PH Ludwigsburg
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Portfolio

dealing with linguistically diverse students in non-formal science education

examples of best practice

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Contents

THEORY: DEALING WITH LINGUISTICALLY DIVERSE STUDENTS

Importance of the language for science education

Language is a tool which we all constantly use in our everyday life. We use it to communicate and express our thoughts, wishes, ideas, and feelings. We use language to capture and express any kind of information or thoughts. This is also the case in every teaching and learning activity, which is why language is central to every learning process in which teaching takes place on a linguistic level most of the time. Practically all teaching and learning activities are taught through language, either in oral or in written form (Markic et al., 2013, p. 128).

Following the statement of Postman and Weingartner (1971), the knowledge is defined through language. Thus, language is the key factor for understanding of the subject in general and chemistry in particular. This is in a political educational discussion for already more than 20 years. Already TIMSS- and PISA-studies show the relevance of language in science education (Lynch, 2001). Starting from here, the discussion developed that every teacher is a language teacher as well (Childs et al., 2015, p. 429). Already in the early 1970ies Postman and Weingartner (1971) state that language is now increasingly seen as one of the central issues that support or hinder learning in general and in chemistry classes in particular. That shows very clearly that language skills and learning chemistry do interact.

That's why knowing the language of a subject (scientific language) is a necessary component for understanding it (Hodson & Hodson, 1998). However, the difficulty is that this "language is new to the students and the learning of scientific language can be understood as learning of a foreign language" (Markic et al., 2013, p. 131).

> "*The language of chemistry is rich, diverse, and complex, with roots in alchemy, everyday language, and phenomena. Teaching and learning chemistry is not just about learning the language, though it plays a key role, and learning the language, facts, and concepts of chemistry must go hand in hand. Just as in learning one's language, there should be a natural acquisition of chemical language on a need-to-know basis. [...] The main thing for the teacher is to recognize that the problem of language is bigger than just the [scientific] terms and symbols, and to be aware of the areas where students find difficulty. Language in teaching and learning chemistry, as in any subject, is crucial in thinking, visualization, and understanding.*" (Childs et al., 2015, p. 423)

Cassels and Johnstone (1984) for example, have shown that the level and number of scientific terms used in a teaching material affect students' understanding and their verbal reasoning skills. Furthermore, they showed that the maximum use of scientific terms in different teaching scenarios is found in the laboratory phases due to the naming of devices and the description of the observation during the experiment. Thus, the conduction of the expeiments during the lessons in pairs or groups enchance the complexity of studets communication (Markic et al., 2013, p. 134).

Besides, classroom diversity has a major impact on the use of language in chemistry teaching and learning. Examples of this diversity include mixed ability, second language learners, and students with special needs and disabled students (Childs et al., 2015, p. 437). In general, there was a transition from science as an elitist and specialized subject to 'science for all' in both secondary school and university. Thus, today it is almost always taught in a context of different language skills and great heterogeneity of abilities (Childs et al., 2015, p. 422).

According to an article by Laszlo (2013), teachers want their students to become familiar with the nanoworld, for example, by interpreting the data in terms of entities, such as molecules, that exist in this microcosm. To achieve this, they need to master chemical terminology. Therefore, it is the task of chemistry teachers to be language guides, interpreters, who teach their students to create well-formed chemical sentences and find ways to support them (Childs et al., 2015, p. 430).

In learning and teaching chemistry, some difficulties must be overcome. In the following, there will be presented some difficulties which are related to general communication, the learning of scientific language, as well as to different language levels of the "*chemish*" as defined by Markic and Childs (2016). The language, which is used in chemistry lessons will be called "chemish" hereinafter. This language is very different from the everyday language known to the students. Chemish is multifaceted in itself and has like every other language it´s own rules and special features, which poses special challenges for learners (Markic and Childs, 2016, p.435).

Students` Difficulties with Language in Science Education

One of the difficulties for students in the context of learning and teaching chemistry is chemical terminology. In chemistry, the scientific language used in comparison to everyday language is multi-layered and complex, with a high proportion of specific and unfamiliar terms, complex sentences, and multisyllabic words. The use of a symbolic and mathematical language as well as the use of diagrams and the representation of structures often causes comprehension problems. In addition to learning the scientific language, students must also acquire visual literacy. This is predominantly difficult because there is often a lack of practice in this specific use of language through reading, writing, speaking, and listening (Childs et al., 2015, pp. 430–432).

Beneath new, scientific, and unfamiliar vocabulary, following aspects of language concerning science teaching and learning can cause problems for the learners:

- Scientific "language (unique to each subject)
- Non-[scientific] words used with different meanings
- Command words used in examinations
- Logical connectives
- Scientific symbols
- Mathematical symbols and language" (Childs & Ryan, 2016, p. 44)

As mentioned, the words used in science classroom in general and chemistry classroom im particular are also used in students` everyday life. Comparable to other subjects it is unique in the richness, density, and frequency how words are used in chemistry classes. Studies show that the students in lower secondary schools learn more new words in chemcie classes comparting to a foreign language class (Childs et al., 2015, p. 431) A big problem according to the use of everyday language in the science context is the different meanings of a word even in everyday language. Such a word as 'mass' shows differences between everyday and physics (a large amount or even a religious service) (Childs et al., 2015, p. 432). For more examples see Markic et al. (2013).

It's almost the same with symbols used in chemistry e.g. for quantities like temperature. Confusing for the students is sometimes different subjects use different symbols for the same quantity. Thus, learning new scientific words isn't just linking words to symbols which are known from another subject. However, it can be seen as an advantage, that the symbols are the same in every language. Thus, students may be already familiar with the symbols in their native language before knowing the belonging word in the language of the country they now live in. (Childs & Ryan, 2016, p. 57)

It is to consider as well, that students are not in the same role as their teacher while they learn the scientific language. The teachers already have specific knowledge about the topics, which are discussed. Students haven´t that. Therefore it is necessary, that students do not only learn the vocabulary and their semantics. They also need to learn details about the phenomena and the theoretical concept behind it; the understanding of the phenomena. In many cases, students are overwhelmed by many new terms. They are busy copying the terms correctly so that they don´t have time to understand their meaning. They memorize only the terms (Markic et al., 2013, p. 134).

Besides learning the scientific language another issue is that a lot of students have to deal with problematic familial and social backgrounds. A problematic familial and social background can affect learning success in every subject. A lower level of language skills makes the learning of scientific language in chemistry lessons more difficult than it already is. This students have to learn the spoken language and the scientific language with all their rules at the same time (Markic et al., 2013, p. 137).

Many difficulties lie on the part of the teachers. According to Osborne (2002), only a few science teachers are aware of the role language plays in science education. It is therefore not surprising that most science teachers have the perception that the discourse in science is transparent and the language of science is clear (Childs et al., 2015, p. 429). The majority of language and science teachers have the opinion that learning science and learning language are two different points. But new studies showed that this is wrong. There is a close connection between language and scientific learning. In a lot of schools, we can see, that fact often is ignored. The teachers take a basic understanding of the spoken language in class for granted (Markic et al., 2013).

As 'experts', teachers do not longer recognize the difficulties lying in everyday language (e.g. non-scientific words or logical connectives) - since it is "normal English" but used in different ways or even having another meaning in the science context (Childs & Ryan, 2016, p. 49f.) - as well as in scientific language in science class. As long as the teachers are familiar with the scientific knowledge and the concepts behind the terms, they use them nonstop.

Students are less well prepared for the scientific language because most of them have no knowledge of Latin, still less of Greek and if they don't have it they can't derive any meaning from them. Teachers do often neglect or are unaware of other language issues, "such as non[-scientific] words, logical connectives, and command words in assessment, which also act as barriers to the understanding and mastery of chemical ideas. The barrier to learning presented by language is worse because it is largely unrecognized." (Childs et al., 2015, p. 441)

As language is a mediator in any learning process, the promotion of language skills is one of the goals of chemistry teaching, even in university. The more difficulties teacher students have in understanding the language of chemistry, the more difficulties they will have in using teaching and learning materials in their future chemistry lessons. However, learning "the language of chemistry is a necessary prerequisite to further learning and understanding chemistry, but also to allow accessing the community of chemists with their debates, journals or conferences, or to participate in societal debate on socio-scientific issues" (Markic et al., 2013, p. 128).

PLANNING CHEMISTRY LESSONS WITH RECOGNITION OF LINGUISTIC ISSUES

In the following, different language-sensitive tools for science teaching and learning can be found. Those and a few more are to be found in Markic et al. (2013) and Childs and Ryan (2016).**content first, language second.** From simple to complex: first, the students learn the fundamental concept in everyday language, then the scientific terms for the phenomenon are added (Childs & Ryan, 2016, p. 46).

- **introduce terms in different modes, importance of the visual**

  New terms can be introduced by phenomena, experiments, or pictures. Additionally, a new term should be presented in different representational forms, beginning at a low level of abstraction. Leisen (2005) identified five representational forms: (a) level of object, (b) pictorial level, (c) linguistic level, (d) symbolical level, and (e) mathematical level. The abstraction increases from representational form (a) to (e).

  Accompanying the representational forms, it is also important to develop visual literacy, i.e. the ability to interpret and make sense of pictures and diagrams and relate them to the scientific content. So the picture of the diagram may act as a peg to hang the word or concept on. (Childs & Ryan, 2016, p. 47)

- **the structure of words**

  Many words are polysyllabic, have suffixes, and prefixes. The students should be introduced to these parts of words and shown how to work out the meaning of large words from their parts. (Childs & Ryan, 2016, p. 56)

- **use activities, visual tools, and vocabulary/semantic tools for learning words and terms**

  E.g. concept map, domino/memory game, block-diagram, ...

- **use new terms at the right dose**

  Ask yourself: Are the new terms necessary? Do the students already know a synonym? How often will they be used in the following lessons? Do not use more than 10 new words in one lesson. (Markic et al., 2013, p. 140)

- **help to safeguard new terms and structures**

  Collect new terms during the lesson, using a method like a catalogue of words. Make sure students can spell new words correctly and know their meaning. (Markic et al., 2013, p. 138)

- **teach new terms by training**
  - ***word games***

    Hangman, crosswords, bingo, scrabble, etc. will make learning science fun for all students and reduce the risk of failing, especially for second language learners. (Childs & Ryan, 2016, p. 56)

  - ***talking about science***

    Students have to be given the opportunity to talk about things not only with the teacher but among each other to clarify and develop their thinking and understanding of scientific ideas/phenomena. Methods for more talking in science lessons can be Think-Pair-Share, discussion, projects, and so on. (Childs & Ryan, 2016, p. 59)

  - ***reading for understanding***

    E.g. by comprehension exercises or précis exercises. (Childs & Ryan, 2016, p. 59)

  - ***writing for learning and understanding***

    Writing can be one of the most difficult parts because maybe not all the letters are known or the students have poor writing skills in the (second) language and are not familiar with the writing rules. Motivate them to write (meaningful) texts. Writing can be supported with methods like catalogue of words, field of words, sentence puzzle, text puzzle, beginning of sentence, block-diagram, word rail, … (Childs & Ryan, 2016, pp. 60–62)

- **use language situation-oriented**

  For the teacher, it is very important to reflect on the own language use during lessons. You should use "school language", speak in full sentences, speak slowly, take breaks between sentences, limit the use of ironic statements, wordplay, and synonyms of scientific terms (quality instead of quantity). (Markic et al., 2013, p. 139)

- **address linguistic mistakes**

  It's important that the teacher notices mistakes and addresses them. The students may say or read the sentence again and maybe they will notice the mistake on their own or the teacher can repeat the sentence and follow it with the corrected one. So the students can analyze the mistake and reflect on it. (Markic et al., 2013, p. 139)

- **layout texts carefully**

  Less is more: short sentences, necessary amount of text only, structure through the use of paragraphs and subheadings, leave space for comments (Markic et al., 2013, p. 140)

- **introduce exercises carefully**

  For exercises, write short sentences (Subject – Verb – Object) and take care not to formulate more than one question within one exercise. (Markic et al., 2013, p. 139)

  - ***command words***

    The meaning of command words isn't always shared with the students, although it's obvious to the teacher. It is recommended that all teachers in a school should have a shared set of command words (that are consistent with the words used in state examinations). These should be explained to the student (with lower linguistic skills) and given an example. The command words should be used consistently in all tests and examinations (Childs & Ryan, 2016, p. 50f.)

METHODS FOR DEALING WITH LINGUISTICALLY DIVERSE STUDENTS

In the following chapter, some methods for dealing with linguistical diversity are presented and illustrated with examples. The methods are taken from Markic et al. (2013) and Leisen (2015).

Visual tools

Picture Story

Pictures are supported by speech bubbles (see Figure 1). It's possible to use a whole picture story or only parts of it with some pictures/speech balloons missing. Speech balloons can help to reduce linguistic difficulties by using everyday language. Since the method is short, concise, and taken from the student's life, it's very attractive to them. They can be allowed to use everyday language, simple sentences, and non-scientific words when filling in the balloons.

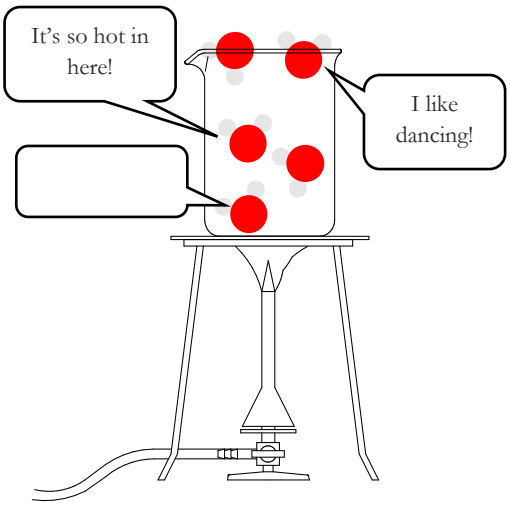

Figure 1: picture story for water molecules in the gaseous state

Sequence of pictures – text level

A sequence of pictures (Figure 2) is an order of pictures that shows a chronological action, a content-related correlation, or spatial set-up, analogous to a movie. The pictures must be clear and not to contain unnecessary details. The pictures help to verbalize e.g. an experimental procedure or prepare students for reading a text. For text production, it's possible to give conjunctions to support coherent text production. Also, other methods can be used to assist the students' understanding and language production if the students are not familiar with the scientific vocabulary/instruments yet (e.g. cloze, beginning of the sentence, field of words, …).

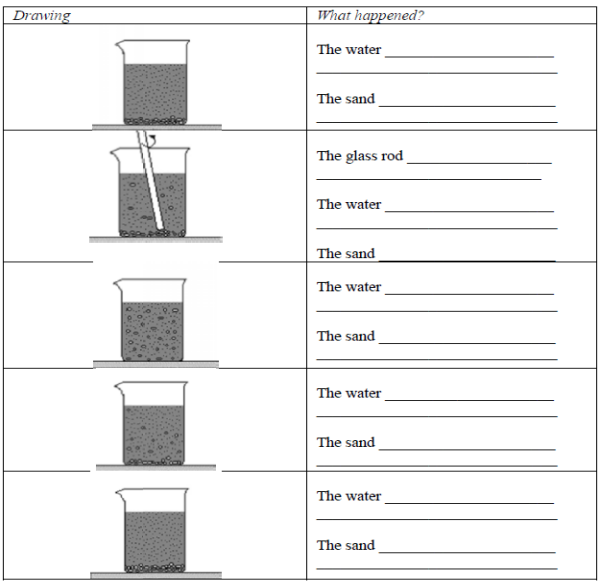

Figure 2: sequence of pictures about stirring a sand-water mixture (Markic et al., 2013, p. 141)

Variations of the method:

- Some of the steps are presented as text and they must sketch the missing picture, so the students change from one representational form to another.
- The sequence is cut into single pictures and the students must put it in the right order.
- During an experiment, the students can take pictures of every step and make a sequence of pictures on their own to help them describe the experiment afterward.

Visual association

Terms are better remembered when combining them with pictures, so-called visual agents. These visual agents can be a picture of the term that should be learned (1) or a picture of things from everyday life having one of the properties that are characteristic for the new term (2) as shown in Figure 3. This method is especially applicable for learning the names of instruments in the lower grades.

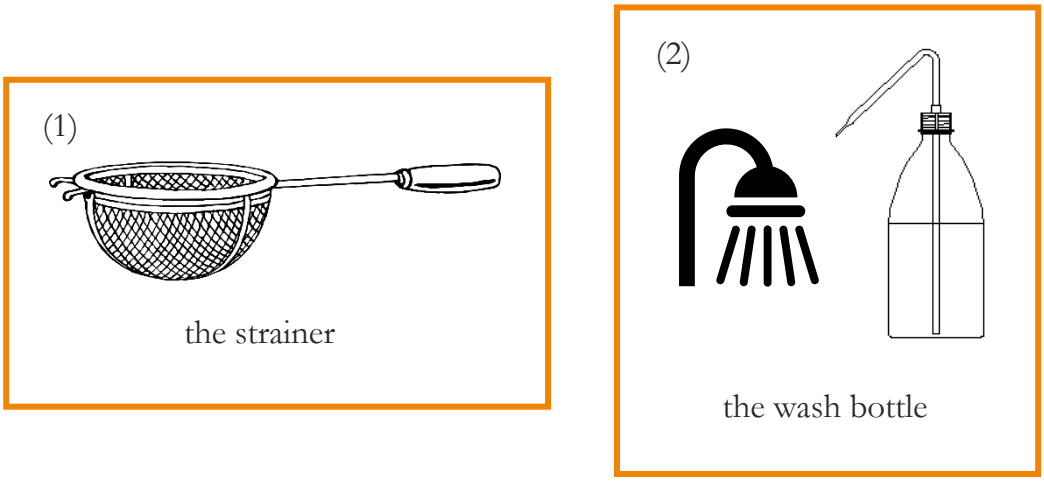

Figure 3: visual association with (1) the picture of it and (2) thing from everyday life with an equal property

Concept Map – sentence level

Concept maps are node-linked diagrams for structures actions and processes, similar to mind maps. In a concept map, the subject content is connected with belonging scientific language. At the same time, the content is reduced to the most important information. It's a visual method, the content is represented non-linear and networked. It can not only be used for the repetition of the content of the lessons but also for checking the pre-concepts of the students to a topic.

The map can be given to help the students write their own text about the specific content or to help them reading/analyzing a text. As a help, they could fist label the arrows with verbs and add adjectives. Therefore the words can already be given (see Figure 4).

Variations for students with lower linguistic skills:

- In a language with different definite articles: the article is written in front of the noun, if possible, the word is coloured (male = blue, female = red, neutral = green), e.g. die Raupe, der Schmetterling, das Hinterbein
- The conjugated form of verb is followed by its infinitive at the end, especially for compound verbs, e.g. schließt … auf (aufschließen).

Furthermore, the students can develop a concept map on their own. The process of constructing can develop literacy skills in two ways: (1) while organizing concepts and words one has to think about their spelling, meaning, and how to connect them; (2) when constructing concept maps in cooperative groups, practical language skills, e.g. pronunciation, are trained while debating about the right structure and how components are linked. A field of words or catalogue of words can be used to ensure all important words are included in the map.

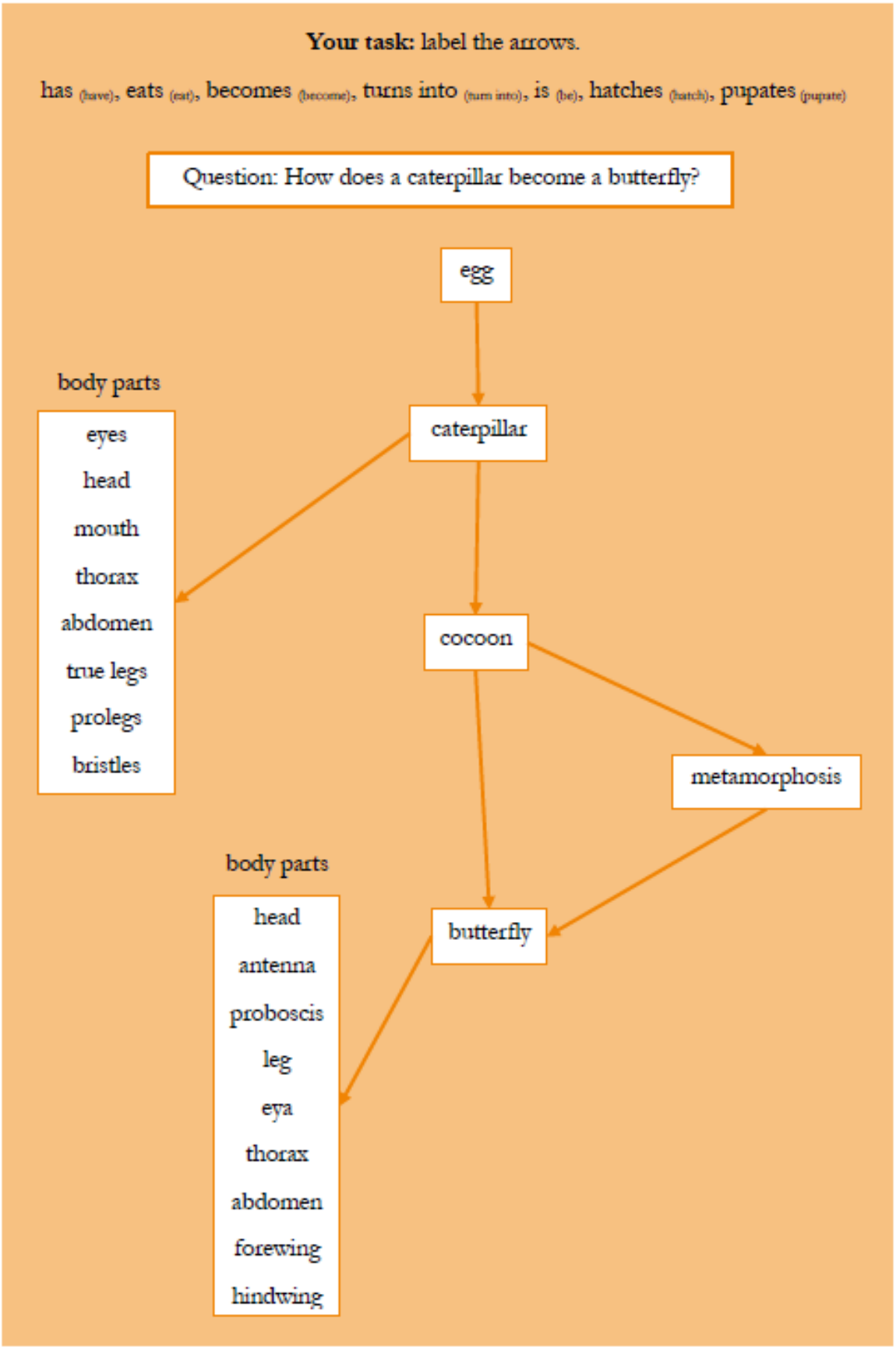

Figure 4: concept map about the development of a butterfly

Vocabulary and semantic tools

Catalogue of words – word level

All the important words and scientific terms that are mentioned in a certain lesson unit or part of it are listed in the catalogue of words. A catalogue of words can be developed step by step during the lesson. So, they already can be used by the students in the context. Internationalisms can help students to learn the new scientific terms and using synonyms should be avoided by using only the most common word.

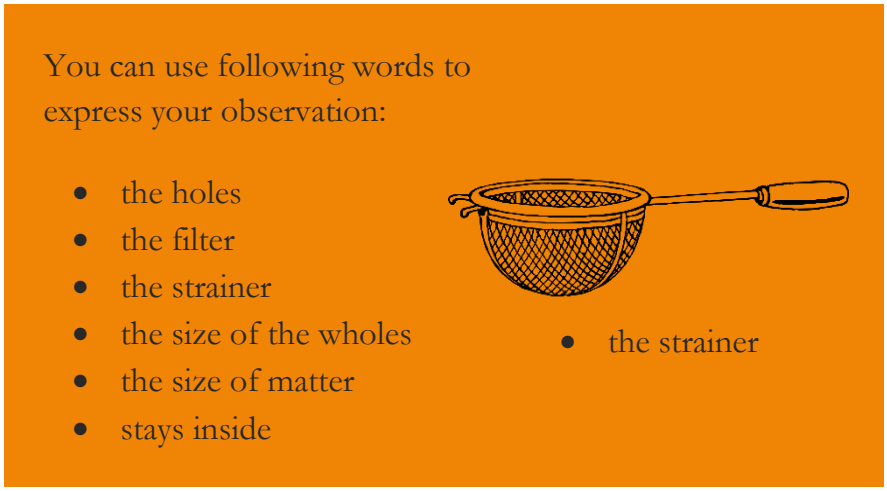

Figure 5: catalogue of words for separation methods (Markic et al., 2013, p. 146)

The catalogue of words can help students to write a piece of text on their own afterward. It serves as language support for scientific phenomena and connections. By the number of the words and the words themselves given, the direction and the content of the text can be influenced.

Variations for students with lower linguistic skills:

- The catalogue can be supplemented not only by explanation of the term/word but also by utilizing pictures as a visual association as shown in Figure 5.
- Substantives are specified with article and plural ending (e.g. the beaker, -s; -s Becherglas, ¨-er).
- Verbs are specified with infinitive and (irregular) past participle (e.g. buy, bought, bought; go, went, gone; start, started, started).
- Compound verbs are separated (e.g. auf/schließen – Ich *schließe* die Türe *auf*.).

Word-rail – word level

A word-rail is a basic structure with given words for writing a sentence/text, it gives the students clues as to the required content (Figure 6). It reduces linguistic complexity and the risk of linguistic errors but at the same time enables only very narrowly defined statements. By decreasing the number of words given, the level of freedom for writing increases. With strongly restricted degrees of freedom typical sentence structures can be practiced. A catalogue of words can be the pre-step of a word rail.

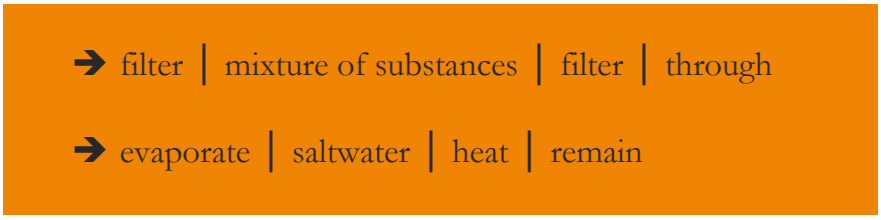

Figure 6: word-rail for separation methods

Variations for students with lower linguistic skills:

- A sketch, experimental set-up, picture, etc. supports the word-rail.
- Compound verbs are separated (e.g. ab/setzen – Der Sand *setzt* sich unten am Becherglas *ab*.).

Field of words – word level

A disordered arrangement of words or parts of sentences on one specific topic is called field of words (Figure 7). It's suitable for the repetition of the content and the scientific language, even for writing texts in a test. The disordered arrangement forces the students to read the words several times. This process strengthens the recognition.

A field of words can also be developed by the students., e.g. from writing scientific terms out a text. It can be combined with other methods, e.g. picture story, sequence of pictures.

Variations for students with lower linguistic skills:

- Compound verbs are separated (e.g. ab/setzen – Der Sand *setzt* sich unten am Becherglas *ab*.).
- Some words or even parts of the sentence can be connected or put in the right order.
- Substantives are specified with article and plural ending (e.g. the beaker, -s; -s Becherglas, ¨-er).

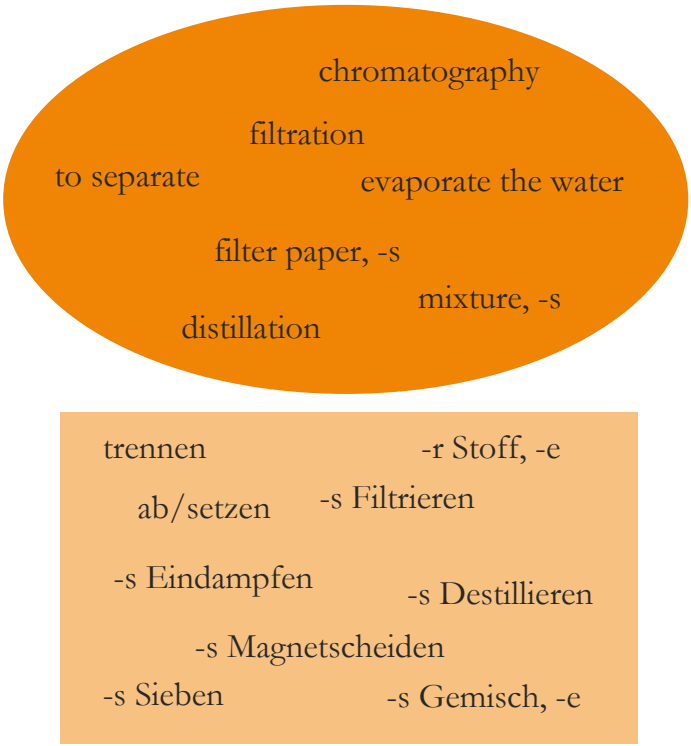

Figure 7: field of words (English) (Markic et al., 2013, p. 147) and German) for separation methods

Beginning of the sentence – sentence level

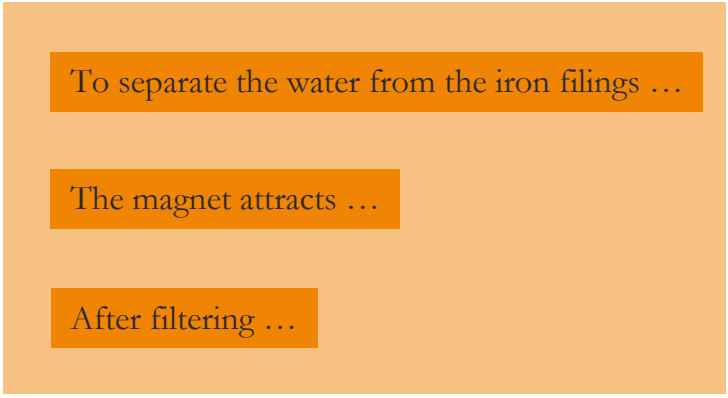

Figure 8: beginning of the sentence

For students, the most difficult part is usually starting the sentence. By providing them with the beginning of the sentences (Figure 8), it can help them to express their opinion and their knowledge. The beginning already is an indication of the expected content. For differentiation, the number of words given should depend on the students' level of linguistic competency.

Sentence puzzle – sentence level

In a disordered arrangement, words (Figure 9) are given. The students' task is to put the pieces together and to make a logical, scientifically, and linguistically correct sentence out of it. This method is suitable for repeating the content and grammar and building knowledge by using the correct syntax. The disordered arrangement forces the students to read the words of the sentences several times, which increases the retention rate and strengthens vocabulary. The difficulty can be increased by adding unnecessary pieces or by leaving pieces out.

Variations for students with lower linguistic skills:

- The same parts of the sentence should be the same color, e.g. verb = green, pronoun = red, ...
- Increasing the level: students color the pieces on their own before starting building the sentences.

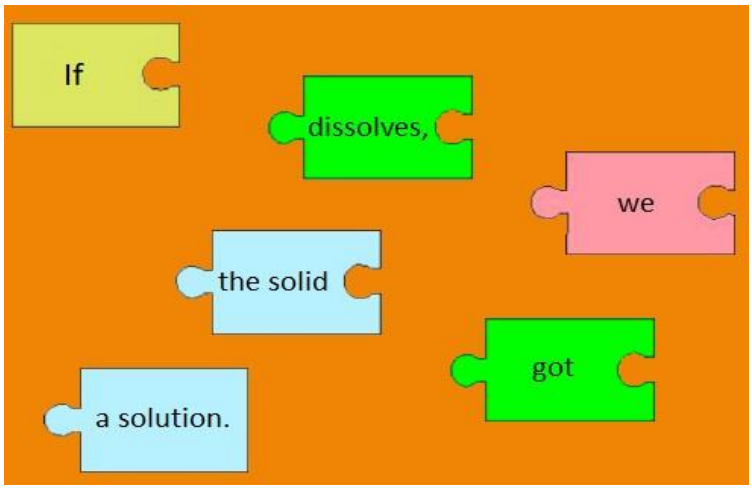

Figure 9: sentence puzzle for preparing a solution (Markic et al., 2013, p. 147)

If-then-sentences – sentence level

If	then
a mixture contains two layers.	I can use a magnet.
a mixture contains magnetic and non-magnetic compounds.	I can to a filtration.
a mixture contains sand and water.	I can pour one layer off.

Figure 10: if-then-sentences for separation methods (Markic et al., 2013, p. 148)

This method is good for practicing special science educational syntax. The first part of the sentence should contain a reason and the second part should contain the consequence, like in Figure 10. Students make one sentence out of two while repeating content, practicing characteristic of the syntax and the grammar of the language. Other sentence types can be used as well, such as more … less, neither … nor.

Block-diagram – sentence level

In a block-diagram, as shown in Figure 11, different parts of a sentence (noun, pronoun, verb, conjugation, adverb, and adjective) are given in different blocks, NOT parts of a specific sentence! This can be helpful for students if a word is missing while verbalizing their ideas, observations, and knowledge oral or for writing a text. It's an appropriate method for describing experimental set-ups and describing experiments. With a block-diagram, syntactical construction cooperated with scientific terms are trained.

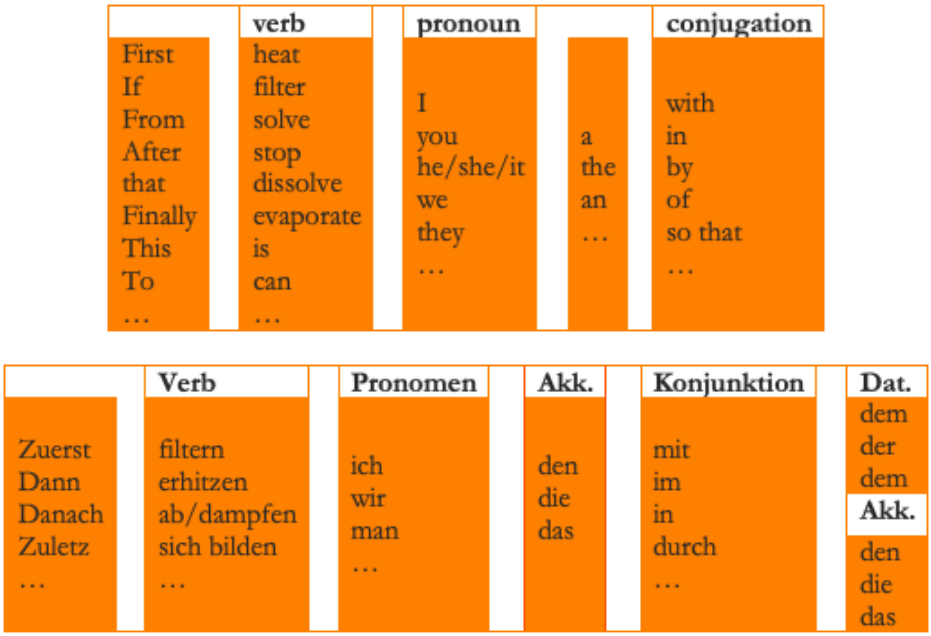

Figure 11: block-diagram, top English (Markic et al., 2013, p. 149), below German

The block-diagram can be supported by a catalogue of words, a picture, an experimental set-up, a concrete action, or other demonstration material. Another possibility instead of using a catalogue of words is adding a column with scientific terms.

Variations for students with lower linguistic skills:

- Compound verbs are separated (e.g. ab/setzen – Der Sand *setzt* sich unten am Becherglas *ab*.).
- The article that follows a verb in a given case is given (e.g. nominative, genitive, dative, or accusative in the German language).

Question pattern – sentence level

Similar to the sentence pattern, the question pattern (Figure 12) includes various questions. As an addition to the question pattern, it can be supplemented with visual associations, pictures, catalogue of words, field of words, and so on.

Question pattern for easy questions:

What do you know about …?
What is the … for?
What do you use … for?
What characteristics/advantages/disadvantages does the … have?

Question pattern for difficult questions:

What's the difference between … and …?
Is it correct that a … is a device with …?
Can there be a device that …?
I do not understand why …?

Figure 12: easy and difficult question patterns

Sentence patterns/speaking frames– sentence level

Distillation Sifting Filtration Magnetic separation Decantation Evaporation Sedimentation	is a separation procedure	to separate to isolate	a an the	solvent liquid coarse material iron layer dissolved substance	from	a an the	dissolved substance. smaller material. fine material. other substance. another layer. solvent. heavy material.

Figure 13: sentence pattern separation methods

Sentence patterns/speaking frames include standardized phrases, in which for every clause there are various options. This method is useful to train the students the scientific language and to formulate sentences with the same structures (e.g. description of a reaction). The verbs and nouns are given in fixed forms. Along with a sentence pattern (see Figure 13), different sentences can be formed by varying the used words. It supports especially students with lower linguistic skills, helping them to formulate sentences more quickly and then participating in classroom discussion. Pictures, picture stories, sequences of pictures, diagrams, etc. can support the sentence pattern. Furthermore, wrong sentences can be used for diagnosing.

Variations for students with lower linguistic skills:

- Compound verbs are separated (e.g. ab/setzen – Der Sand *setzt* sich unten am Becherglas *ab*.).
- Often used sentence patterns can be hang up as a poster in the classroom, so that the teacher can call attention to the poster with silent impulses if a student needs help.

Activities for learning the scientific language of chemistry

Explanation of the word

As a repetition of the teaching lesson, students should take one word from their lesson and present it in different representational forms, e.g. sentence, picture, drawing, action, …

Cloze

A scientific text which leaves some words out is called a cloze. The gaps are purposefully built in that make sense in terms of didactics and language didactics. The students then must fill in the right words. Using a cloze is suitable for practical application and consolidation of vocabulary, repetition of the lessen (unit), and promotion of reading comprehension. It can also be used for practicing the use of the grammar and right syntax.

Fill in the gaps.

A chlorine atom has _____electrons in its outer shell. To achieve a stable _____ of eight electrons, two chlorine atoms share a _____of electrons with each other, i.e. a _____ bond is formed between the two _____. Thus, each atom has its own seven _____ electrons and a share in one of the outer electrons of the other atom.

Figure 14: cloze (Markic et al., 2013, p. 149)

Words to add: *pair, outer, covalent, atoms, octet, seven*

A cloze can be edited not only in writing but also oral (alone or with a partner). The teacher should take care that the words remaining will provide enough information to allow the students to complete it. The solution of the gaps can be clear or open so that own formulations are allowed. Furthermore, the sentences can be numbered to make the discussion of the solution easier. Students can make a cloze on their own and ask another student to complete it.

Variation for students with lower linguistic skills:

- The missing words could be given in a catalogue of words or a field of words. These methods could be used for all students too when using a difficult text.

Domino/memory games

Domino and memory rules are known by almost every student. So no long explanation is needed, using this method. Because using different representational forms (words, pictures, formulas, calculations, …), knowledge is consolidated in different ways. The method is suitable for partner/group work because the students have to talk about the content in this way. the cards can be reused and laminated for better durability. If several sets are produced, it makes sense to use different colors for them.

The methods have the following advantages:

- Students are active.
- Domino and memory have a playful character and motivate.
- The cards can be prepared /extended by the teacher or by the students (at the end of a lesson unit).
- The game can be played at school and home.

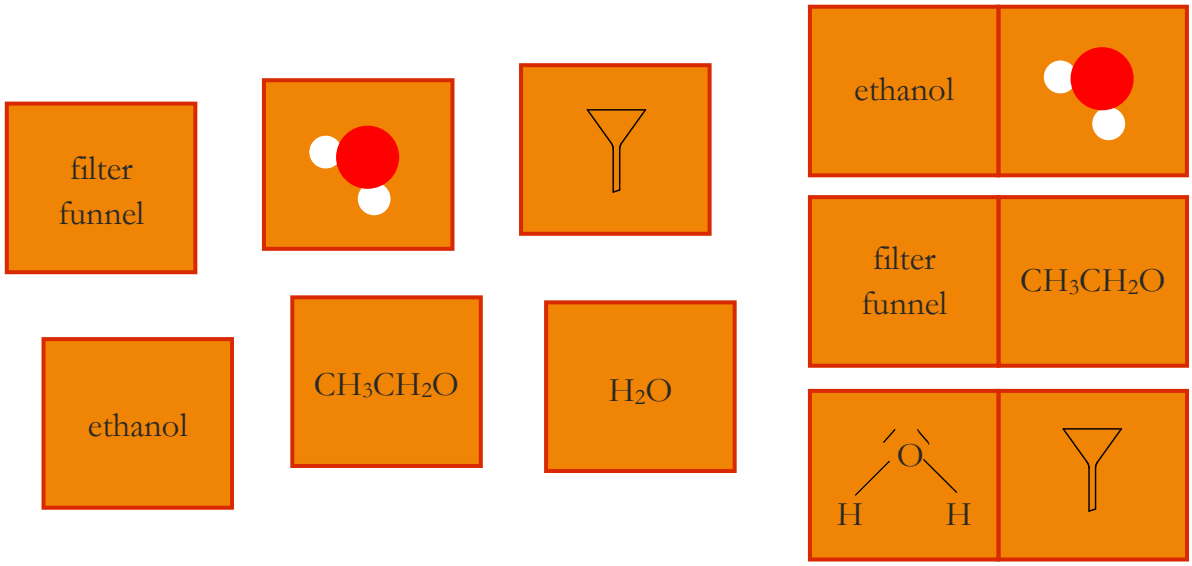

Figure 15: memory and domino game (Markic et al., 2013, p. 151)

Domino: The tiles (example in Figure 15, right side) should be placed together so that the sides of two tiles match to each other. For this, all tiles are shuffled, face down, and evenly distributed to all players. One player lays out a tile, the other player must place a suitable tile on one end of it. If he/she doesn't have the matching tile, the other player is on the line. The player who first laid out all his tiles, wins. It's possible to design the domino as a circle, to ensure the tiles are put in the correct sequence.

Memory: One has to find matching pairs with pairs that are illustrating the same thing through different representational forms. It's possible only to use pictures, too. So there are two different ways to play. First, memory cards are shuffled and laid out face down.

1) only pictures: one memory card is turned up and the student names the term (plus definite article in language with different articles) plus its plural form. If the student named the picture wrong, it's another students' turn. Did the student do it right, he/she can turn up another card. If they match, he/she can keep the pair. If the second card shows another picture, both cards are turned down again and it's the next students' turn.

2) different representational forms: one memory card is turned up, the student has to find the belonging card, representing the first card in a different way (Figure 15, left side). If he/she finds it by turning up a second card, he/she can keep the pair. If not, the two cards are turned down and it's the next students' turn. It's possible to design the backside of the cards with different representational forms differently to help the students finding the right cards faster.

The student with the most pairs wins.

Text puzzle – text level

Similar to the sentence puzzle or cut out pictures of a sequence of pictures, for a text puzzle (Figure 16) pieces of sentences (one sentence in two/three pieces), whole sentences ore pieces of texts have to be put together to a continuous, logical, scientifically and linguistically correct text. This method is suitable for learning control, repeating the content and grammar, and building knowledge through using the correct syntax. The disordered arrangement forces the students to read the words of the sentences several times, which increases the retention rate and strengthens vocabulary. The difficulty can be increased by adding unnecessary pieces or by leaving pieces out or by not marking the beginning/end of the sentence. All in all, it's important to ensure that a clear sequence remains recognizable.

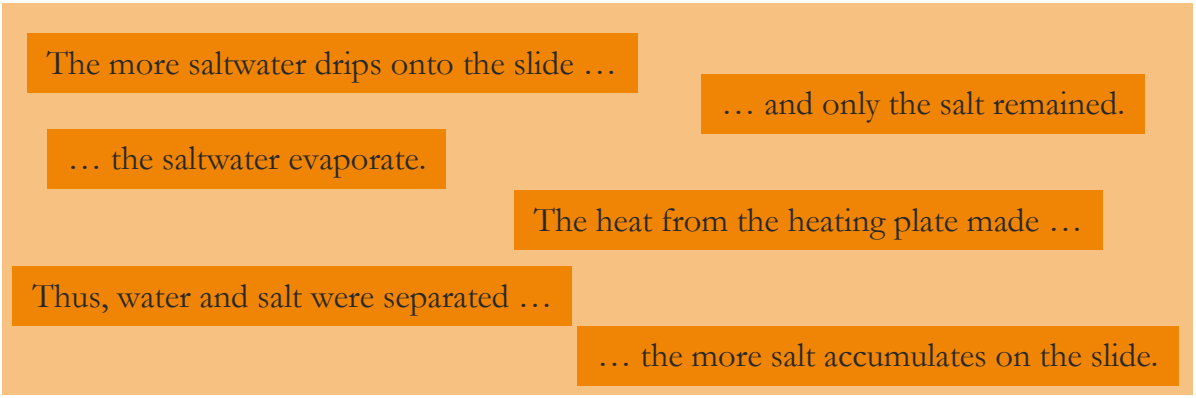

Figure 16:text puzzle

PROJECTS

German Projects

Fachspezifische Professionalisierung zur Sprachförderung (Fach-ProSa), University of Flensburg

(Subject specific professionalization for promoting language)

Interdisciplinary project (German language and literature studies and chemistry) to focus on language during professional studies for teacher professionalization. In the modules, the teacher students' awareness of the importance of language is raised, they reflect their own use of language and gain didactic knowledge of language use and options to support students with lower linguistic skills.

https://www.uni-flensburg.de/chemie/forschung/fach-prosa/

Schülerlabor NanoBioLab, Saarland University

(Student laboratory NanoBioLab)

Student laboratory from grades four to twelve (age 10 to 18) . Different projects with the student laboratory should optimise the teacher training, through the promotion to work with heterogeneity and individualisation in lessons. A subproject on the topic sustainability focuses especially on students with migration backgrounds.

http://www.nanobiolab.de/index.php

Schülerlabor Freies Experimentieren (FreiEx), University of Bremen

(Student laboratory Free Experimenting)

Student laboratory for students from grades five to ten (age 11 to 16), focusing on inquiry-based learning experiments on the topic of chemistry and sustainability. The students can use various learning helps while experimenting. The student laboratory offers a lot of applied and modern educational opportunities.

https://www.uni-bremen.de/freiex.html

Schülerlabor makeScience University of Education Karlsruhe

(Student laboratory makeScience)

Students laboratory from grades five to twelve (age 11 to 18). Within the framework of a DBU project of cooperation with the universities of Bremen, Saarbrücken, and Erlangen/Nürnberg, the make Science Laboratory offers experiments on chemistry and sustainability. The focus is inquiry-based learning and the majority of experiments are on level 2.

http://www.mint2ka.de/index.php/schuelerlabore/make-science-chemie-ph/

Förderung von Kindern und Jugendlichen mit Migrationshintergrund (FörMig), University of Hamburg

(Promotion of children and young people with a migration background) -

The FörMig program is specialized in language support for children and young people with a migration background. It is about the promotion of continuous language support with a special focus on the development of language-sensitive teaching and the valuation of multilingualism.

https://www.foermig.uni-hamburg.de/

Mercator-Stiftung für Sprachförderung und Deutsch als Zweitsprache

(Mercator-Foundation for language improvement and German as a second language)

The Mercator Institute contributes to more equal opportunities in the education system through various projects by promoting language skills in different areas. The Mercator Foundation's tasks and areas of activity are research and development of innovative concepts for language promotion, further training for educators in various fields, and the preparation of scientific findings for decision-makers. The Mercator Foundation thus contributes to equal opportunities in the educational system.

Project: Entwicklung sprachlicher und fachlicher Kompetenzen bei neu zugewanderten Schülerinnen und Schülern

(Development of linguistic and technical skills among newly immigrated students)

The project uses the scoping review process to systematically bundle the research studies carried out to date to collect performance data and their development, taking into account relevant standards.

https://www.mercator-institut-sprachfoerderung.de/de/forschung-entwicklung/aktuelle-projekte/entwicklung-sprachlicher-und-fachlicher-kompetenzen-bei-neu-zugewanderten-schuelerinnen-und-schuelern/

Project: Methodenpool für sprachsensiblen Unterricht

(Method pool for language-sensitive teaching)

Within the framework of the project, an online tool will be developed with which teacher trainees and teachers of all subjects and school types can search for and download didactic method suggestions for language-sensitive teaching free of charge.

https://www.mercator-institut-sprachfoerderung.de/de/forschung-entwicklung/abgeschlossene-projekte/methodenpool-sprachsensibel/

Project: Digitale Medien im sprachsensiblen Fachunterricht

(Digital media in language-sensitive lessons)

In seminars for teacher training students, a module is offered that focuses on the topic of digital media in language-sensitive subject lessons.

https://www.mercator-institut-sprachfoerderung.de/de/studium-weiterbildung/ausgewaehlte-lehrprojekte/digitale-medien-im-sprachsensiblen-fachunterricht/

Sprachsensibles unterrichten fördern – sprachliche Bildung systemisch im Vorbereitungsdienst implementieren, North Rhine-Westphalia

(Promoting language sensitive teaching – implementing language education systematically in teacher education)

The project promoted the integration of language-sensitive teaching as an element of the 'diversity' guideline of the core curriculum in North Rhine-Westphalia in the training of trainee teachers. Material was developed for different subjects and published as OER on the homepage of the project.

http://www.sprachsensibles-unterrichten.de/wp-content/uploads/2017/12/Buch_Sprachsensibles-Unterrichten-foerdern.pdf

http://sprachsensibles-unterrichten.de/

Sprachbildung im Fach, Leibniz University of Hannover

(Language education in the subject)

Online course for language-sensitive teaching in secondary schools for the subjects biology, chemistry, German, geography, history, mathematics, physics, politics/economy, and ethics. The online course contains packages for students to learn the basis of language-sensitive lessons in groups of heterogeneity. The courses are used for further education and training as well.

https://www.sprachbildung.uni-hannover.de/552.html

International projects

CORI-program/ Reading-Engagement Projekt, University of Maryland and Frederick County Public Schools (USA)

Projekt for students from grades two to five (age 8 to 11). Concept-Oriented Reading Instruction (CORI) is a program developed by John Guthrie and Allan Wigfield to teach reading strategy and research science. The goals of CORI are to increase students' reading comprehension, reading motivation, and science knowledge.

http://www.corilearning.com/research-projects/reading-engagement-project/

PROMISE - Promotion of Migrants in Science Education, Humbold-University of Berlin (Germany), University of Sarajevo (Bosnia and Herzegovina), Yildiz Technical University of Istanbul (Turkey), University of Vienne (Austria), European Training and Research Centre for Human Rights and Democracy (Graz, Austria)

Within the framework of the EU project Promotion of Migrants in Science Education, teaching materials were developed for language and culture sensitive physics lessons. to create equal opportunities in science education and to promote the choice of scientific studies and supporting the careers of migrants are the goals of the project.

http://www.promise.at/

LIST FOR FURTHER READING

Childs, P., & Ryan, M. (2016). Chapter 4: Strategies for Teaching the Language of Science. In S. Markic & S. Abels (Eds.), *Education in a competitive and globalizing world. Science education towards inclusion* (pp. 43–66). Nova Publishers.

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Osborne, J. (2002). Science Without Literacy: A ship without a sail? *Cambridge Journal of Education*, *32*(2), 203–218. https://doi.org/10.1080/03057640220147559

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