

Development of Science Lessons for Grade 5-8 PROMISE Team Vienna

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A major part of the work accomplished by the PROMISE team (PT) of the University of Vienna was the development of science lessons especially suitable for students with migration background. This article provides teaching ideas for grade 5-8 (students aged 10-14) by presenting complete lesson concepts which can be adapted to other backgrounds. Lesson concepts of the PT teachers were considerably influenced by the approaches of Josef Leisen, head of the “Staatliches Studienseminar für das Lehramt an Gymnasien” in Koblenz (Germany), who focuses on the use of specific methods to combine language and content learning. One of the concepts described in this article especially focuses on implementing some of these methods. Furthermore, two concepts are based on implementing hands-on experiments and group-work as an effective way of fostering language competence and supporting teamwork among students with different needs. All of the described science lessons were observed and partly videotaped in order to provide opportunity for discussion and enhancement. For every lesson concept in this article background information, a detailed description of the lesson, comments and self-reflection by the teacher as well as teaching material is provided.

1. Introduction

In Austria, students with migration background have to face various barriers in school. Not only is there little individual support, e.g. in developing language skills, but major problems occur to the specific school system. Students in Austria are separated at the age of 10 years into two types of schools: lower secondary and academic secondary school. Especially in congested urban areas, this early separation leads to a specific phenomenon: Most parents with better educational and socio-economic background tend to send their children to academic secondary schools, whereas lower secondary schools have to accept the challenge in teaching high percentages of less privileged students. Many of them have migration background and they lack German language abilities, even if they were born in Austria.

School authorities therefore set activities in lower secondary schools to help students learn German, for example additional native language teachers in normal lessons or additional German lessons. For the members of the PROMISE Team of the University of Vienna these support measures are not enough to help students develop their individual skills and give them a real chance to achieve higher education. Especially in science, where the use of technical terms is very important, it seems to be a great challenge on the one hand to motivate students to participate in the lesson and on the other hand to effectively teach them how to use terminology and coevally conceive the science content.

Following the objectives of the PROMISE project (Tajmel and Starl 2005), four dedicated teachers developed three concepts to meet the challenges named above. All three concepts put the focus on language and science and effective use of language by the students. Methods and tools developed by Josef Leisen, an expert on science and language teaching, were modified and adapted to the individual requirements of the classes, especially in the lesson concept of Martina Schueller. Hands-on experiments and support by an additional native language teacher are used by Werner Rentzsch as ways to motivate students with great needs in enhancing German language competences. The article also shows how Muhammet Tosun’s concept of group work can be an effective way to foster students’ language abilities in lower levels of an academic secondary school with Islamic background, where 100% of the students have migration background and all try hard to reach the higher level of academic secondary school.

1.) Science Lesson “Electric Bell”

a) Lesson Concept

How an electric bell works

Use the following pictures to repeat how an electric bell works. Write a suitable text next to the pictures.

1	The switch.....
2	The coil.....
3	The metal strip.....
4	The hammer.....
6	At the same time.....
8	The electromagnet.....
7	The hammer.....
8	At the same time.....
This process.....	

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Due to the fact that many of the students of the class face language problems, the teacher aimed to focus on these difficulties. In addition to that the teacher wanted to react to the challenges that are encountered in heterogeneous classes. Conventional methods do not work any more, but new ideas have to be implemented in order to offer each of the students an interesting learning atmosphere. Using different methods combined with a focus in language has already been discussed in the PROMISE-Team meetings. In one of the team meetings the method tools by Josef Leisen were presented and discussed, several teachers showed great interest in using them. These method tools were implemented into the following lesson concept:

In the first phase, the class splits into two groups, each having its own teacher. The teachers explain to the students how an electric bell works by showing the processes using a real bell. The students are asked to match the correct names to the parts of the bell with the help of cards (where the names of the parts are written on). They are asked to repeat the working process of the bell with the help of the teacher.

In the next phase, they gather in the plenum and complete a fill-in-the-blanks exercise shown on a transparency where the process is described. A sketch of an electric bell with the most important parts labelled on it is shown as well. Afterwards

they write down the process in their exercise books.

In the second block, the class splits into groups of four students. Based on a worksheet the students build a model of an electric bell using the prepared materials. Then they fill out a worksheet where they have to describe how the model works. On another worksheet – available in two severities – the students are asked to add text to a film strip showing the different processes that happen in an electric bell. In the end, there are dominoes (see teaching resources) available for students who have already finished the compulsory exercises.

b) Background Information

The lesson concept was tested in a lower secondary school, situated in a town in Lower Austria, approx. 50 kilometres from Vienna. The school is the only secondary school in the neighbourhood, but still, it begins to feel the competition to academic secondary schools in towns nearby. One generation ago, all of the inhabitants of the town used to send their children to this school. Now, parents from higher social backgrounds tend to avoid the school and prefer to send their children to academic secondary schools, although the children have to accept a longer way to school. The result is that nearly only under-privileged children attend the school – a process well known in Vienna.

The fact that accommodation facilities for asylum seekers are close to the town together with the low land price (due to the industrial area around the town) leads to a high concentration of students with migration background. On average, the school has approximately 30% of students with migration background. Although this percentage may not seem very high (compared to Vienna), the teachers and the headmaster were surprised by the sudden growth in this category.

The school has approximately 300 students in 13 classes and offers several autonomic subjects such as conversation with an English native speaker and information technology.

The class where this lesson concept was tested is an integration class focusing on integrating children with deviant behaviour and learning disabilities. Therefore a second teacher assists the class teacher to be able to foster children with special needs. There are also two students that are not yet enrolled in the same way as the

others because they have just immigrated from other countries and are busy with learning the German language. They can participate in the lessons but are not graded. In Austria, this special status can last for max. two years.

c) Self-Reflection by Martina Schüller

In my experience, students with migration background usually enlarge language and cultural diversity to the science lessons, a challenge which I had to meet. The teaching strategy focusing on *science with language learning* can help these students to understand science while developing listening, speaking, reading and writing skills in the new language. The science lessons about the electric bell showed that students with migration background participated more intensively than in the lessons with conventional teaching methods: During the phase of the teacher demonstration they had the opportunity to observe and listen before having to talk. In the group activity they could cooperate and communicate with others in order to use the new science content and the science language. In the phase of the individual activity they worked with learning materials based on the *Method Tools* by Josef Leisen. These materials which focus on language learning helped them to make the different processes in the electric bell more understandable. As all of the students enjoyed working with these learning materials and because of the high learning outcome, they were offered some other method tools in the following science lessons, too.

Developing such learning materials for students with migration background is very time-consuming. In order to solve this problem it would be necessary to exchange materials with other colleagues.

2.) Science Lesson “Hands-On Experiments”

a) Lesson Concept

The lesson focuses on hands-on experiments. The students build groups of three to four students, each of them gathering around a table, where the materials needed for the experiments are already prepared. The teacher first shows an experiment, that all of the students do at the same time following the instructions of the teacher:

Each student gets a crayon and dips it in a coloured liquid (blue, red or green), which is soaked up. After some minutes the crayon is taken out of the liquid and dipped into the next liquid. This also happens with the third liquid. As a result, the students get colourful crayons which are stored at the windowsill to dry.

The teacher explains five hands-on experiments, which the students will conduct afterwards. He draws the attention to the materials used and the set-up. He also mentions safety regulations for one experiment. The experiments are the following:

- Two capillary tubes – one thinner than the other – are dipped into a coloured liquid. The students observe that the liquid in the thinner tube will rise higher because of capillarity.
- A cold bottle (taken from the fridge) is immersed into a container with ice cubes. The students put a wet coin on the opening of the bottle and heat the bottle using their hands. They observe that the coin bounces because of the thermal expansion of the air inside the bottle.
- A metal tube is filled with some water and closed with a cap. The tube is heated using a Bunsen burner. The students observe that the cap all of sudden flies away because of the thermal expansion of the gases inside the tube.
- A glass containing an ice cube is filled with water up to the brim. The students observe that the water does not overflow because the volume of the melted water is smaller than the volume of the ice cube.
- Two jars are filled with water – one with cold, the other one with warm water. The students measure the temperatures using a thermometer and they take notes.



The teacher chose this experimental approach because he wants to encourage the students to work in groups and to talk. The lesson also offers a good opportunity to cooperate with the additional teachers, especially by implementing the students' mother tongue.

b) Background Information

The lesson concept was tested in a “Kooperative Mittelschule” (KMS) situated in the 20th district of Vienna, a district with a high percentage of inhabitants having migration background. It used to be a lower secondary school, but like many of these schools in Vienna it changed its name into KMS, meaning "cooperative secondary school". This name points out that the school cooperates with academic secondary schools (AHS) in the neighbourhood. The KMS employs teachers of the AHS for some lessons which also makes it easier to find children who would be qualified to attend an academic secondary school and motivate them to change schools. The school focuses on creative subjects, such as music and arts and provides special classes for the integration of students with learning disabilities.

The observed class – students are aged 12-13 years – is one of these integration classes. In all of the lessons, an additional teacher takes care of the students. Due to the high percentage of students with Turkish migration background a third teacher of Turkish origin helps the children with language problems in some lessons by incorporating their mother tongue.

c) Self Reflection by Werner Rentzsch

As the introduced concept focuses on hands-on experiments, naturally there were lots of surprises and curiosity for the students. This class was much more interested as a “standard” one, as their visual and kinesthetic abilities were challenged by experiments.

They received support in their mother tongue by an *additional-native-language-teacher* and therefore their attention and understanding could be fostered. All the students enjoyed participating in this unique possibility. Nobody stood aside or was passive, but the students were fully active and filled with zest of action and research. Even students who are normally more reserved and introvert took part in the experiments. Observations and results of the experiments stayed in students’ minds very precisely. “Learning by doing” is generally very well accepted and the students are always looking forward to this kind of science lessons.

Moreover, the technical language could be taught with a higher reminder value. I noticed, that these words and technical terms could be still recalled in the following lessons.



Furthermore, I – as well as the additional-native-language-teacher, who is responsible for additional training in the students’ mother tongue – recognized that the interest of students with less German language ability could be enhanced and the learning effect could be improved. Talented students are often uncommunicative due to language barriers but they become more confident, motivated and interested if they can learn, think and talk a bit in their mother tongue. The fact, that the students were filmed was an additional motivation criterion and contributed to their confidence.

I showed some lesson scenes to the PROMISE – Team Vienna which we discussed in detail. Of course, my colleagues’ feedback was particularly important for the work with students. For me, this was a very helpful process, as it is not usual to

receive feedback by scientifically trained and well-versed colleagues.

As a result of teaching in integration groups with high percentages of students with lacking German language abilities, I would like to highlight the following issues, I personally learned:

- Focusing on the most essential content – “Less is more!”
- If there are two physics lessons a week, one should be allowed for students’ experiments.
- The following lesson should be allowed for summary, repetition and engrossing the mind. It has been good practice to draw a sketch of each experiment together with the students on the blackboard. Ideally, the proposals for labelling come from the students, who can remember the experiments exactly in most cases (also the details).
- It should be abstained from long memory texts.
- In addition to the hands-on experiments, also demonstration experiments by the teacher should be shown, especially if the multiplication-effort for including the students is too high. To integrate the students, some of them can assist at these experiments. With this kind of training, it is feasible to make the unpopular subject of physics and chemistry more attractive.

3.) Science Lesson “Solar Eclipse”

a) Lesson Concept

The teacher starts the lesson by showing pictures of lunar and solar eclipses in a PowerPoint-Presentation. He asks his students to tell the others about eclipses they have observed.

After this introduction the lesson continues as follows:

The students are asked to read one of the prepared worksheets (one explaining the solar eclipse, the other explaining the lunar eclipse) by themselves and try to understand the physics behind the phenomenon.

Then four groups are formed (A, B, C, D) of four or five students each. A and C are prepared in solar eclipse and B and D in lunar eclipse. They discuss the physics of the eclipses and try to understand it.

After that, the students come together in pairs. One of them explains the solar eclipse to the partner, who him/herself explains the lunar eclipse to the partner afterwards. The objective is that both partners will understand the physical background of both eclipse phenomena.

Then, randomly, one student is chosen to explain the solar eclipse to the plenum. Afterwards another student explains the lunar eclipse to the plenum.



b) Background Information

The lesson concept was tested in a private secondary school supervised by the Islamic Community in Austria. The school offers secondary education for students including the Austrian school-leaving certificate that enables students to enrol for university. The school was founded in 1999 in order to “enable students to build bridges between muslim and non-muslim fellow citizens by granting them a high-quality education”. “An important objective is the integration of muslim adolescents into the Austrian society by conserving and strengthening muslim self-conception and maintenance of muslim culture and identity.” (quotes from the website). As in many private schools, a specific association is responsible for financial issues and decides on innovations the school takes.

The school is situated in the fifteenth district of Vienna, the one with the highest percentage of inhabitants having migration background. According to the teacher, most of the students of this school have Turkish migration background. The students’ command of German varies a lot according to their age.

Like several private schools in Austria, the school struggles for financial support. Although teachers are paid by the Austrian state, additional staff as well as all kinds of running costs for the building has to be paid from the students’ fees. For the school building a normal apartment house was adapted. As a consequence, classrooms are very small and there are only a few additional rooms for special lessons. Science equipment just as well is very limited and teachers have to be creative to be able to show experiments.

Students of the class where this lesson concept was tested are aged 13-14 and attend higher secondary school.

The described science lesson was also videotaped by members of the PROMISE-Team Vienna.

c) Self Reflection by Muhammet Tosun

The idea to this lesson concept was on the one hand to draw the attention of the students by choosing an exciting topic and on the other hand to show the students how science influences every-day life. By connecting the topic of eclipses I hoped to increase interest and motivation to gain physical knowledge.

My major objectives referring contents and behaviour were:

- being able to read and work with high-level texts
- learn how to deal with technical terms
- being able to excerpt texts

- promoting social competences

As my science lesson was recorded, I had the opportunity to not only draw conclusions by remembering situations but also by carefully analyzing the lesson. The following results could be gained:

- I was very surprised by the success of the practical work of the students: Students who usually tend to act in a very reserved way showed active cooperation and seemed to enjoy the discussion with partners and groups. Unfortunately, it cannot be excluded that this reaction might also be caused by the presence of the video camera.
- Through direct feedback by the students it turned out that the used worksheets were not appropriate for this age and that there was too little time for working on the tasks. Furthermore, students criticized that too many unknown technical terms were used (e.g. ellipse, ...). However, this showed the high potential of interdisciplinary teaching. Connecting and adjusting the studying topics in different subjects (maths, geography, ...) may help to prevent these difficulties.
- Due to the fact that students tend to be used to teacher-centred teaching, a change in the teaching method seemed difficult at the beginning. This problem is easily solved by regularly implementing this method.

The video-reflection of my lesson supported me in deciding what I would change about the lesson concept for another try:

- Worksheets must be arranged more clearly. The linguistic level of the students – caused by the age and the migration background – must be considered more intensively. The use of dictionaries or sheets with useful keywords should be tested.
- More time for working on the tasks must be allowed in order to finish the lessons successfully. It is especially important to plan enough time for all of the phases. The fourth phase, in particular, as well as the discussion should be given a large amount of time. Post-processing of the lesson should not be left out.

4.) Conclusion

The experiences of the teachers who tried out and evaluated their own developed lesson concepts showed clearly that the key to effective learning of science in classes with a high percentage of students with migration background is to focus on language.

Systematic motivation of the students is important to raise the rate of active participation which is essential to get them talking about science and using technical terms by their own. Methods and tools by Josef Leisen have been proven and seem to be very appropriate to meet the challenge of science and language learning in our special situation. Furthermore, student-centred learning methods like group work, hands-on experiments and others have resulted as the proper way to motivate students to participate. In cases of great needs in enhancing German language competences, an additional native language teacher can help students to build bridges between thinking and talking about science in their mother-tongue and in German.

Due to the exchange of teachers' experiences in the PROMISE-Team meetings after testing the concepts described above, we have anecdotic evidence that teacher-centred concepts that focus on learning standard phrases by heart are not effective in increasing the students' competences neither in language nor in science compared to the student-centred lessons.

We suggest testing similar concepts by adapting and modifying the teaching materials provided on DVD (Tajmel and Starl 2009). The authors would appreciate any feedback concerning experiences and new ideas.

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