, e.g., mathematizing
 - Real-life situations/interpreting/validating mathematical results
 - Using/comparing/reflecting on/critically evaluating mathematical models, e.g., formulas/equations
 - Verifying model results
 - Developing complex mathematical models

Source: based on Jordan et al. (2006)

Intra-mathematical problem-solving

Internal mathematical problem solving is characterized by the following indicators (at least 1 applicable indicator):

- Design/implementation of a comprehensive solution strategy
- Making general statements about the task
- Critical reflection on the solution approach

Source: Jordan et al. (2006)

Science

Processing of documented experiment

The treatment of a phenomenon is characterized by the following two indicators:

- Handling/evaluation of an experiment documented in the task/in additional material
- The experiment described must be carried out as described

Source: Kühn (2010)

Mental development experiment

The conceptual development of an experiment is characterized by the following indicators:

- Conceptual development of an experiment based on theoretical preliminary considerations
- Explanation of the conceptual development in oral/written form
- The developed and documented experiment must be carried out as described

Source: Kühn (2010)

Processing demonstration experiment

The processing of a demonstration experiment is characterized by the following two indicators:

- Demonstration of the experiment by the teacher/task assignment

When a rubber ball falls to the ground, it bounces back up halfway. The ball is dropped from an 18-meter-high roof. What is the total distance traveled by the ball when it hits the ground for the third time?

Sample task mathematics, source: Jordan et al. (2006). Klassifikationsschema für Mathematikaufgaben: Dokumentation der Aufgabekategorisierung im COACTIV-Projekt. Materialien aus der Bildungsforschung: vol. 81. Max-Planck-Institut für Bildungsforschung

The symmetrical star shown here has the following properties: All sides and the lines AC and CE are of equal length. Describe how the figure is constructed.



Sample task mathematics, source: based on KMK (2004a). Bildungsstandards im Fach Mathematik für den Mittleren Schulabschluss: Beschluss vom 4.12.2003

The experiment sketch (Fig. 1) shows a beam of light hitting a prism and being deflected. The aim of the experiment is to find out how the angle of incidence of the light beam influences the refracted angle.

a) Describe how the experiment should be carried out to investigate the relationship between the angle of incidence and the refracted angle.

Sample task physics, source: own development

Plan an experiment to test the electrical conductivity of mineral water. Explain the results of the experiment.

Sample task chemistry, source: Bose et al. (2020). PRISMA Chemie Differenzierende Ausgabe A ab 2020 Schülerbuch | Klasse 7-10 (p. 37). Ernst Klett.

Functional diversity of proteins: You will be shown experiments for detecting proteins and a carbohydrate in aqueous solution. Prepare a protocol for this.

Sample task biology, source: Kultusministerium LSA (2004). Abituraufgaben Sachsen-Anhalt, Grundkurs

Conducting/editing student experiment

- Description/evaluation of the experiment by learners

Source: Kühn (2010)

The implementation of a student experiment is characterized by the following two indicators:

- Implementation of an experiment by learners
- Subsequent description/evaluation of the experiment by learners

Source: Kühn (2010)

2004-2, A 3.

Investigate the influence of temperature on the solubility of solids. - Add a spatula tip of ammonium chloride (XN) and potassium nitrate (O) to two test tubes, each containing 5 ml of distilled water. Close the test tubes with a stopper and shake them vigorously. Repeat the process until a sediment remains. Heat the solutions with the sediment in a water bath to 70 °C. Record your observations. Interpret the results of your observations. *Disposal:* Pour aqueous solutions into the waste water collection container.

Sample task chemistry, source: Arndt et al. (2017). Fokus Chemie – Neubearbeitung. Gymnasium Baden-Württemberg Gesamtband. Schülerbuch (p. 142). Cornelsen.

Appendix 2

Interrater Agreement of textbook tasks

Item	Mathematics Textbook tasks		Science Textbook tasks	
	%	GwetAC1	%	GwetAC1
Real life context				
Constructed	92.03	0.87	93.80	0.91
Authentic	92.03	0.88	86.78	0.80
Real	99.28	0.99	92.56	0.91
Openness				
Work order	97.10	0.97	94.21	0.94
Solution	89.13	0.87	89.26	0.85
Solution path	94.93	0.94	94.63	0.94
Lingusitic complexity	93.48	0.93	96.28	0.96
Activating prior knowledge	100	1	99.17	0.99
Argumentation	92.03	0.89	89.67	0.85
Possibility to deepen knowledge	99.28	0.99	97.11	0.97
Discussion/reflexion of solution paths	100	1	100	1
Activating metacognition	100	1	99.17	0.99
Mathematics				
Modelling	79.71	0.66	—	—
Intra-mathematical problem-solving	66.67	0.39	—	—
Science				
Processing of documented experiment	—	—	96.69	0.97
Mental development experiment	—	—	98.35	0.98
Processing demonstration experiment	—	—	100	1
Conducting/editing student experiment	—	—	89.26	0.85

Appendix 3

Interrater Agreement of classroom tasks

Item	Mathematics Classroom tasks		Science Classroom tasks	
	%	GwetAC1	%	GwetAC1
Real life context				
Constructed	92.32 - 93.59	0.88 - 0.90	94.47 - 95.33	0.92 - 0.94
Authentic	94.75 - 98.24	0.94 - 0.98	96.69 - 97.45	0.96 - 0.97
Real	98.38 - 99.48	0.98 - 0.99	96.39 - 98.50	0.96 - 0.98
Openness				
Work order	91.70 - 96.00	0.87 - 0.95	94.06 - 95.43	0.90 - 0.94
Solution	94.55 - 97.91	0.94 - 0.98	94.53 - 96.39	0.93 - 0.96
Solution path	98.31 - 100	0.98 - 1	97.24 - 99.58	0.97 - 1
Lingusitic complexity	94.34 - 97.26	0.94 - 0.97	95.54 - 97.78	0.95 - 0.98
Activating prior knowledge	97.98 - 98.49	0.98	95.12 - 96.39	0.95 - 0.96
Argumentation	93.90 - 96.97	0.93 - 0.97	95.67 - 97.66	0.95 - 0.97
Possibility to deepen knowledge	99.80 - 100	1	99.58 - 100	1
Discussion/reflexion of solution paths	97.98 - 100	0.98 - 1	97.45 - 100	0.97 - 1
Activating metacognition	99.35 - 100	0.99 - 1	99.64 - 99.79	1
Mathematics				
Modelling	94.06 - 97.55	0.92 - 0.97	—	—
Intra-mathematical problem-solving	94.61 - 99.19	0.94 - 0.99	—	—
Science				
Processing of documented experiment	—	—	97.06 - 100	0.97 - 1
Mental development experiment	—	—	99.34 - 100	0.99 - 1
Processing demonstration experiment	—	—	99.88 - 100	1
Conducting/editing student experiment	—	—	99.22 - 100	0.99 - 1

Appendix 4

Coefficients for Q3 statistic

Scale	Q3
Generic PCA in textbook tasks	0.161
Subject-specific PCA in mathematics textbook tasks	0.000
Subject-specific PCA in science textbook tasks	0.269
Generic and subject-specific PCA in mathematics textbook tasks	0.237
Generic and subject-specific PCA in science textbook tasks	0.157
Generic PCA in classroom tasks	0.233
Subject- specific PCA in mathematics classroom tasks	0.000
Subject-specific PCA in science classroom tasks	0.031
Generic and subject-specific PCA in mathematics textbook classroom	0.211
Generic and subject-specific PCA in science textbook classroom	0.237