

**COMPARATIVE STUDY OF
NATURAL SCIENCE CLASSES IN
SLOVENIA AND BELGIUM**

Erasmus+, K2

Institute for Education Research and Development (InERD),
St. Stanislav's Institution

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1 Introduction

The Diocesan Classical Gymnasium and the Sint-Calasanzinstituut are partner schools in the K2 Erasmus+ project entitled Natural Science for Social Impact. With this project, both schools would like to strengthen their cooperation that already existed before the start of this project and exchange good practice and knowledge in the field of natural science with an emphasis on environmental protection, sustainable development and care for our planet.

Mrs Nasta Zupančič, a chemistry teacher from the Diocesan Classical Gymnasium, is a project coordinator. Mrs Lieve Snels is responsible for the coordination of the project at the Sint-Calasanzinstituut. In addition, other natural science teachers participate in the project with their contributions. So far, they have recorded their lessons, answered a questionnaire and were informed about the results of a student survey. Right now, they are working on lessons plans for natural science extracurricular activities that will be translated into English, exchanged and used both in Slovenia and Belgium.

In the following chapters, there is a comparative study of natural science classes in Slovenia and Belgium. The first step in preparing this study was to become familiar with the syllabi of chemistry and biology of both schools. InERD took a closer look at the syllabi, gained a better insight into the issue and discussed it with the project coordinator.

Secondly, InERD worked on the preparation of an online questionnaire for students. First, the questionnaire was sent to the selected Slovenian students and was translated into English to be sent to Belgium. Over 100 Slovenian students responded and their answers were analysed right away. The results and analysis were compiled into a 19-page report written in Slovenian and given to the Slovenian teachers for consideration and reflection. This report is not included in this study; however, it is partially translated into English and available upon request. After obtaining the answers from the selected Belgian students, a comparative study of their answers and the answers of the Slovenian students were done. This study is included in the report and finds its place in one of the following chapters.

The third step was then to interview the Slovenian and Belgian natural science teachers. InERD along with the project coordinator decided not to conduct interviews in person but to prepare a special questionnaire to ensure anonymity. The teachers of both schools replied to the questionnaire. Their answers are discussed and compared with each other in the chapter entitled Teacher Survey: Presentation of the Results. Because, it is very interesting to confront

the teachers' answers with the answers of their students, the next chapter called Teachers' Answers vs. Students' Answers features this confrontation which is very useful for teachers to reflect on their work.

Last but not least, there is a comment on the recorded lessons. 11 natural science lessons were recorded and submitted to InERD for analysis. Of course, it is impossible to generalise from 11 lessons, but still this chapter aims at encouraging teachers to exchange good practice and above all to learn from each other and be willing to further improve.

2 Syllabi

The first step in conducting this study was to review the syllabi of chemistry and biology of the Diocesan Classical Gymnasium and the Sint-Calasanzinstituut. Both schools submit their syllabi to InERD. One of the InERD researchers reviewed the syllabi, made a short summary and discussed it with the project coordinator, Mrs Nasta Zupančič. The summary is available in the Slovenian language and can be translated into English if the need arises.

It should be stressed that the Slovenian and Belgian secondary school system differ from each other. In Belgium, when graduating from primary school around the age of 12, students enter secondary education. They choose a course that they want to follow, depending on their skills and interests, either regular (like gymnasiums in Slovenia) or technical (vocational) programme. Secondary education consists of three cycles (first cycle: year 1 and year 2, second cycle: year 3 and year 4, third cycle: year 5 and year 6). In Slovenia, students finish their primary education at the age of 14 or 15 and enrol either in gymnasium, technical school or vocational school. The Diocesan Classical Gymnasium is a gymnasium. The first and the second grade of the Diocesan Classical Gymnasium correspond to the second cycle at the Sint-Calasanzinstituut, whereas the third and the fourth grade to the third cycle. We paid attention to this fact while taking a look at the syllabi. It turned out that the syllabi are quite similar as far as teaching content is concerned. This finding was helpful and served as a basis for continuing this study.

In a discussion with two Belgian teachers during their visit to Slovenia, we came across another difference. In Belgium, every student should have an agenda book meaning it is obligatory for students to write down the lesson plan of every lesson. In case of regular inspection, inspectors also check these agenda books.

3 Teacher Survey: Presentation of the Results

In addition to 147 students of both schools who responded to the questionnaire on natural science classes, all natural science teachers of the Diocesan Classical Gymnasium and four natural science teachers of the Sint-Calasanzinstituut answered a special questionnaire intended for them. Their questionnaire was made of four questions. As for the first two questions, they graded certain statements, whereas the third and the fourth question allowed them to write down their thoughts. The next chapters feature a presentation of their answers and a kind of comparison with the students' results.

3.1 The First Question of the Survey

The first question of the survey was made of nine statements (sub-questions). Each statement was further divided into two parts meaning that the teachers evaluate each statement twice. First, they evaluate how important this particular statement is for them and then they have to decide how successful they are in this area. For evaluation, they could choose from 1 to 5 (1 means extremely unimportant/extremely unsuccessful and 5 means extremely important/extremely successful).

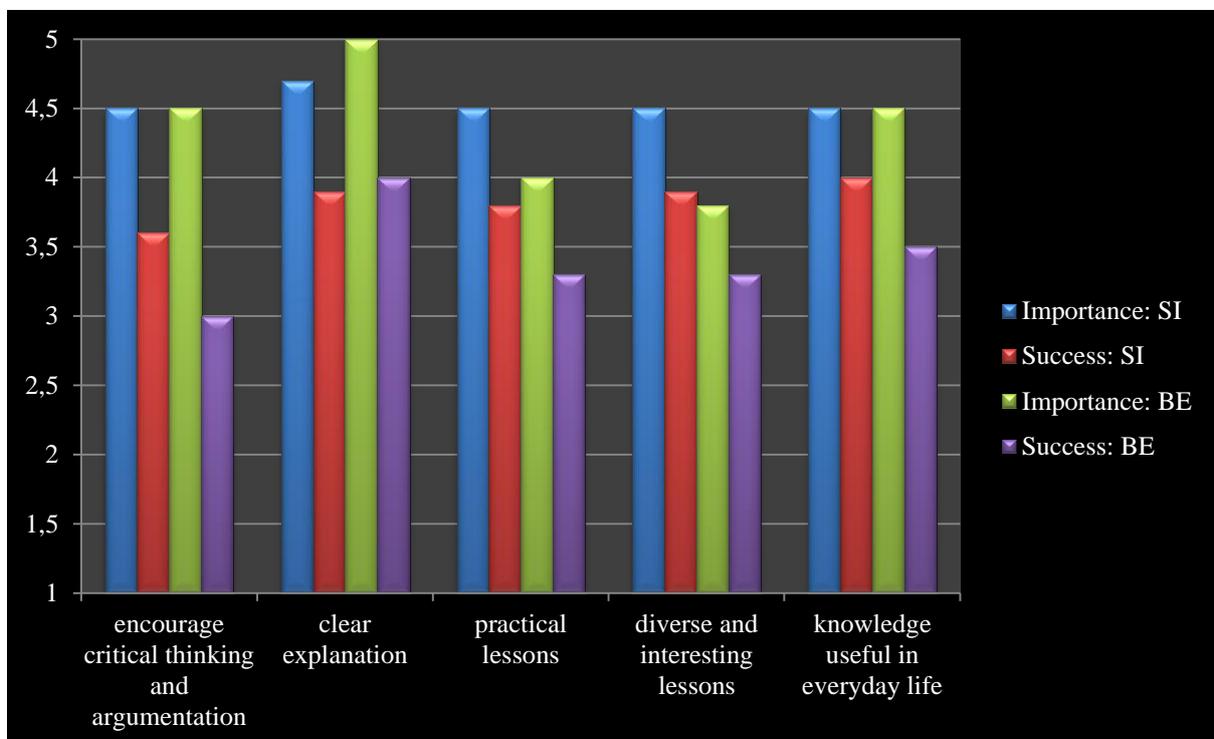


Table 1. The average values of the first five sub-questions of the first question.

According to the survey, it is equally important to the Slovenian and Belgian teachers to encourage critical thinking and argumentation. However, the Slovenian teachers feel they are more successful when it comes to realisation. As for the answers of the Belgian teachers, there was a pretty big gap of 1.5 points between their average values.

Considering all the answers, the Belgian teachers think they are the least successful in encouraging critical thinking and argumentation.

The second statement was about explaining the subject matter in a way that is understandable to students. The teachers of both schools find it extremely important to be clear while explaining, but they still have some room to improve.

The teachers of both schools agree it is pretty important to make lessons practical. However, their average values differ for 0.5 point from each other. At this point, it should be stressed that the difference may also occur because of a slight difference between the Slovenian and English wording: *lessons are practical enough* (would be word by word translation) vs. *making lessons as practical as possible* (actual translation). The situation is the same with the next statement on diverse and interesting lessons.

The teachers of both schools think it is important to pass on knowledge which is useful in everyday life. However, the Belgian teachers are more doubtful whether they are successful or not in doing so.

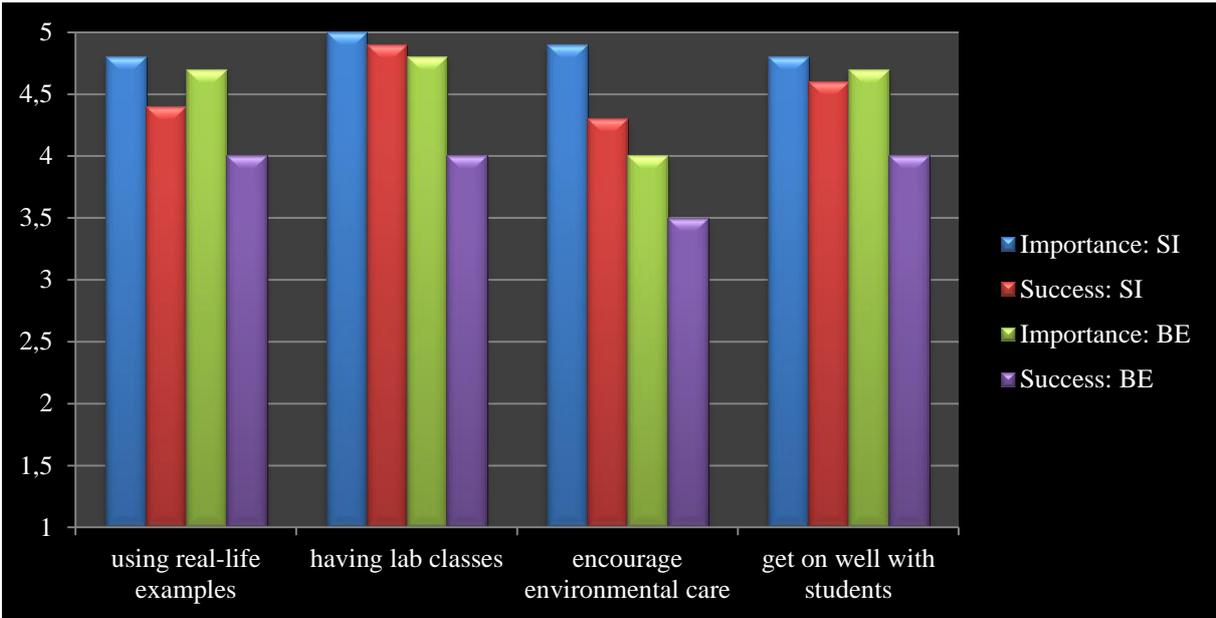


Table 2. Average values of the last four sub-questions of the first question.

Having lab classes was the best graded statement of the Slovenian teachers both in terms of importance and their success. They feel confident while conducting lab classes, which is a bit less evident with the Belgian teachers.

Considering the “importance” part of all the questions, the greatest difference in the average points was in encouraging environmental care. Encouraging environmental care is very high on the importance list of the Slovenian teachers.

The teachers of both schools strive to get on well with their students. According to the survey, the Slovenian teachers are doing better than their Belgian counterparts, but both think they are on good terms with their students.

In general, the Belgian teachers are more sceptical about them being successful. However, it is impossible to draw conclusions from these few questions insisting that the Slovenian teachers are doing better. One of the possible reasons why the Belgian teachers feel a bit less successful may be that they are younger and, therefore, less experienced. Another reason may be that they take a more critical stance on their work or are more eager to further improve. To conclude, it is always possible to become better and it is not good to rest on your laurels.

3. 1. 1 Teachers’ Answers vs. Students’ Answers

However, it is interesting to compare the teachers’ answers with the answers of their students and take a look at how they differ from each other. As for the teachers, the “success part” of their answers will be presented in the next tables.

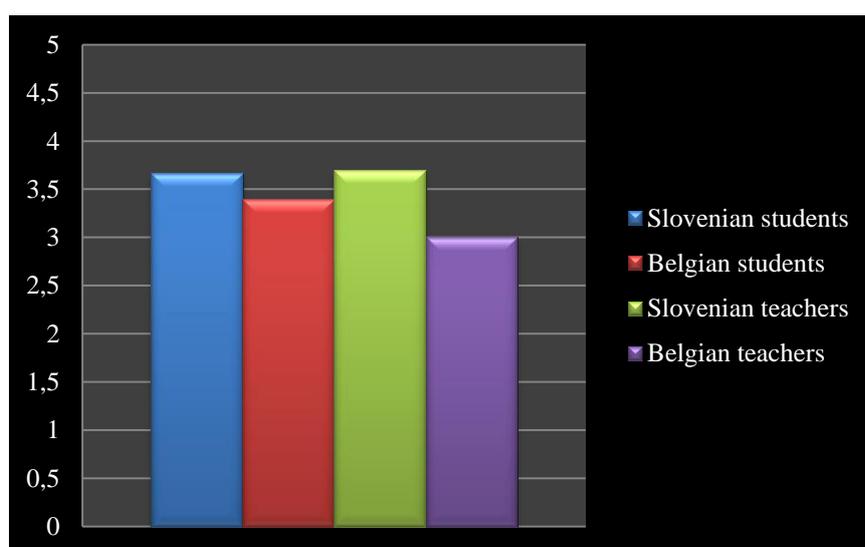


Table 3. Our teacher encourages critical thinking and argumentation.

The table shows that as far as encouraging critical thinking and argumentation is concerned, the Belgian teachers undervalued their success, whereas the Slovenian teachers are more convinced about them being successful comparing to what their students say.

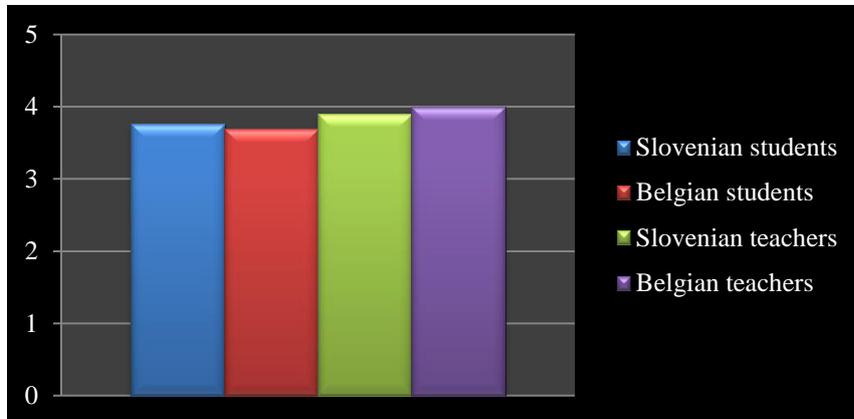


Table 4. Our teacher gives his/her best to explain everything as clear as possible.

The smallest deviation between the students and the teachers can be seen at the question concerning clear explanation. This suggests that the teachers' efforts to be as clear as possible do reap the rewards.

How important is it to you that you explain the subject matter in a way that is understandable to students? In answering this part of the question, all of the Belgian teachers decided for 5 (extremely important), whereas the Slovenian teachers were not unanimous (6 x 5 and 2 x 4). It is clear that everyone has bad days and sometimes fails to be clear and persuasive but still every teacher should do his/her best to provide students with understandable explanation. Therefore, explaining the subject matter in a way that is understandable should top the list of the teacher's priorities.

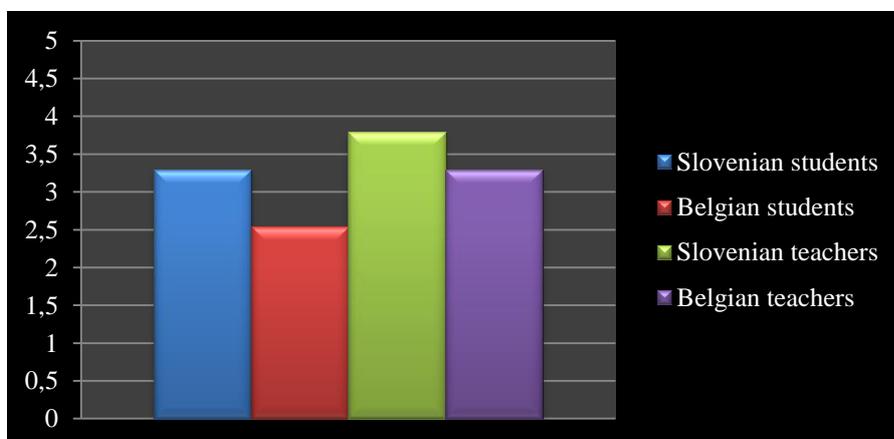


Table 5. Our lessons are practical enough.

The Belgian students are pretty unsatisfied with the practical aspects of their lessons. However, it should be stressed that the students who answered the questionnaire are students who chose science as their main track meaning they will probably study medicine, chemistry, maths, etc. Therefore, the study plan is more science-oriented and theoretical to lay the grounds for their future studies. Even though there is no science track to choose from at the Diocesan Classical Gymnasium, our regular programme provides enough knowledge for all kind of study tracks. To consider this, it is clear that the lessons cannot be as practical as they can be at vocational schools.

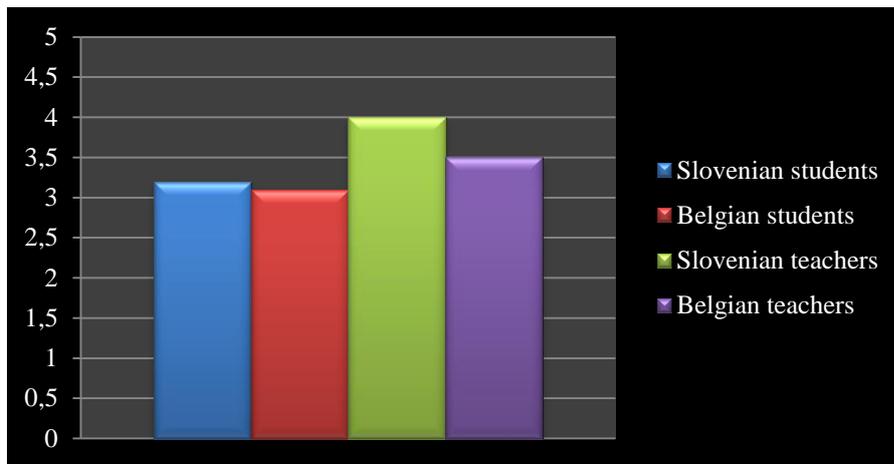


Table 6. The knowledge that I acquire is applicable in life and I believe I will be able to use it in the future.

The students of both schools are pretty unsure whether they will be able to use the obtained knowledge in their everyday lives. If a lot of emphasis is laid on theory, it is quite obvious that they are unaware of how to make use of their knowledge in practice. At this question, there was quite a big difference of 0.8 points in the average values between the Slovenian students and teachers comparing to the difference of 0.4 points between the Belgian students and teachers suggesting that there is a kind of a misunderstanding on this issue between the Slovenian teachers and students.

3.2 The Second Question

At the second question, the teachers were asked to indicate to what extent they agree or disagree with the following statements:

- It is difficult to motivate students.
- I feel restricted by the syllabus.

- I must explain the subject matter fast otherwise I don't have enough time to discuss everything.
- There are many students who learn everything by heart.
- I don't have enough time for discussion during my classes.

The possible answers were: 1: totally disagree, 2: disagree; 3: agree, 4: totally agree.

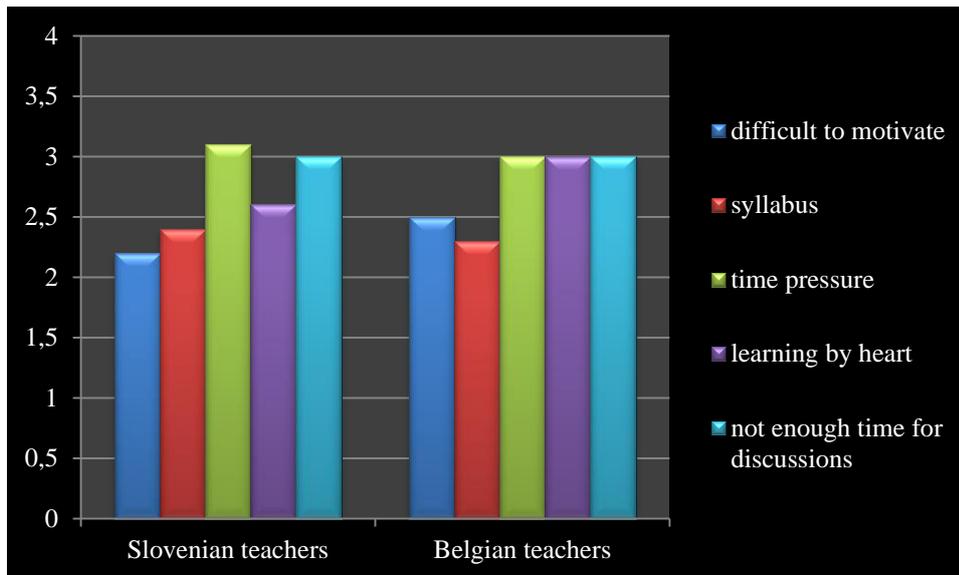


Table 7. Slovenian vs. Belgian teachers

The results suggest that 7 out of 9 Slovenian teachers disagree with the first statement and the remaining two agree, whereas 2 Belgian teachers agree and 2 disagree.

The Belgian teachers feel less restricted by the syllabus, only one teacher decided for the answer agree, whereas 4 Slovenian teachers agree and 5 disagree with this statement.

As far as time pressure is concerned (3 and 5 question), the teachers of both school would like to have more time at their disposal. 7 Slovenian teachers either agree or totally agree that they have to explain the subject matter fast otherwise they will not have enough time for everything they should do. In addition, 8 of them think that they do not have enough time for discussion with students. It is similar with the Belgian teachers; only one teacher feels that he/she is not under time pressure, the rest of them (3) either agree or totally agree that they would need more time.

As far as learning by heart is concerned, four of the Slovenian teachers disagree with the fact that many students learn by heart and five of them agree with it. On the other hand, one Belgian teacher disagrees and the other three either agree or totally agree (1).

3.3 Strong and Weak Points

At the end of the questionnaire, there were two questions at which the respondents were free to write whatever they want.

- The first question was: In which areas of teaching do you feel you perform competently and successfully?

Following careful examination of the answers, it seems that the Slovenian teachers, in general, feel that they are quite competent and successful. At this point, we would like to mention those answers that come up at least twice: experiments (3 times), explaining the subject matter (3x), relationships with students (2x).

As far as the Belgian teachers are concerned, it was not possible to combine the answers because they differ a lot from each other. In general, it seems that the Belgian teachers feel they are good in the areas they feel comfortable themselves.

It should be stressed that only four Belgian teachers answered the questionnaire and one of them is a novice who has been teaching for the first year.

- The second question was: Where do you see the potential to further improve your teaching? In which areas of teaching do you feel you would still like to develop your skills?

One of the Slovenian teachers wrote that it would be possible to make improvements if there were fewer students in a class, otherwise he/she do not see any potential. The other teachers would, above all, like to pay more attention to experiments and visual materials.

One Belgian teacher wrote that he/she who would like to use different teaching methods so that students can participate more but he/she lacks the time to do so.

4 Student Survey: Presentation of the Results

The questionnaire for students was made of five main questions and answered by 107 Slovenian and 38 Belgian students. Some of the students did not finish the questionnaire.

4.1 The First Question

The first question, for example, was composed of 10 sub-questions or statements. The students should indicate to what extent they agree or disagree with each of the statements for chemistry, physics and biology classes respectively (from 1: totally disagree to 5: totally agree). For the purposes of this study, we will present the average values of all three subjects together. What we want is an overview of the situation of the natural science classes as a whole and not to compare the subjects with each other. However, there is a more detailed analysis of the answers of the Slovenian students that concentrates on chemistry, physics and biology respectively and in relation to each other. This analysis is written in Slovenian and will be given to the Slovenian teachers for reflection.

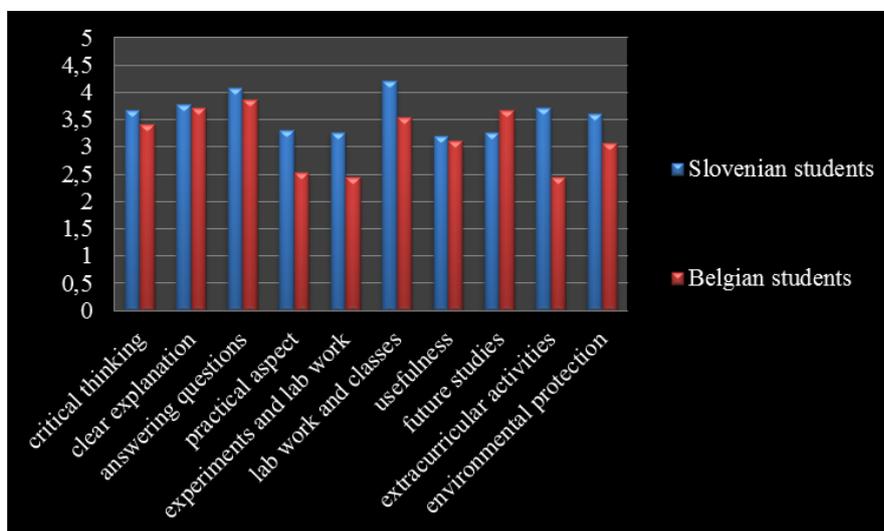


Table 8. Slovenian vs. Belgian students

As already mentioned before, the first question includes 10 sub-questions or statements:

- Our teacher encourages critical thinking and argumentation.
- Our teacher gives his/her best to explain everything as clear as possible.
- Our teacher is always willing to answer our questions.
- Our lessons are practical enough.
- There is enough time dedicated to experiments and lab work.
- Practical work in the lab goes hand in hand with what we do in the classes. The knowledge that I acquire is applicable in life and I believe I will be able to use it in the future.
- The knowledge that I acquire is a good basis for my future studies.

- At our school, we have opportunities to attend various natural science-related extracurricular activities.
- Our teacher stresses the importance of environmental protection and sustainable development and encourages us (even if indirectly) to take care of the environment.

The possible answers were: 1: totally disagree, 2: disagree, 3: undecided, 4: agree 5: totally agree.

Considering the answers, it seems that the Slovenian students are, on average, a bit more satisfied with their natural science classes than their Belgian peers. They appreciate the teachers' efforts to answer their questions (average grade: 4.067) and think that the practical work in the lab goes hand in hand with what they do in the classes (4.2 was the best average grade). In addition, they are also satisfied with the science-related extracurricular activities that the school offers (3.7) and are pretty happy with how their teachers explain the subject matter (3.767). What the Belgian students like the most is that their teachers are willing to answer their questions (3.867). They are also satisfied with the explanation they are given (3.7) and believe that the knowledge they acquire is a good basis for their future studies (3.67). On the other hand, the Belgian students quite critically evaluated some other aspects of their lessons. They believe there is not enough time dedicated to experiments and lab work (the statement *there is enough time dedicated to experiments and lab work* was given an average grade of 2.43 meaning that about 20 out of 38 students (totally) disagree with this statement) and insist that their classes are not practical enough (the statement *our lessons are practical enough* received an average grade of 2.53). In comparison to the Slovenian students, the Belgian students are dissatisfied with the extracurricular activities that the Sint-Calasanzinstituut offers (the statement *at our school, we have opportunities to attend various natural science-related extracurricular activities* was given an average grade of 2.43, again meaning that almost half of the students (totally) disagree with the statement, whereas more than 60 out of 107 Slovenian students (totally) agree with the statement (3.7)). Similar to the Belgian students, the Slovenian students also do not really believe that the knowledge they acquire is applicable in their everyday life (the statement *the knowledge that I acquire is applicable in life and I believe I will be able to use it in the future* received an average grade of 3.2). In addition, the Slovenian students also think there is not enough time for experiments and lab work (3.267); however, their lowest average grades are still for more than 0.5 points higher than the lowest average grades of the Belgian pupils. At a very important question whether *the knowledge that they acquire is a good basis for their future studies* the Belgian

students are, in comparison to the students of the Diocesan Classical Gymnasium, more convinced that what they have learnt will help them after graduating from high school (3.67 vs. 3.26).

The highest average grades (chemistry + physics + biology)

4.067	Slovenia	Our teacher is always willing to answer our questions.
4.2	Slovenia	Practical work in the lab goes hand in hand with what we do in the classes.
3.767	Slovenia	Our teacher gives his/her best to explain everything as clear as possible.
3.867	Belgium	Our teacher is always willing to answer to our questions.
3.7	Belgium	Our teacher gives his/her best to explain everything as clear as possible.
3.667	Belgium	The knowledge that I acquire is a good basis for my future studies.

The highest average grades per subject

4.3	chemistry, SI	Our teacher is always willing to answer our questions.
4.2	physics, SI	Practical work in the lab goes hand in hand with what we do in the classes.
4.2	biology, SI	Our teacher gives his/her best to explain everything as clear as possible.
4.1	chemistry, BE	Our teacher is always willing to answer to our questions.
3.8	physics, BE	Our teacher is always willing to answer to our questions.
3.7	biology, BE	The knowledge that I acquire is a good basis for my future studies.

The lowest average grades (chemistry + physics + biology)

2.433	Belgium	At our school, we have opportunities to attend various natural science-related extracurricular activities.
2.433	Belgium	There is enough time dedicated to experiments and lab work.
2.533	Belgium	Our lessons are practical enough.
3.2	Slovenia	There is enough time dedicated to experiments and lab work.
3.267	Slovenia	The knowledge that I acquire is a good basis for my future studies.

3.3	Slovenia	Our lessons are practical enough.
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The lowest average grades per subject

2.3	biology, BE	There is enough time dedicated to experiments and lab work.
2.4	chemistry, BE	At our school, we have opportunities to attend various natural science-related extracurricular activities.
2.4	physics, BE	At our school, we have opportunities to attend various natural science-related extracurricular activities.
2.8	biology, SI	There is enough time dedicated to experiments and lab work.
2.9	chemistry, SI	The knowledge that I acquire is applicable in life and I believe I will be able to use it in the future.
3.2	physics, SI	The knowledge that I acquire is applicable in life and I believe I will be able to use it in the future.

The greatest difference in the average grade between Slovenia and Belgium:

3.7	Slovenia	2.43	Belgium	At our school, we have opportunities to attend various natural science-related extracurricular activities.
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The smallest difference in the average grade between Slovenia and Belgium:

3.767	Slovenia	3.7	Belgium	Our teacher gives his/her best to explain everything as clear as possible.
3.2	Slovenia	3.1	Belgium	The knowledge that I acquire is applicable in life and I believe I will be able to use it in the future.

To conclude with this first question, it should be mentioned that the statement *the course of a lesson is always the same (meaning our lessons are too monotonous)* was excluded from the analysis so it deserves a quick attention at this point. Even though there are quite some students who think that their classes are in general monotonous, more than 50 % of both Slovenian and Belgian students (totally) disagree with the above-mentioned statement.

4.2 The Second Question

The second question says: *please, indicate the frequency of the following activities*. The students were asked to evaluate the following statements:

- While explaining the subject matter, our teacher writes on the blackboard.
- Our teacher uses the Internet, visual material, models (e.g. 3-D molecule structures), etc.
- Our teacher uses many different teaching approaches (demonstration, group work, independent work, pair work, homework assignments, etc.).
- Our teacher gives real life examples and makes reference to everyday life.
- Our teacher does an experiment.
- Our teacher mentions current events and innovations from his/her area and makes comments on them.
- Our teacher points to similar topics in other subjects (e.g. when you deal with a certain topic, your teacher says, for example, you will meet this in maths) and encourages us to make use of our knowledge.

The possible answers were: 1: never, 2: rarely (several times a year), 3: sometimes (once a month, 4: often (at least every second lesson), 5: regularly (every lesson).

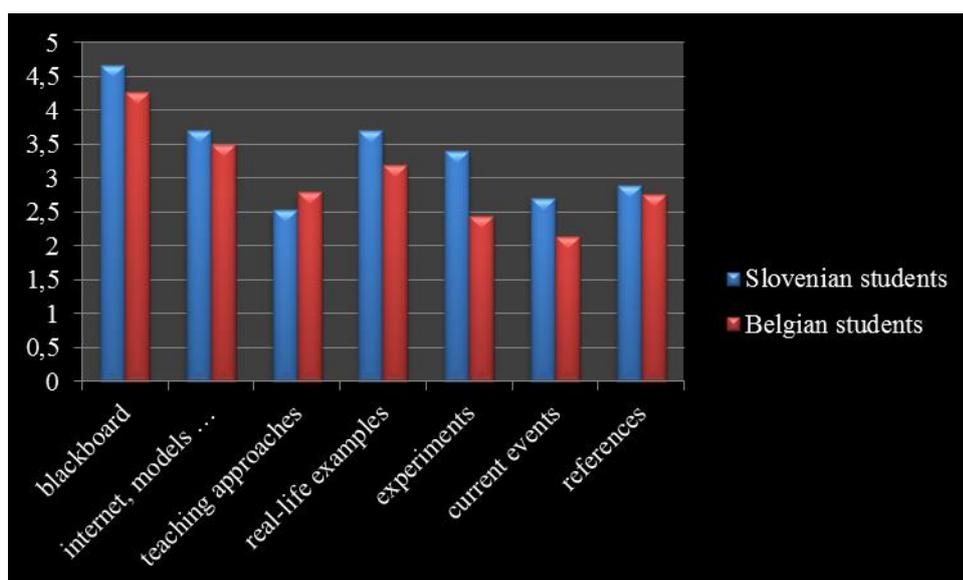


Table 9. Slovenian vs. Belgian students.

The results suggest that both Slovenian and Belgian teachers use blackboard very often during their classes. More regular than sometimes (what would mean once a month), they also use the Internet, visual material, models (e.g. 3-D molecule structures), etc. and give real life examples and make reference to everyday life. In addition, the Slovenian teachers also do experiments more regular than sometimes. However, conducting experiments vary a lot from subject to subject. Both at the Diocesan Classical Gymnasium and the Sint-Calasanzinstituut, the physics teachers are the ones who perform experiments more often than their colleagues

who teach other natural science subjects (average grades: 4.0 in Slovenia and 2.8 in Belgium comparing to 3.3 for chemistry and 2.2 for biology in Slovenia and 2.6 for chemistry and 1.9 for biology in Belgium). According to the students' answers, the Slovenian teachers are not very innovative when it comes to teaching methods. As far as using different teaching approaches (demonstration, group work, independent work, pair work, homework assignments, etc.) is concerned, they were graded with an average grade of 2.5 meaning they use different teaching approaches somewhere between rarely and sometimes. The Belgian teachers do a bit better in this area with an average grade of 2.8., but they are less successful when it comes to mentioning current events and innovations and making comments on them (average grade 2.13).

To conclude, there were no average grades below two and only two below 2.5. This means that the teachers (even if not often enough) try to use different teaching methods, strategies, materials, conduct experiments, mention different events, make references, etc. during their classes. Of course this is a positive sign which shows that the teachers want to come closer to their students and put efforts in designing their lessons.

4.3 Are Natural Science Classes Intertwined?

The next question was whether the natural science classes are intertwined (related, connected) with each other.

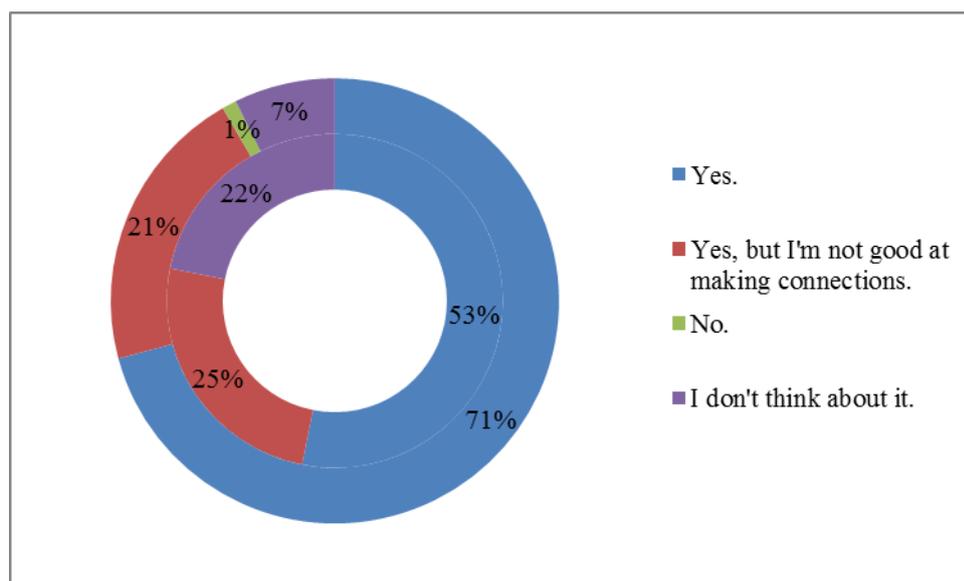


Table 10. Presentation of the answers (inner circle: Belgium; outer circle: Slovenia).

The results suggest that the students of both schools largely believe that the natural science classes are somehow intertwined. However, about 25 % of them think they fail to make connections. One Slovenian student thinks that there is no connection between the natural science subjects and 22 % of the Belgian students do not really speculate about connection (e.g. when they study chemistry, they study chemistry and do not care about physics).

4.4 Positive and Negative Features of the Classes and Suggestions

There were also two questions where the students can name positive and/or negative features of their classes and suggest changes or improvements to make their classes more interesting, close to life and useful.

In the following, their answers are compiled together into larger “units”. Those answers that do not fit into any of these units and come up only once or twice are omitted. The answers of the Belgian students are underlined and the answers of the Slovenian students are written in italics.

Positive features:

- good teachers (e.g. awesome chemistry teacher, teachers ready to help ...);
- interesting and good explanation;
- the use of videos, powerpoints, you tube, etc. to support the explanation;
- enough exercises;
- learn a lot for future studies;
- *many experiments at physics*;
- *lab classes*;
- *interesting and good explanation*;
- *additional explanation if needed*;
- *real-life examples, exercises related to everyday life*;
- *usefulness*.

Negative features:

- not enough experiments and lab classes;
- too much theory (e.g. the subject stays very theoretical);
- too difficult;
- too small classrooms and bad chairs;

- *too fast explanation (especially at physics);*
- *not enough interaction (e.g. a teacher speaks and students listen to him and make notes);*
- *lack of group, pair and independent work;*
- *not enough videos;*
- *not enough experiments at biology;*
- *lack of reference to real life.*

The survey results suggest that the Slovenian students think that physics is the most and biology the least practical. However, they believe that the knowledge they obtain at biology is more useful in their everyday lives and serves as a good basis for their university studies. As for biology, they would like to do more experiments and get more visual material (pictures). Last but not least, they would love to spend more time outdoors. On the other hand, the Belgian students find chemistry the most practical and believe that the natural science classes provide them with the knowledge they need for their future studies.

In general, both students like lab classes and would not have anything against if there were more lab classes in a year. As for the last question, a great number of the Belgian students stressed that they would like to do more experiments and the results from one of the previous questions reveal the same (*lessons are practical enough*: average grade 2.53 and *there is enough time for experiments and lab work*: average grade 2.43). The Slovenian students really like that their physics teachers do a lot of experiments during their lessons; however, they would love to conduct some of them on their own, too. In addition, some of the Belgian students mentioned that the natural science classes are very demanding and that they sometimes do not understand everything. The Slovenian students, on the other hand, were more critical to the explanation insisting that sometimes they do not understand the explanation of their physics teachers. Taking into consideration that physics is quite a demanding subject, it is not surprisingly that some students have difficulties in understanding physics.

As far as suggestions for improvements are concerned, the Belgian students were quite unanimous and did not offer many suggestions. They only had two suggestions: more experiments and reference to real life (getting to know how they can use the things they learn in their lives). On the other hand, the Slovenian students would also like to meet more real life examples. In addition, they do not like learning by heart and would like to be more actively involved in their lessons. They believe that they would learn more if their lessons were more

diverse and dynamic (watching videos, animations, working in pairs, in groups or individually, doing more experiments and having discussions, etc.). If this comes true, they believe that they will not forget as much as they do now.

5 Analysis of the Recorded Lessons

For the purpose of this study, 11 natural science classes were recorded – 7 at the Diocesan Classical Gymnasium and 4 at the Sint-Calasanzinstituut – and submitted to InERD for further analysis. The aim of the recordings was to take a closer look at lessons (how they are designed and carried out), point to similarities/differences and above all to encourage the teachers of both schools to reflect on their work and thus find areas in which they can further improve. It should be stressed that we did not check the quality of lessons with these recordings. We were, above all, interested in teaching methods.

As already mentioned before, there were 11 recordings submitted to InERD: three chemistry classes from Slovenia (two regular lessons and one lab class), two physics classes from Slovenia, two biology classes from Slovenia (one regular lesson and one lab class), three chemistry classes from Belgium (one regular lesson and two lab classes) and one biology class from Belgium (a regular lesson).

Before watching the recordings, we had decided on the features we wanted to pay attention to while watching the recordings and created 14 different categories. The researchers at InERD watched the recordings carefully and counted the occurrence of each of these features. Due to the language barrier (the lessons recorded in Belgium were in Flemish), some features of the Belgian lessons could not be assigned to any of the categories.

The categories helped us observe the teaching methods that were used in the recorded classes. Considering the results, InERD prepared a survey for natural science teachers and for students to confront the teachers' opinions on their lessons with the students' opinions on how lessons should be carried out.

The next charts correspond to 14 categories that were observed during the careful examination of the recordings. Some of the categories were only established for the Slovenian lessons: *references to other subjects or mentioning other subjects; real life examples, references to everyday life; interesting facts; oral examination; homework*. With an exception of oral examination, the other categories could not have been observed because of the language

barrier. As far as oral examination is concerned, it can be mentioned that there is a difference in systems at this point. At the Diocesan Classical Gymnasium, oral examination is usually part of a lesson whereas at the Sint-Calasanzinstituut, oral examination does not take place during regular lessons but along with the exams.

subject	teacher-student interaction (a teacher poses a question, students response or engage in conversation)
chemistry (SI)	40
chemistry (SI)	56
chemistry (SI), lab classes	12 (interaction during conducting experiments is not included)
physics (SI)	84
physics (SI)	16
biology (SI)	7
biology (SI), lab classes	No interaction during the instructions and a lot of interaction during practical work.
biology (BE)	4
chemistry (BE)	23
chemistry (BE), lab classes	3 questions during the instructions and a lot of interaction during practical work.
chemistry (BE), lab classes	3 questions during explanation/instructions and a lot of interaction during practical work.

The survey results of the Slovenian students suggest that chemistry lessons are the most monotonous. However, there was quite a lot of teacher-student interaction in the recorded chemistry classes suggesting that the teachers ask questions and encourage students to participate in the class. As far as the Belgian regular chemistry lesson is concerned, there were 23 cases of teacher-student interaction in about 30 minutes (from 33 minutes on the recording stopped working). What struck us while watching this recording (even though we did not understand the language) was that the teacher really tries to involve her students in the lesson to the best possible degree (questions, facial expression, etc.).

There was a significant teacher-student and student-teacher interaction in the first physics class. It was a highly interactive lesson with a lot of participation of the students and various activities and material (discussion, explanation, experiments, pictures, handouts).

The second physics class is marked with less interaction but the teacher did four experiments in the class and the students got the opportunity to give it a try and do one of them.

There were only seven cases of interaction in the first biology class. However, the teacher did check if the students understand and follow her. The Belgian biology lesson is marked with even weaker teacher-student interaction.

Subject	student-teacher interaction (a student ask a question, express his/her opinion without being asked for it)
chemistry (SI)	6
chemistry (SI)	1
chemistry (SI), lab classes	13 (or even more: the students are divided into groups to conduct experiments and it is not always clear from the recording if they discuss something with the teacher or really ask questions).
physics (SI)	21
physics (SI)	no questions
biology (SI)	1 (+ one girl raises her hand but the teacher doesn't notice her).
biology (SI), lab classes	One question during the instruction time and many questions during practical work.
biology (BE)	3
chemistry (BE)	13
chemistry (BE), lab classes	Many questions during practical work.
chemistry (BE), lab classes	Many questions during practical work.

Considering the above chart, it seems that the students do not ask many questions at biology both in Slovenia and Belgium. The situation is better with chemistry and physics.

subject	revision and exercises
chemistry (SI)	Indirect revision

chemistry (SI)	Oral revision: what they did in the lab classes; one exercise (on the blackboard); at the end, the teacher sums up and asks some questions.
chemistry (SI), lab classes	Exercise (first individual work and then they go through the exercise together to check the answers); practical work.
physics (SI)	Oral revision at the beginning of the lesson (with key words on the blackboard).
physics (SI)	Exercise (the teacher picks a student to come to the blackboard to do an exercise with his help; it is an introduction to a new topic).
biology (SI)	Oral revision at the beginning of the lesson (the teacher sums up what they have already learnt).
biology (SI), lab classes	Practical work
biology (BE)	Not understood from the context.
chemistry (BE)	Exercises (in form of an independent work, the teacher goes around and offers help where needed).
chemistry (BE), lab classes	Practical work.
chemistry (BE), lab classes	Practical work.

Revision is very important for refreshing what has been learnt. Due to the language barrier, it was impossible to find out if there was any form of revision in the recorded Belgian classes.

As far as exercises are concerned, it seems that the students like taking exercises to test their knowledge. There were quite some students that suggested that they should be given more exercise to be surer of their knowledge and better prepared for the tests.

To do an exercise as an introduction to a new topic is a very good idea, because it involves the students who are, consequently, more concentrated on the topic.

In addition, we really liked how one of the Belgian teachers organised the exercise work. She told her students what to do and then they worked independently. She was kind of a supervisor and offered help if it was needed.

subject	using a blackboard
chemistry (SI)	No.
chemistry (SI)	Yes.
chemistry (SI), lab classes	No.
physics (SI)	Yes.
physics (SI)	Yes.
biology (SI)	Yes. (In addition to writing on the blackboard, she also sketches some pictures.)
biology (SI), lab classes	No.
biology (BE)	No.
chemistry (BE)	Yes.
chemistry (BE), lab classes	Yes.
chemistry (BE), lab classes	Yes.

The recorded lessons suggest that the teachers who had power point presentations for explaining the subject matter do not use the blackboard (with an exception of one lesson).

We believe that power point is a great tool; however, it might be difficult to follow the explanation if you are shown too many slides per lesson.

subject	using a computer
chemistry (SI)	Yes, (power point).
chemistry (SI)	Yes. (The teacher shows an animation of neutralisation titration in English; they watch it step by step and make comments in between.)
chemistry (SI), lab classes	No.
physics (SI)	Yes, (to show some pictures).
physics (SI)	Yes, (to show an experiment).
biology (SI)	No.
biology (SI),	No.

lab classes	
biology (BE)	Yes. (Power point presentation, 3 you tube videos. The videos were in English.)
chemistry (BE)	No.
chemistry (BE), lab classes	No.
chemistry (BE), lab classes	Yes. (Power point presentation for the explanation of a new formula.)

In 6 out of 11 classes, the teachers made use of a computer. Three teachers used the computer for explaining the subject matter with the help of a power point presentation. Two of them only used their power points and did not write a single word on the blackboard. Other teachers used their computers to show videos or experiments.

In the suggestion part of the student questionnaire, many students wrote that it would help them a lot if they were shown more videos, animations, short films, etc. during their classes. In addition, watching videos, films, etc. would also enrich the lessons.

subject	a teacher shows something, uses visual material
chemistry (SI)	partly (pictures on power point)
chemistry (SI)	Yes. (The teacher shows burette and passes it to the class to take a look at it; she also shows an Erlenmeyer flask and a beaker and tells the difference between them.)
chemistry (SI), lab classes	Yes. (The teacher shows the equipment they are going to use to conduct experiments.)
physics (SI)	Yes. (The teacher shows some pictures.)
physics (SI)	Yes. (The teacher has some objects for conducting experiments.)
biology (SI)	Yes. (The teacher shows pictures on transparencies and points to pictures in the so-called picture supplement.)
biology (SI), lab classes	Yes. (The teacher shows the equipment they are going to use to conduct experiments.)
biology (BE)	Yes. (The teacher shows some pictures.)
chemistry (BE)	No.
chemistry (BE),	Yes. (The teacher shows the equipment they are going to use.)

lab classes	
chemistry (BE), lab classes	Yes. (The teacher shows the equipment they are going to use.)

In almost all of the recorded classes, the teachers used visual material. This is very praiseworthy. According to the questionnaire results, the students like if their teachers uses visual material.

subject	other participation of students
chemistry (SI)	No.
chemistry (SI)	Two students come to the backboard to write down something.
chemistry (SI), lab classes	In addition to conducting experiments, 5 students read the instructions and introductory text, 2 students read the answers to the exercise, 3 students conduct an experiment with the teacher.
physics (SI)	A volunteer conducts an experiment; all students do another experiment; one student tells an anecdote; one student comes to the blackboard to draw something.
physics (SI)	The teacher does an experiment and then passes around the thing so the students can do the experiment for themselves; one student comes to the blackboard to do an exercise.
biology (SI)	No.
biology (SI)	No.
chemistry (BE), lab classes	Filling out the handouts.
chemistry (BE), lab classes	Filling out the handouts.

At this point, we would like to pay some attention to the lab classes. If we compare the Slovenian chemistry lab class with the second Belgian chemistry lab class, we come across some interesting differences. The following can serve as an idea or inspiration for those teachers who want to try something new in the future.

In the Slovenian class, the students work in pairs and in the Belgian class, they work in groups of four. The Slovenian students can make the pairs on their own, whereas in the Belgian class, it is a teacher who formed the groups. In the Slovenian class, all pairs do the same

experiments and do not have to hand in the findings/solutions when the bell rings. In the Belgian class, the teacher gives the handouts to the groups. The experiments differ from each other so that the students cannot cheat and copy from each other. Each group has to conduct two experiments and fill out the handout. They have to use a new formula that the teacher explained before the start of the lesson and hand in the handouts when the lesson is over so they have to carefully plan their work. What is similar in both classes is that the teacher walks around, checks and offers help if the students need it.

subject (lab classes are not included)	experiments
chemistry (SI)	No.
chemistry (SI)	She shows a recorded experiment.
physics (SI)	Yes. (The entire class do the same experiment and a volunteer does another experiment.)
physics (SI)	4 experiments.
biology (SI)	No.
biology (BE)	No.
chemistry (BE)	No.

The above chart proved that the physics teachers at the Diocesan Classical Gymnasium often conduct experiments during their classes.

There are, of course, not enough lessons to generalise and there is also a need to stick to the syllabus, but still the students expressed in the questionnaire a wish to have more experiments in their classes.

The next set of charts only features the Slovenian classes.

subject	references to other subjects (or mentioning other subjects)
chemistry (SI)	2, (reference to biology).
chemistry (SI)	0
chemistry (SI), lab classes	0
physics (SI)	Reference to biology (the topic of the lesson is eye lenses: eye structure,

	sight problems, conditions ...).
physics (SI)	Reference to maths (the teacher explains how something is called in maths and tell students when they are going to discuss this issue in their classes).
biology (SI)	0
biology (SI), lab classes	0

Subject (lab classes not included)	real life examples, references to everyday life
chemistry (SI)	The entire lesson is dedicated to oxygen organic compounds and where people meet them in their everyday lives.
chemistry (SI)	Yes. (alkaline vs. acidic cleaners used at home)
physics (SI)	Yes. (long-sightedness, short-sightedness)
physics (SI)	Yes. (reference to induction top)
biology (SI)	Yes. (situation in Austrian forests vs. Slovenian forests)

subject (lab classes not included)	interesting facts
chemistry (SI)	3
chemistry (SI)	1
physics (SI)	Yes.
physics (SI)	1
biology (SI)	2

subject	oral examination
chemistry (SI)	No.
chemistry (SI)	No. (postponed to the next week)
chemistry (SI),	No.

lab classes	
physics (SI)	No.
physics (SI)	Yes. (1)
biology (SI)	Yes. (2)
biology (SI), lab classes	No.

subject	homework
chemistry (SI)	No.
chemistry (SI)	Yes, but not for everyone (two volunteers are going to conduct an experiment, make a presentation and deliver it to the class).
chemistry (SI), lab classes	No.
physics (SI)	Yes.
Physics (SI)	Yes.
Biology (SI)	No.
biology (SI), lab classes	No.

subject (lab classes are not included)	other
chemistry (SI)	0
chemistry (SI)	0
physics (SI)	The students get hand outs.
physics (SI)	The students get hand outs.
biology (SI)	0

To conclude, the analysis of the recorded lessons proved what some of the results of the student questionnaire suggested: The teachers do use a blackboard and a computer. The physics teachers are those who conduct the most experiments during their lessons. There is quite some interaction during the lessons but sometimes it seems that there is too much ex-cathedra teaching. Of course, it is impossible to generalise and draw conclusions from 11

recordings. However, the results of the student questionnaire and the teacher questionnaire also suggest that more diverse teaching methods should be introduced to the lessons.

5 Conclusion

This comparative study of natural science classes in Slovenia and Belgium suggest that both Slovenian and Belgian students are quite critical towards their teachers. We believe that some of their critics/suggestions deserve consideration and reflection, whereas some of them are either unfounded or impossible to fulfil. It is clear that teachers often feel somehow restricted by the syllabus or time. This is one of the reasons why they cannot introduce new teaching methods and fresh ideas in their work. However, some of the “improvements” are not really a matter of time but rather a matter of will, e.g. supporting the explanation with visual material, videos, etc. If one is determined to make a small change for the better, there are no insurmountable obstacles that stand in his/her way. If a teacher manages to motivate his/her students, nothing can prevent him/her from being successful. We believe that the saying: *teaching is an adventure not a job* applies to the teacher of today. Being a teacher is very demanding and rewarding task at the same time.

The surveys suggest that the wishes and expectations of the students on how to design lessons partially go hand in hand with those of their teachers. The students praised the teachers for their willingness to answer the questions they have and for their efforts to explain the subject matter in an understandable way. The students appreciate the teachers’ efforts even if they sometimes fail to be clear. They often complained of not having enough lab classes or at least of not being shown enough experiments. On the other hand, the results also suggest that the students would like to come to some solutions on their own; therefore what is needed is less ex-cathedra teaching. One possible solution would be introducing more diverse teaching approaches. New technologies offer various opportunities and it is a pity if we ignore them or restrict to home use. Not only because they are modern and attractive but, above all, because the students are familiar with them and feel comfortable with them. Last but not least, we would like to mention another possible suggestion to achieve less ex-cathedra teaching. However, it requires a change in the mindset. What we have in mind is a different role of the teacher who is more of a supervisor and co-researcher than an all-knowing instructor. One who gives hints, explains and leads his/her students to find some answers on their own.

We hope that this study points to some strong and weak points of the natural science classes at the Diocesan Classical Gymnasium and the Sint-Calasanzinstituut and will also trigger some changes and encourage reflection.

6 Attachments

6.1 Teacher Survey

Q1 - From 1 to 5 evaluate the following statements (1 means extremely unimportant/extremely unsuccessful and 5 means extremely important/extremely successful).

	How important is ... to you?					How successful are you in ...?				
	1	2	3	4	5	1	2	3	4	5
encouraging critical thinking and argumentation?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
explaining the subject matter in a way that is understandable to students?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
making lessons as practical as possible (e.g. you do an experiment, show something, etc.)?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
making lessons as interesting/diverse as possible (including other methods of work rather than just ex cathedra teaching)?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
passing on the knowledge that is useful in everyday life?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
using real-life examples (from everyday life)?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
having lab classes?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
encouraging your students to take care of the environment?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
getting on well with students?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q2 - To what extent do you agree with the following statements?

	Totally disagree.	Disagree.	Agree.	Totally agree.
It is difficult to motivate students.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel restricted by the syllabus.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I must explain the subject matter fast otherwise I don't have enough time to discuss everything.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There are many students who learn everything by heart.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I don't have enough time for discussion during my classes.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q3 - In which areas of teaching do you feel you perform competently and successfully?

Q4 - Where do you see the potential to further improve your teaching? In which areas of teaching do you feel you would still like to develop your skills?

6.2 Student Survey

Q1 - Please indicate to what extent you agree or disagree with the following statements.

	Totally disagree	Disagree	Undecided	Agree	Totally agree	Totally disagree	Disagree	Undecided	Agree	Totally agree	Totally disagree	Disagree	Undecided	Agree	Totally agree
Our teacher encourages critical thinking and argumentation.	<input type="radio"/>														
The course of a lesson is always the same (meaning our lessons are too monotonous).	<input type="radio"/>														
Our teacher gives his/her best to explain everything as clear as possible.	<input type="radio"/>														
Our teacher is always willing to answer our questions.	<input type="radio"/>														
Our lessons are practical enough.	<input type="radio"/>														
There is enough time dedicated to experiments and lab work.	<input type="radio"/>														
Practical work in the lab goes hand in hand with what we do in the classes.	<input type="radio"/>														
The knowledge that I acquire is applicable in life and I believe I will be able to use it in the future.	<input type="radio"/>														
The knowledge that I acquire is a good basis for my future studies.	<input type="radio"/>														
At our school, we have opportunities to attend various natural science-related extracurricular activities.	<input type="radio"/>														
Our teacher stresses the importance of environmental protection and sustainable development and encourages us (even if indirectly) to take care of the environment.	<input type="radio"/>														

Q2 - Please, indicate the frequency of the following activities.

	Never	Rarely (several times a year)	Sometimes (once a month)	Often (at least every second lesson)	Regularly (every lesson)	Never	Rarely (several times a year)	Sometimes (once a month)	Often (at least every second lesson)	Regularly (every lesson)	Never	Rarely (several times a year)	Sometimes (once a month)	Often (at least every second lesson)	Regularly (every lesson)
While explaining the subject matter, our teacher writes on the blackboard.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Our teacher uses the Internet, visual material, models (e.g. 3-D molecule structures), etc.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Our teacher uses many different teaching approaches (demonstration, group work, independent work, pair work, homework assignments, etc.).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Our teacher gives real life examples and makes reference to everyday life.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Our teacher does an experiment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Our teacher mentions current events and innovations from his/her area and makes comments on them.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Our teacher points to similar topics in other subjects (e.g. when you deal with a certain topic, your teacher says, for example, you will meet this	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Never	Rarely (several times a year)	Sometim es (once a month)	Often (at least every second l esson)	Regularl y (every lesson)	Never	Rarely (several times a year)	Sometim es (once a month)	Often (at least every second lesson)	Regularly (every lesson)	Never	Rarely (several times a year)	Sometim es (once a month)	Often (at least every second lesson)	Regularl y (every lesson)
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in maths) and encourages us to make use of our knowledge.

Q3 - Do you think that biology, chemistry and physics are intertwined (related, connected) with each other.

- Yes, if you understand what you've been learning, you can notice that they are related with each other.
- Yes, but I am not very good at making connections between subjects.
- No, each subject is a world for itself.
- I do not think about it. When I study chemistry, I think about chemistry, when I study biology, I think about biology and so on.

Q5 - Name three positive and three negative features of your classes (you can write about natural science classes in general or you can write about a particular subject).

Q6 - What is your proposal for changes or improvements? What would you change (if anything) to make your classes more interesting, more close to life and useful?

Q8 - Gender

- female
- male

Q9 - Class