Guide working students through SPU

Secondary Education, age-group 16 to 18

A Working Guide for Teachers of Science for Public Understanding (SPU)

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Enschede, the Netherlands, 2003

These activity sheets were produced on the basis of students' and teachers' experiences. The following teachers lent their assistance to the realisation of this publication:
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∘ easy to realise ∘∘ more complicated to realise

Introduction

SPU, more than just a school subject

Science for Public Understanding is about enabling students to deal with scientific information, to make well-considered choices and to take part in discussions.
Science for Public Understanding is a new subject, which is continually developing. Each teacher makes his or her own contribution together with the students.
The six key questions are:
– How is scientific knowledge generated?
– How is scientific knowledge used?
– How do you know whether something is true?
– How do society and science influence one another?
– What is your opinion on certain applications of science?
– Is everything possible also allowed?
The scientific content serves as a support and can change. It is important that the content fits in with topicality and current events.
Effective use of time and energy is a necessity.

Limited time

Science for Public Understanding is rounded off with a school examination. This offers possibilities. Make sure that your study planning and programme as well as the students' activity sheets are not experienced as a straitjacket. Draw them up so that they form a flexible framework, and it is probably more advisable to arrange them in domains rather than chapters.

Working guide objectives

This working guide comprises a number of activity sheets, which give teachers the possibility to try out new methods in the organisation, new ways to deal with the subject matter and the implementation of new working methods. Each activity sheet contains one or more of the following points of attention:

– Reinforcement of the interaction among students and teacher, a way to further collaborative conceptualisation of education in Science for Public Understanding
– Better use of the interaction with teachers of the same subject, to further a more effective use of time, energy and creativity. Benefit from experiences of colleagues.
– Gaining understanding of the specific characteristics of the subject Science for Public Understanding against the background of their own mono-subject biology, physics or chemistry.
– Ensure that less pressure is put on the teacher. Make better use of the opportunities offered by the textbook and prevent the textbook from being a straitjacket. Give more leeway to the effects of the personal work and the work of students.
The working guide including the activity sheets has been developed together with teachers in Dutch teaching practice. Teachers and students commented on lessons where activity sheets were used. These comments have been incorporated, and thus the working guide has been adjusted. The considerations and reflections of teachers are mentioned in the working guide.

How to use the activity sheets

Some of the activity sheets put the emphasis on one of the points of attention.
Most of them, however, offer a hybrid of points of attention. Some teachers are more experienced than others in teaching SPU-like topics. The degree of complexity is marked by dots, one dot ° meaning easy, two dots °° meaning a bit more complicated, and three dots °°° meaning that ample experience in working with alternative working methods is required of the teacher.
We hope that each SPU teacher will find something to suit his or her own teaching style, and that there is sufficient leeway for everybody's personal insight and personal benefit.
The activity sheets can be downloaded from www.slo.nl/anw. On this site you can also find the addresses of other relevant websites.

Tips

– Contact an SPU colleague outside your own school, who uses the same textbook. Exchange ideas and experiences on absolutely anything. Try to keep the balance between giving and taking. Don't demand the impossible.
– Include a few hours of Internet-search into your planning of a series of lessons. Make use of a search engine. Type in the key words that you find important, and get inspired by the results of the search. See paragraph: 'Using the Internet efficiently'. Adapt the materials you find on the Internet to your own needs. 'A good pinch can be better than a bad invention'.
– Make a top ten chart of SPU sites and visit them regularly. Discover what sites are regularly updated. See paragraph: 'Using the Internet efficiently'.
– Ensure that the educational publisher of your textbook knows that you are an SPU teacher, so that you receive their current information.
– Give the students the practical assignment to assess websites with respect to clearly structured information, attractiveness and reliability. In this way the teacher learns at the same time.
– Make sure there is enough light, fresh air and space in your SPU-lessons.
– Make SPU a contemporary subject, an active subject, a subject for opening up new horizons and for breaking new grounds.

SPU, breaking new grounds

More than just the textbook

Why

Teachers can protect themselves from overburdening by drawing lines. That's a way to put limits to the amount of your own work and to reduce insecurity. Sometimes, however, the lines teachers draw can form blockades and impede creativity. To avoid this happening keep on asking yourself questions while drawing the lines.
Every teacher has the chance to develop his or her own SPU-style. The content of the SPU-textbook can serve as a basis. Include current topics from the news in your programme. Put your colleagues' suggestions into practice. Students often come up with their own ideas for the lessons. Listen to them.
Every year you can build on your own SPU experiences, those of your students and those of your colleagues. Decide for yourself when and where you want to develop SPU further, and which should be the logical steps.

What

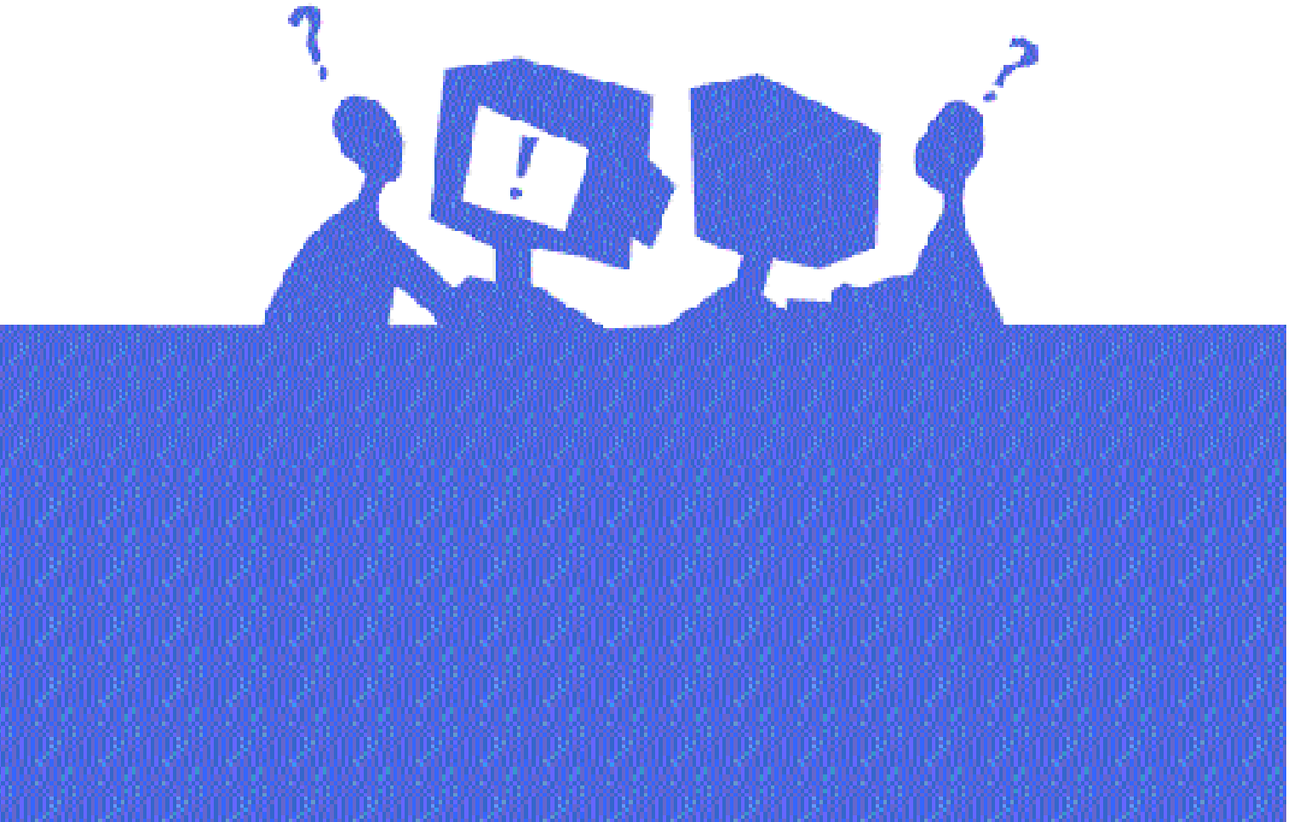
There are quite some organisations that develop materials for an SPU course and make those available via the Internet or by means of learning packages. Make use of them. At SPU conferences colleagues exchange their own ideas and experiences. Make use of your own experiences and those of others. Within school there are lots of possibilities to collaborate with colleagues of other subjects: English, history, geography, philosophy, religious education, arts. Make use of the possibilities in your direct school environment: Visit the open days of companies, public hearings or exhibitions.
Ask the students for suggestions.

How

– Make sure the structure of the lessons is clear to all students. Base this structure on the textbook, just to have something to hold on to.
– Include in your planning some lessons 'to be worked out later', so that you have the possibility to seize upon current events in the course of the year.
– Before you start a new series of lessons, take some time to consult some SPU assignment-sites. What can you use immediately, and what can be used in an adapted form in the long run?
– Make your rounds along the homepages of associations and organisations that the students can visit on their own. Let a smart student make an SPU-starting page for those sites.
– Visit students' sites regularly and use the ready-made presentations you find there as source materials for new assignments.
– Don't be a slave of the traditional limitations: the limitations of the textbook, the classroom, the school building, a limited horizon, the mono-subject, and ..... your own role as a teacher!

When

In the first lessons, try to fit current topic materials into the topics of your lessons. In the course of the school year you may want to deviate from the original schedule of your lessons for a retrospective, or because there is some very interesting news.
In their practical assignments students can make ample use of SPU source materials other than the textbook, but ensure that there is enough time for the students to handle the study load of the assignment.
Start with a modest assignment: 1-hour study load. It works better to regularly make little excursions away from the book than to start with an extensive current topic, where both students and teachers run the risk to be driven off course.



Tips

– Sit next to a student who is searching on the Internet, and ask why he or she does it in that particular way. Make use of other people's searching experience and ask for tips.
– If the search does not lead quickly to the desired result, blame the sites for user unfriendliness rather than blaming the one who is searching.
– Try not to save everything. Particularly useful information can be saved as a document after cutting and pasting. Open next to the internet explorer a word processing programme, select the interesting parts, copy them and paste them into the document. Also copy the name of the website and give a short description of what you want to use the information for. Give the document a unique name when you save it.
– Use the search engine www.google.com and search for several keywords at the same time. You can also find illustrations via www.google.com by clicking on 'illustrations' or 'pictures'.

Using the Internet efficiently

Finding what you are looking for

Why

To be a good SPU teacher it is important to supplement your professional knowledge by learning to find your way on the Internet. On the Internet you can find a lot of information that can be useful for your lessons, but often the information is not structured or not directly accessible. There is a danger that you get lost in all the information.
The idea is that teachers also use the Internet to find what they are looking for, instead of letting the results of an at random search rule them. It is also important that the teacher learns how to assess quickly, whether the information on the website is reliable and relevant with respect to the search question.
Via school-websites it is possible to visit the teachers' pages of SPU colleagues: such an exchange is always informative and valuable.

What

The Internet opens the doors to all sorts of places all over the world. On the Internet you can visit a company or a virtual museum. On the Internet you can find course materials with illustrations, animations of schools and universities inside and outside your own country, as well as examples of tests and quizzes.
On several sites you find practical assignments for SPU, which can be copied and adapted to your own needs. On the Internet you can find a great supply of illustrations, which can be very useful for your lessons or for tests. Via the Internet you can visit the archives of newspapers and (scientific) journals. The government publishes more and more on the Internet, which makes it possible to read official publications directly.

How

– The search starts with a search question. Take your time to think of what the search question exactly is. Write it down in keywords, which can serve as search words. Make an estimate of which sources of information will lead to a quick and reliable result. The Internet is not always the first choice.
– Click the 'back' button to go back to the last page you visited. Click on 'history' to go back directly to a page you saw much earlier.
– Use the button 'favourites' to create folders where you save the addresses of websites you often visit.
– Put limits to the searching time on the Internet. If the search question does not lead to the desired result within a limited period of time, give priority to an alternative source of information, email for instance to an SPU colleague.
– Always be critical of the reliability of the information found.

When

Suitable Internet sites can be very convenient for the preparation of your lessons as well as for brushing up your own knowledge.
The Internet can also be a source for good illustrations to use for transparencies, working sheets or tests. In that case the language is not an obstacle, and you can search worldwide.
When educational policy changes are announced, the teacher has direct access to the latest information on the current rules and on educational policy.
As for assignments, it can be useful to get an impression beforehand of the information students can find on the Internet.
The Internet can be a very good resource if you want to get ideas for your lessons. School-websites, and especially those developed for SPU offer a variety of information.

Tips

– Popular newspapers offer inimitably clear and short articles. Why use difficult, long texts if the same can be achieved with short and clear articles.
– On the Internet you can search in archives of national and regional newspapers. It is no longer necessary to cut, paste and save yourself.
– Visual materials such as photographs, infographics and cartoons appear in newspapers only. Collect them together with the accompanying article and the date of publication.
– Current affairs are an opportunity, not a burden for SPU lessons. A modest, well-chosen use of them is preferable to very ambitious plans.
– For use in tests or whole-class lessons cut away those parts of the text, which are not absolutely necessary. After all the point is to offer background information, it's not a training in extensive reading.
– Do not make reduced copies of bigger articles. This has a discouraging effect and is definitely a problem for dyslexic students.
– Discuss more extensive assignments where newspaper articles are used with your colleagues to avoid overlap.

A teacher's reflection

'What struck me most was that students mainly chose medical-biological topics. I made pairs of students present transparencies on a newspaper article. That's how they learn to give presentations and to look for SPU–topics in the news. I assumed that students would bring their own articles to the lesson. That's exactly what they do, if you set the example. Present some articles yourself regularly and discuss them in your lesson. It's my task now to integrate the topics students come up with into my lessons.'

Current affairs

The news as a source for SPU

Why

SPU is on the news every day, because SPU is about the interaction between science, technology and society. And this is everyday news. Including recent news from the newspaper or TV into your lessons will get the students more involved, which is motivating. Current topics make SPU dynamic, because it is a surprise which news will be a topic in the lessons later in the year. The students can get to work with current topics on the basis of the six SPU key questions. Examples from the times when the SPU-textbook was developed are often outdated. SPU as a subject is continually developing; today's and tomorrow's society asks for new topics to be dealt with.

What

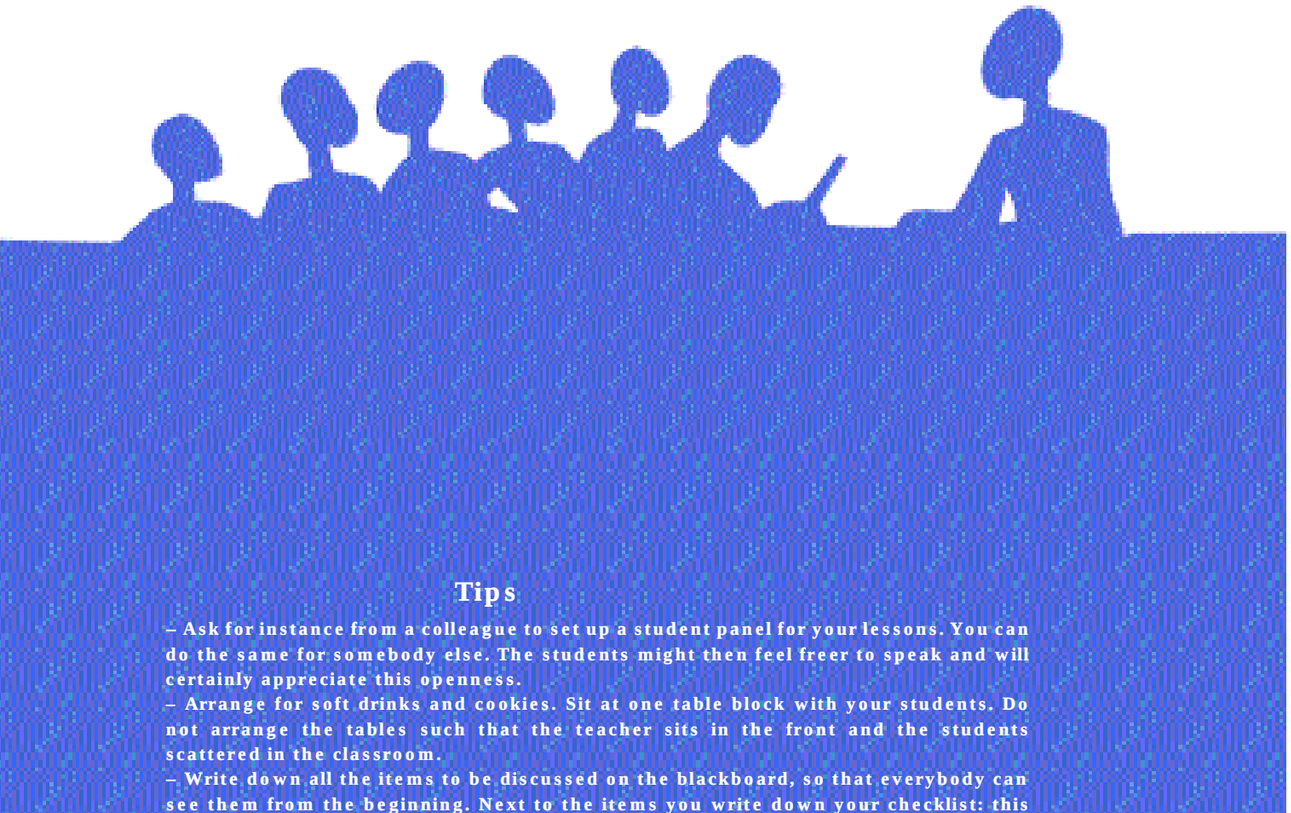
Front-page news can be used as a swing-in for a new lesson. Hot topics outside the lesson can also catch on. Salient fragments of the TV news on video can serve as an introduction or as an impetus for discussion for years. Interviews and fragments of discussions from a talk show can be used for a long time as an example of important SPU topics. In the students' perception newspaper articles get out of date sooner than visual material.
Not everything you can find in scientific supplements of newspapers is suitable for use in the classroom. Short letters to the editor can come in handy for tests. Dossiers of digital newspapers give a good survey of socially relevant SPU-topics. Ask the students which sources of information they find attractive and include their suggestions in the programme.

How

– Look in the SPU-textbook for topics that are related to current topics in the news. This can be a useful criterion for selection and protects you from being swayed by the issues of the day.
– Let students work through a dossier of a (digital) newspaper for three weeks. Give them the practical assignment to make a synopsis in the form of a summarising general article, in which at least two key questions of SPU are addressed.
– Let pairs of students in a whole-class assignment address one or more SPU questions working with some short newspaper articles. Distribute five to eight different articles, let the pairs of students hand them in halfway through the lesson. Let other pairs of students look at the work and let them write a well-founded assessment
– Include in your planning that all students are allotted five minutes speaking time for a report that struck them the most. Besides a short summary of the content it is important that they make clear why the report struck them as special and why they find it very suitable for SPU lessons.

When

Using a fragment from the TV news or a newspaper as an introduction is motivating for the teacher and the students. A newspaper article followed by a letter to the editor can be very useful and stimulating as a first step towards a debate or a discussion. A good general newspaper article or a digital section of a newspaper can replace a paragraph or article from the textbook. The science supplement of a newspaper can serve as a source of information for a practical assignment on current scientific issues. A newspaper article on a current topic can be used as part of a test, thus giving the possibility to put the SPU main questions in a new context. To prevent fraud with the composition of written papers it is advisable to allow recent articles only as a source of information.



Tips

– Ask for instance from a colleague to set up a student panel for your lessons. You can do the same for somebody else. The students might then feel freer to speak and will certainly appreciate this openness.
– Arrange for soft drinks and cookies. Sit at one table block with your students. Do not arrange the tables such that the teacher sits in the front and the students scattered in the classroom.
– Write down all the items to be discussed on the blackboard, so that everybody can see them from the beginning. Next to the items you write down your checklist: this can also lead to new suggestions.
– Give students some time to prepare the discussion. Leave the organisation of the panel to the students themselves as much as possible. This will not take time, but rather save time!
– Hang the conclusions of the discussion up on a notice board or write them down in a class book. Put questions such as:
– Imagine you are the Deputy Headmaster and your headmaster asked you to propose some measures to improve the achievements of students in SPU. What would be your suggestions?
– Can you think of things that should be organised differently next year for the students?

A teacher's reflection

'In one of my lessons I asked six students to join a panel. I went with them into a separate classroom. The rest of the students went on with their work.
I explained to the panel what I thought their task should be, and I mentioned four points that should be discussed in any case: the organisation of the lessons, the optional assignments, the relevance of SPU and autonomous working.
I chose this way of organising it, because that saves the students extra time.
By choosing them myself it was up to me who would join the panel. For a first time this seemed a good idea to me. I expected a lot of criticism concerning the lessons. But the students only mentioned positive things. Only at my urgent request a few points of criticism were cautiously vented. Some of the students I had to invite explicitly to express their own opinion.
I found it a nice way of talking about the lessons with the students. A panel is in fact a suitable method to do that. The working guide is very clear to me. The next time students must have more time to think about and formulate points for improvement. Next time I shall ask them earlier to take part in the panel and to think of at least one point for improvement.'

Student panels

Teacher and students content discussions

Why

Students appreciate that teachers regard them as equal partners in content discussions. They like to take part in discussions and to make suggestions for improvement. Sometimes students can see possibilities that the teacher can't see, and they can be very open about it! It is therefore advisable to arrange situations where the lessons are discussed with some of the students. In this way teachers can improve the contact with students, which is very valuable. Unfortunately many of the professional interactions between teachers and students sometimes remain limited to the lesson and the dimension of the subject.

What

Ask some six students from one of more forms to discuss the lessons every now and then. In fact that means that the teacher calls in his or her target group for advice. After all this is also in the interest of the students. It should be a relaxed discussion. Students must be sure that what they say will never be turned against them. The teacher asks some well-chosen questions and lets the students react to them. The teacher should not give any comments, but should just listen. The teacher's performance should not be the topic of discussion. The main question is how the learning process can be further improved. The role of the teacher is part of this process.

How

– Try to clarify for yourself what the discussion should be about. Make a checklist of the issues that you would like them to address.
– Think of some suitable sentences to start the discussion. Interactivity will automatically develop. After all you do it together! Take an inviting role in the discussion: 'I am very interested in what you all have to say.' Refrain from verbal reactions. Take some notes to let them know that you are listening.
– Formulate stimulating and open questions.
– Find questions that appeal to the creative talents of the students and that make them react in a positive and critical way.
– Try to convey in your questions that you trust them to be respectful and fair in their reactions.
– Never put the questions such that the performance of students or teachers is the main topic. Each question should include the learning process of the students, the contribution of the student and the learning situation.
– At the end of the discussion give a short summary of what has been said: 'If I understood you right…'

When

Set up the student panel if everything is going as planned. This prevents problems, and it gives you relevant information in time. Start from scratch! Think in terms of a frequency of twice per year. Flank your student panel with a suggestion box in the classroom. This is also a means to receive signals at an early stage and an incentive to organise a panel.
When there are problems a student panel can be helpful, but it is better to prevent problems. Student panels can be useful outside the lessons but also in your lessons. Another way to initiate a student panel is to put evaluative open questions at the end of a test.
For instance: 'What changes could you or your teacher make, so that you can learn even more?'

Tips

- Make the questions such that for each part of the topic they go from simple to more complicated. Give some students more easy questions and others more difficult questions.
- Involve students in the preparation. Students that know a lot about biology can be asked to make questions for a particular biological topic and students with knowledge of physics can be appointed a more physically oriented topic. For these students this approach appeals to their previously acquired knowledge in a different way.
- During the exchange of questions and answers monitor whether students automatically apply a logical sequence in the discussion of the questions.
- It is possible to assess the content of the oral report afterwards. In this case the students should be told beforehand that there will be a test of the contents of what they tell in their report to the whole group.
- As a more extensive assignment instead of one lesson, two or three lessons can be reserved.
- The differences in the sources can also be brought about by letting students look at the topic from various roles. For the topic 'health and medicine' the roles could be 'the scientist', 'the doctor', 'the policy maker', 'the producer', 'the patient'. Each group is given a certain role. With this role in mind the students answer questions such as 'Is the pill the best contraceptive?', 'What are the side-effects of taking the pill?', 'How bad are the side-effects of the pill?' Again the groups will be given the same questions; their roles will result in different answers. In the evaluation the different answers will be clarified.

Learning from each other

Follow-up on students' prior knowledge

Why

The subject matter of Science for Public Understanding is extensive and the available time is limited, which gives rise to the danger that students are facing a scientific information overload they cannot structure very well. Often students are heard to say 'I have already had this in biology classes (or chemistry or physics).' Whether these remarks are justified or not, the fact is that students often know quite a lot about a scientific topic. Benefit from this knowledge, give students the opportunity to be an expert, and follow on from the knowledge that students have already. If this knowledge is captured in a challenging way students will become interested in the topic, their knowledge will serve as a foundation to build new knowledge on, misconceptions will show up and students will see that there is still much to learn about the topic.

What

Students will do the following:
Each student is given a card with one or two questions that should be answered individually. The internet and books can be used to retrieve information.
The student also receives a symbol of a certain colour.
After the student has given the answers, he/she will look for other students with the same symbol. The group thus formed will discuss the questions and answers together. The questions in the groups with the same symbols concern one part of a topic, for example a heart attack. Questions in another group will then concern for example a stroke. The different parts of the topic are derived from the overall topic, which in this example would be 'blood vessels and diseases of the blood'.
After the group discussions one student of each group is to report to the whole group.

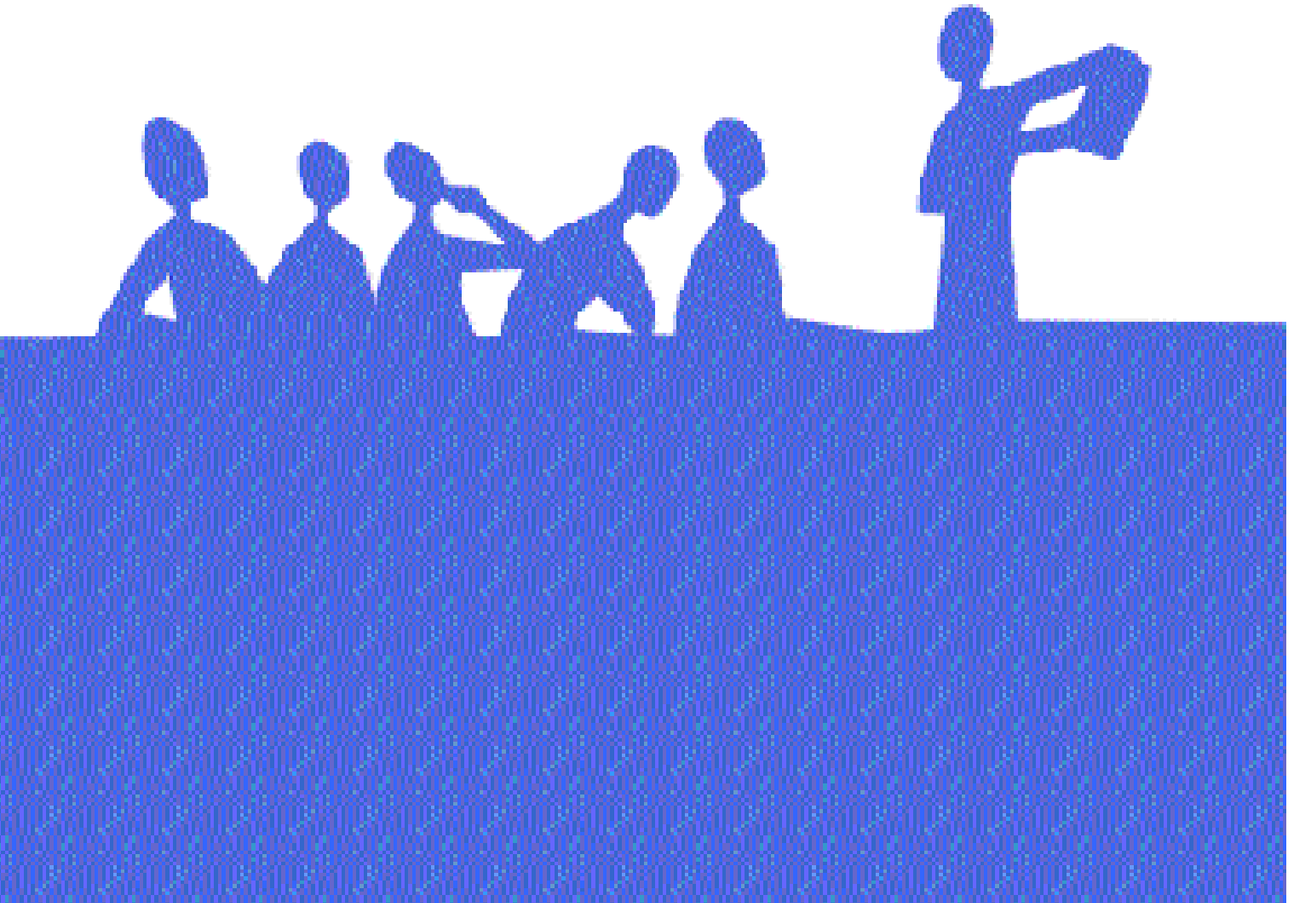
How

The teacher will do the following:
Preparation:
- Choose a topic. Think of parts of the topic.
- Make questions for each part of the topic to put on the cards, which together will cover that part of the topic. Put one or two questions on each card.
- Make symbols in different colours. Use the same colour for each symbol.

Implementation:
- Hand out the cards with the questions together with the colour symbols. Make sure that the symbol matches that part of the topic.
- Let students think of the answer to their question(s) individually. If necessary they can use the internet or the book. Duration: 15 minutes.
- Let students look for others with the same symbols they have and have them form groups to discuss their questions and answers. Duration: 15 minutes.
- Make clear beforehand that one person of the group will be appointed to report.
- Choose a certain colour and let one student from the group with that colour report to the whole group. Duration: 20 minutes.
- Evaluation.

When

For a topic such as DNA, which is also covered in biology, students can pass their revived knowledge quickly and effectively on to others. In this case opt for topic-parts that show students how cells, chromosomes, DNA, genes and proteins are related.
To introduce students to questions such as 'Where do I gather my knowledge?' and 'Which sources are reliable?' the use of the working method can be varied by letting students explore different sources. Each group explores a particular source, for example a newspaper, a young people's magazine, a scientific magazine, a women's magazine, a popular internet site. The questions for each group are the same. The difference in sources will result in different answers. In the evaluation the different answers will be clarified.



Tips

– Find out beforehand in what other subjects the students have to make oral presentations and how.
– Discuss the structure of a good oral presentation with the English teacher.
– Students who are too shy to come forward can be interviewed by their classmates and be helped to formulate the questions beforehand.
– Give insecure students the tip to practice their presentation by walking around and speaking out loud. A set of cards with keywords written in big letters help to keep the presentation to the point.
– The structure of power point is very convenient for the preparation, even if the power point slides will eventually not be used.
– As for more extensive presentations, let students do a 'try out' in a smaller group. Ask the group to write down points for improvement and to give instructions. Ask them to give you a copy of their notes.
– To prepare their presentations give the students the assignment to set up a list of 'tips and tricks' they can copy off professional presenters on TV. Let them also name the characteristics of everybody's style of presenting.
– Let groups of students write down strong and weak points of their own presentation. The classmates then think along with them and serve as coaches when it comes to tackling the weak points.
– Give the students a group task to give three short oral presentations on the same subject. Have those recorded with a digital camera. Mix the recordings and add illustrations. The result is a school video for SPU.

Oral presentation

The students' turn to speak

Why

In SPU lessons the students often work in groups. By means of an oral presentation they report to the class afterwards. This is how they show to each other how they dealt with the SPU topic in their personal way. This gives variety to the lessons, and at the same time they learn from each other.
Oral presentations can have different functions: conveying information, creating interest, focusing the attention on something, reproducing knowledge, summarising knowledge, stimulating critical thinking. But also: thinking along with classmates to improve the achievements, serving as a guinea pig.
Well-organised oral presentations are teacher friendly in terms of a low work load. Directly after the presentation the teacher can give his or her assessment, possibly assisted by the students.

What

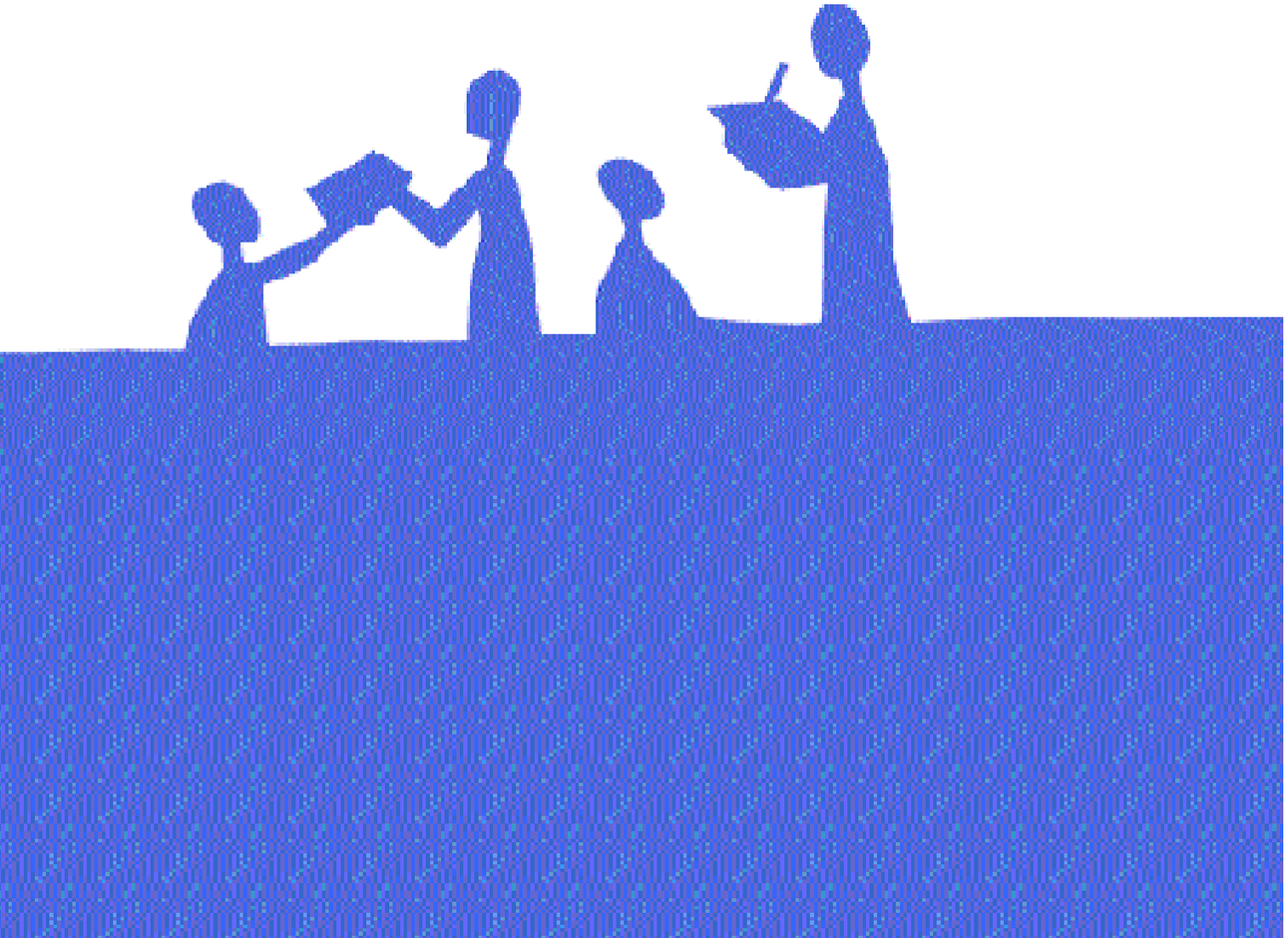
By presenting an oral 'report' of an interview or an excursion the student can share his or her experiences or learning results with the classmates. The audience takes notes of the most essential points. The presentation of a student can be part of the whole planned programme, especially if the teacher later falls back on the information given in the presentation. The teacher can for instance ask questions about the content of a presentation in the written test. A short oral presentation of a current topic from the media can for instance serve as an illustration of the content of the lesson, and at the same time as an exercise to gain more experience in presentation techniques. Students with special knowledge of certain SPU topics can share this knowledge by giving an informative oral presentation.

How

– Pay structural attention to oral presentations. Start with simple short presentations (without assessment) and proceed with longer and more complex presentations. In this way new students will not be put off. Try to fit in with what students do or have done in other subjects.
– Make the function of the oral presentation clear, because only then will the presentation live up to its promise.
– Make clear what you expect from the students, and what will be included in the assessment.
– Be strict with the available presentation time, a fellow student can give a sign when the last minute has started.
– Reserve some time in your planning for questions from the students. Adequate reactions to questions can be part of the assessment. Stimulate the students to put questions by inviting them explicitly to do so after the presentation, and try to have a question in your mind just in case it's necessary.
– Make sure there is enough variety. This can be achieved by making them present from different roles. Or make the condition that every presentation should contain at least one element of surprise
– Appeal to the creativity of the presenting student in order to involve the public actively in the presentation.

When

It is advisable to pay attention to oral presentations from the first SPU lesson. The advancement from easier to more complex presentations as well as the different functions of a presentation can be a guideline for the structuring of suitable assignments.
Under the heading 'The SPU-news of the week' a student can present the most striking SPU-article from the newspaper each week. As the news is unpredictable, the element of surprise guarantees the attention of the public. In a concluding whole-class discussion the SPU-news can be addressed by means of the SPU key questions. An oral presentation dealing with a problem or a dilemma can serve as an introduction to other class activities.
Presentations in a small group intended to round off an assignment make it possible to let many students present within a short period of time. This is particularly effective if classmates function as critics.
As a preparation for the test students can present the essential points of a paragraph or a chapter from the textbook.



Tips

- Let a duo assignment start as a solo assignment with mutual intermediate assessment. Then let the students combine the best of each other's work and for reflection purposes ask for a report on the discussion of the combination process.
- As a variation a standard assessment of 'highly sufficient' or '7 points' can be used. This will quickly lead to assessment aspects below or above average.
- If students find it difficulty to be critical of each other's work it helps to place the emphasis on the role as coach of the other.
- Students learn to improve their assessment if they can compare their individually made assessments. The differences are particularly interesting. Have three students explain how they came to their assessment. The results will be significant if the individual assessments differ considerably.
- Include a bonus point for intermediate assessment of each other's work in a group assignment. Have the assessment signed and handed in with the work.
- With exercise assignments do random checks of the way students assess each other. Take particular note of striking assessments. Co-assessment of assignments for school exams by students is definitely possible provided the procedure is clear.
- Discuss with the class which advantages and disadvantages they experienced in assessing each other's work.
- The teacher can also ask the students to utilise self-assessment.

Peer assessment

The first step towards self-assessment

Why

With Science for Public Understanding students often work on assignments individually or in groups. They like all their work to be seen and assessed. If students assess one another they relieve the teacher from a lot of work.
Looking closely at the work of someone else enables them to have a more realistic impression of the quality of their own work. In doing so they also broaden their thinking perspective on Science for Public Understanding themes because they are looking through the eyes of someone else. Especially where themes are concerned that require the development of a personal opinion, focussing on as well as empathising with somebody else, is stimulating and instructive. Students with weak language skills can learn very much from the experience with the use of language use of their peers while assessing them. In mutual assessment students express their opinions on quality, which can then be used by the teacher.
In doing so they increasingly learn to look at the work of others, give feedback and a well-argumented assessment.

What

Students can assess each other's products, and presentations, during the process or in a final stage.
If the assignment results in a product intended for a certain target group, students can assess the product as part of that target group. This may concern a poster, a leaflet or a website. In the role of the consumer, students can assess information intended for the general public on topics related to Science for Public Understanding. This may concern written assignments, such as writing a column, article or editorial for a newspaper or magazine, or oral assignments such as acting as a public relations officer, helpdesk staff or radio or TV journalist.

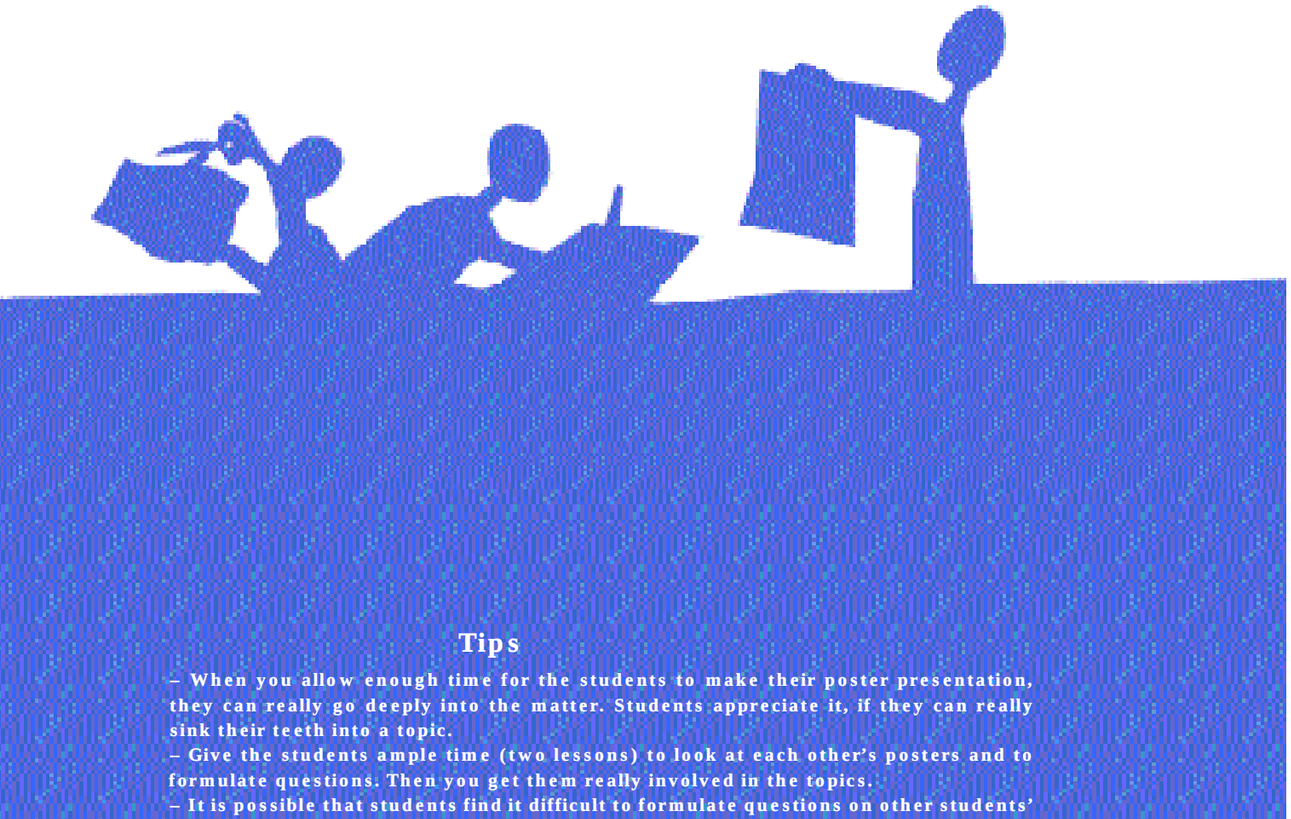
During the assessment students take over part of the teacher's role, monitored by the teacher who takes note of the development. For example, a student gives a preliminary assessment of written work and reports as a preparation for the assessment by the teacher. The student will give a verbal explanation of the assessment and will give suggestions for improvement. The student therefore has a monitoring role. In the final assessment the teacher can take the suggestions for improvement up again and if necessary discuss them. Another example: the teacher and the students assess an oral presentation. The teacher puts his/her own well-argumented assessment next to the assessment of the students.

How

Incorporate the assessment aspects in the assignment instruction. Indicate the requirements as to content and structure. Add the assessment form to the assignment instruction. For written assignments the ten-point scale is very suitable for students. It helps students to explain their assessment. For oral assignments an insufficient-sufficient-good scale is preferable.
Ask students to mention a strong point of their peer's work. Let them indicate points for improvement. Mutual student assessment half way through the assignment works as progress control if the student is referred to the teacher when the quality is doubted.

When

When the teacher wants to help students to work on assignments more effectively an assessment form and assessment of each other's work can be used as an eye-opener.
When students need directions for improvement of their work, mutual assessment can be brought into play.
During assignments for the school exam it can be useful for students to help each other with checking if their work meets the requirements of the assignment.
If the teacher wants students to look better at their own work, experiences with assessing others can serve as a starting point for self-assessment. People learn about themselves by looking at others. By assessing each other they also assess themselves.



Tips

– When you allow enough time for the students to make their poster presentation, they can really go deeply into the matter. Students appreciate it, if they can really sink their teeth into a topic.
– Give the students ample time (two lessons) to look at each other's posters and to formulate questions. Then you get them really involved in the topics.
– It is possible that students find it difficult to formulate questions on other students' posters. The reason may be that they don't have enough knowledge of the topic. During the lessons when they look at each other's posters you can show them some fragments from the chosen topics on video.
– Save the posters for a following group to motivate them and to practice the skill of asking questions about each other's posters.
– The assessment of each presentation by the students and by the teacher gives the poster presentations a more serious touch, and at the same time saves a lot of correction time for the teacher.
– Students who do not have such a scientific turn of mind find a challenge to go into the subject in their own way. This can result in unexpected learning experiences.
– Try to gear your activities to those of other subjects.

A teacher's reflection

'I started with a poster session, because in my school this working method was allotted to the SPU-lessons. I hadn't pitched my expectations too high. I could not see the good of all that cutting and pasting work. I expected a confirmation of this idea. But I learned that the composition of a poster can be a very good working method. The result is astonishing and the students are enthusiastic. The evaluation showed that they had the idea that they had learned a lot both about the working method and about the subject content.
Especially the process of summarising the abundance of information on one sheet of paper was a very instructive experience for the students.
This requires a lot of time. You must be willing to take that time.
You must allow the students that amount of time and responsibility.
I am now going to improve my working methods: I'll allow two lessons to look at each other's posters and I'll also let the group look at the two or three posters to be discussed before we start the group discussion. I shall also show them a video film. The students indicated that the best time to show the film would be at the end of the lesson after the group discussion. I can understand that, because during the discussion a lot of questions arise that cannot directly be answered. If the answer is in the video film, this can be an important moment of learning.'

A poster presentation

SPU in the picture

Why

In SPU-lessons not all the subject matter can be dealt with extensively. By choosing a poster presentation as a working method you distribute different topics among the students. This challenges them to search for information together, in order to make a selection from the abundance of information and to come to a creative presentation. They go more deeply into one topic. They think about SPU key questions like 'How do we acquire knowledge?' and 'How is knowledge used?'
Their own presentation makes them have a critical look at their own product and that of their classmates. At the same time they learn to put different sorts of questions at different levels. That is how they acquire information together.

What

The topics should be related to each other. Take astronomy for instance. The different topics might then be: 'the origin of the universe', 'the life of a star', 'the sun', 'satellites' etc. Because the topics are all related to each other, the students will ask questions that are in line with each other. That is how they learn about the coherence of certain topics.
Students need sources of information: books as well as the Internet. It is good to have the books (and a computer with an Internet connection) available in the classroom while looking at each other's posters. It is then possible to find direct answers to the questions that arise.
In order to make the posters it must be possible for students to use the facilities in the school building, for instance the art room.

How

The students get a duo assignment:
– Make a poster according to the given guidelines, and make a choice from a list of twenty topics. Available time: ten lessons.
– Hang the poster up. Look at each other's posters. Write down the questions that you are going to ask during the presentation of each poster. Available time: two lessons.
– Present your poster to your classmates. Answer the questions of your classmates and those of the teacher (three presentations per lesson).
– Have your poster assessed by your classmates and your teacher according to the guidelines on the assessment sheet.
– The following addition is possible: Do the test your teacher has composed as a result of the poster presentations. Make use of the notes you took after each poster presentation.
The method described above is an example of an extensive poster presentation. Often this working method is used in a shortened form taking no more than a few lessons.

When

This working method can best be applied, when the topics within the subject content are so extensive that they cannot be dealt with in a regular way. This is certainly the case for subjects that contain enough topics for every student to delve deeper into. For students this can be a welcome alternative to the usual working methods. The poster can be composed in a period when students have a lot of homework from other subjects. In that period they can be released from homework for SPU.
Before the students start working on their poster presentation, they should be trained in:
– Gathering and selecting information from various sources,
– Having a critical look at the information gathered, for instance by training to write an essay in their English lessons.
– Composing a good poster is more difficult than it seems. It is therefore advisable to make them do some finger exercise in presenting information in a creative way, for instance in art education or in the English lessons.

Tips

– Let the students work in small groups of two, three or four in the first two phases, thinking and sharing.
– While the students are thinking and sharing, observe their behaviour and the way they work with each other. Give them some feedback on their co-operation in the phase of exchanging views.
– Give them very strict directions for the three phases, if necessary, but seek to develop a natural way of working with each other in the long run.
– When using the working method (thinking, sharing, exchanging views) for the first time, start with a safe and not too complicated question.
Here are some aids for maintaining strict order:
– A bell rings when thinking switches over to sharing, and when sharing switches over to exchanging views.
– An icon attached to the blackboard with a magnet indicates that they should be silent (thinking), or that they can now talk together (sharing).
– Each group of students receives one sheet of paper to write things down in the phases of thinking and sharing, see also paragraph 'Place mat'.
– The central question is written on the blackboard.

Thinking, sharing, exchanging

considering and talking

Why

Thinking, sharing and exchanging views is a very suitable working method for SPU-questions with an ethical, philosophical, historical, cultural or religious background.
It helps the students of SPU:
– prepare a discussion and think of an answer.
– brainstorm as an individual as well as a common activity,
– think for themselves and express their thoughts aloud in front of others.
Thinking, sharing and exchanging is an example of an activating pedagogy. Do not let students 'steal' the teacher's knowledge passively. Real art is to activate them to acquire their own knowledge. With this method they will have to talk, to listen actively, to write and to think.
Thinking, sharing and exchanging views is a suitable method to introduce a topic, to focus the attention and to keep it focused.

What

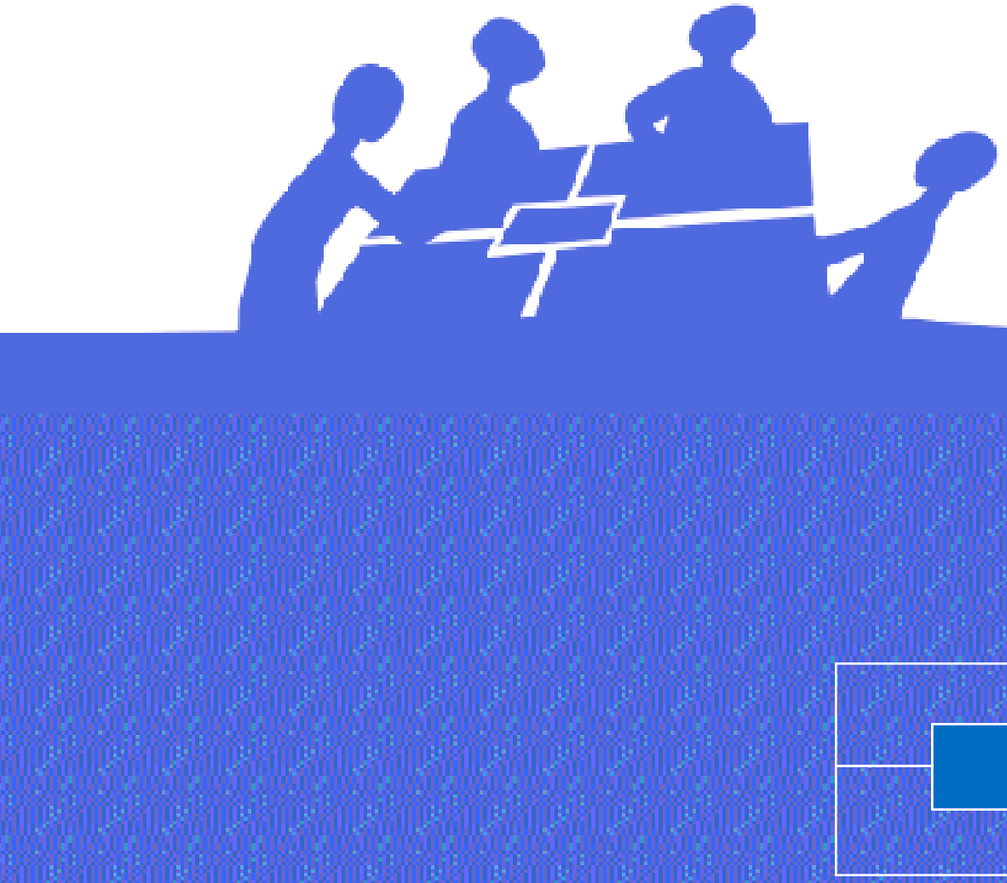
There is one central question. There are three phases. First of all there is silence, because everybody is thinking individually. Then there is conversation, because students are telling each other what they have thought of. Finally the teacher leads the discussion, where all groups make their contributions. The three phases, thinking (individually), sharing (groups of two or four) and exchanging views (with all the classmates), are clearly distinguished from each other. When views are exchanged the teacher also reports on his or her observations during the phases of thinking and sharing. Through this sort of reflection the achievements of the group are raised. The long-term aim is that this happens naturally. After all, communication is always a process of thinking, sharing and exchanging views!
The central question can be the same for all three phases. It is also advisable to approach the question in each phase from a slightly different angle. In the phase of thinking we are talking about associations. Sharing implies possible actions, and in the process of exchanging views the focus is on the decisions that have to be made.

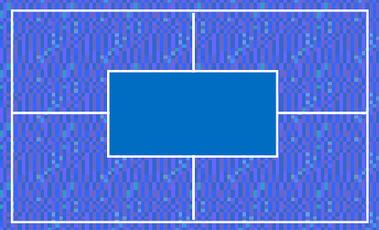
How

During preparation the teacher must find out whether the students are familiar with this working method. If necessary, discuss the rules beforehand. You might want to choose for strict directions. The instruction will then be as follows:
– The teacher writes a question on the blackboard and agrees with the students that everybody thinks silently about the questions and writes down some keywords. He or she then indicates how to proceed: 'When you hear the gong after four minutes, you are going to share the results: discuss the results in your own group and think about what you have written down. Make a list of those points that you agree are the best. Four minutes later there will be another gong. Then each group will get the opportunity to say what they have found out.'
– During the process of exchanging views the teacher will make evaluative remarks. Keep these remarks within certain limits. Give them beforehand a point of attention for improvement. For instance: 'Keep in mind this time that while sharing the results you are going to create something together that has an added value!'

When

Thinking, sharing and exchanging views is a suitable initial assignment to let students get familiar with the topic of the lesson. It leaves sufficient room for emotions, knowledge and the development of a common language. In SPU there are many questions that require balanced answers.
If the classroom atmosphere is not safe enough for some students to express their opinions, it can be helpful to let them talk in small groups first. After that it is safer for them to communicate their thoughts in front of the whole class. Thinking, sharing and exchanging views is also a means to increase the students' involvement with the topic. This working method can also help in situations where there are order problems, where they seem to need some practise in listening or talking to each other.
If there are many different opinions on the topic this working method offers the possibility to work in small groups first to structure the variety of opinions





Tips

– Ensure that the size of the paper you use is big enough, but on the other hand it must not be bigger than the tables the students have to work at.
– Fold the paper in four. The folding lines are helpful for subdividing the paper into squares. You can do it yourself or let the students do it.
– Do not put any restraints on the way the students take their notes. Some students like to use paper, pencil and coloured pencils while thinking, others like to make schematic drawings. Observe their manner of working and give them feedback on their approach to the task. Keep on observing the students while they are working. You may get some important indications concerning individual study behaviour (making a drawing, writing a text, working with colours, schematic outlines, concept mapping). Let students observe each other's manners of taking notes and supply each other with ideas for different approaches.
– A place mat is a suitable tool to make the result of a brainstorm session visible and to start an ethical discussion.
– For an assignment to design something this working method offers a stimulating framework for different sorts of contributions. This can be achieved by giving the participants different roles, such as consumer, producer, environment official or technical expert.

Place mat

Writing down your thoughts and talking about them

Why

In SPU lessons students from different subject combinations and with different prior knowledge can learn to co-operate. Working methods that make evident that each student's contribution is of the same value, can sometimes be a support. Writing down their thoughts on a place mat can be of some help.
The teacher can quickly get an overall view of the students who have difficulties with the assignment. In this way direct and non-verbal help can be offered.
By means of a place mat the development of a group result can be made evident. This is helpful during a retrospective on the working process. Some do it this way, others that way. Students can learn two things: they can learn from each other and thus increase their knowledge, and they can learn for themselves and thus confirm their knowledge.
The SPU key question 'is everything possible also allowed?' is a suitable working method to chart the facts for the start of the discussion. After all, an ethical discussion always starts with the facts.

What

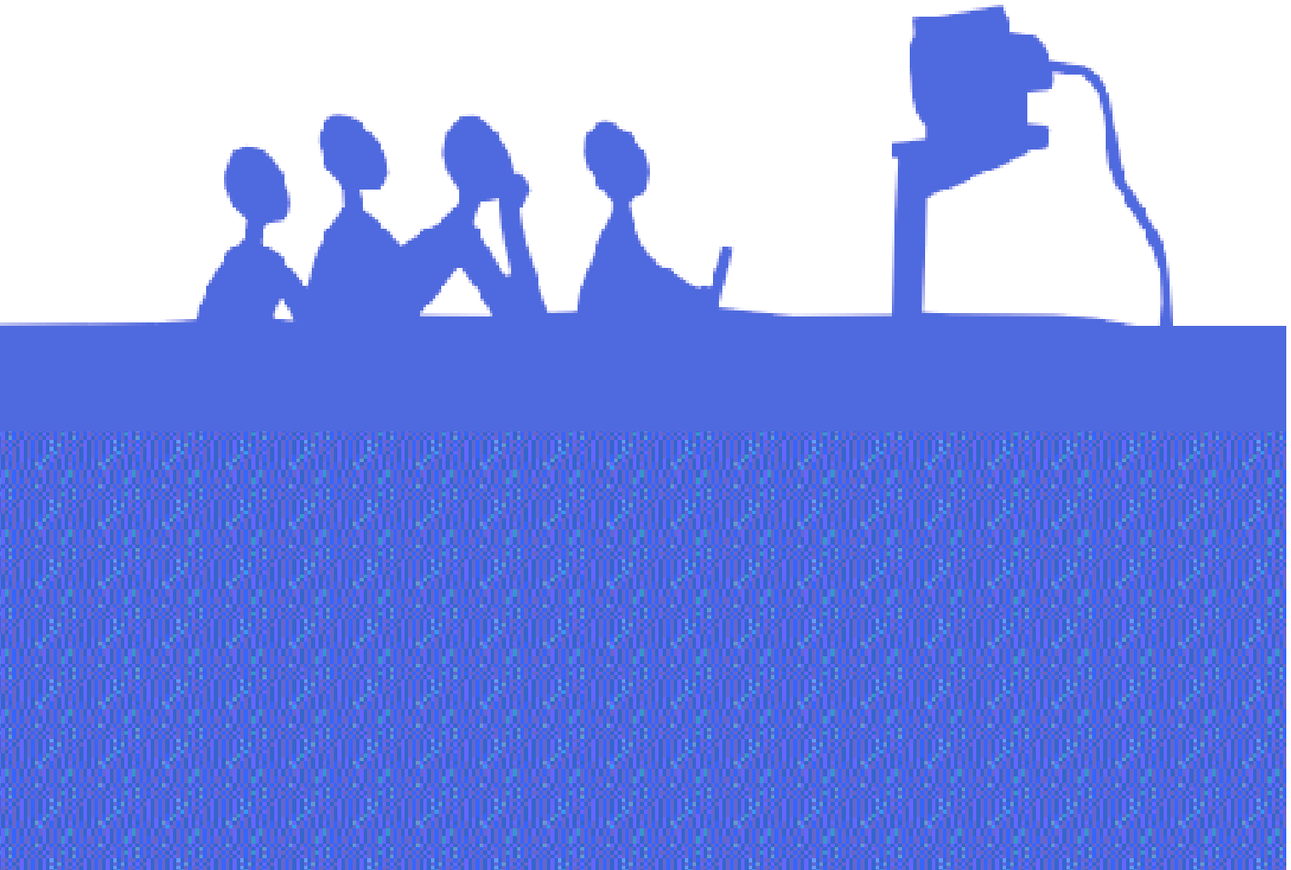
Subdivide a piece of paper with a felt-tip into five squares to write in, the same way as it is done in the drawing. At the angular points every group member can write down notes. The central square is reserved for the notes of the group discussion, which is held on the basis of the contributions of the different group members.
Make sure that the paper format is big enough and that there are sufficient felt-tip pens, so that students feel 'invited' to write or to draw.
The place mat can be used for all kinds of assignments, a language assignment, mind mapping, designing, carrying out an experiment or making drawings.
A language assignment can elicit associations, different points of view, solutions to a problem, possible answers to a question, possible actions or decisions.

How

Be precise in your preparation of the topic with this working method. Form groups of four students and make them sit around two tables pulled together. Agree on the working procedure and the time available for the subsequent steps. Distribute the papers among the groups and ensure that every student in a group has a felt-tip pen of a different colour. Write the question that has to be answered on the blackboard.
Let every student think and write individually and in silence. Give a clear signal when the time is up. Make every group discuss what has to be written in the central square. Tell them that there will be an exchange of views in front of the whole class. This can be an oral report, but also the assignment to react to the place mats of other groups. Never appoint the spokesperson yourself and ensure that everybody remains alert. Support the different phases with an audible signal (gong), if necessary.

When

Sometimes the students need a structure that persuades them to think first. After all, SPU is the subject that asks for forming of opinion as well as scientific knowledge. It's only too often that students are tempted to react immediately without having sufficient knowledge. That leads to discussions of a purely strategic nature that lack the foundation of knowledge. Students also need support to listen to each other systematically. Not every student gets enough attention. The place mat creates a podium; at the end of the lesson everybody has made his or her contribution.
It has a stimulating effect to confront students in a physical way with the room available for their contribution and with the registration and administration of the development of their common point of view. The place mat shows the thoughts that have been taken over by the group. This increases the involvement of all participants.
An initial assignment for an ethical discussion on organ transplantation could be set up as follows: 'Write down what will (possibly) happen when an organ transplantation takes place from the moment of the donor's death to the moment when the receiving patient has had the new organ for one year.'



Tips

– The school television programme www.channel4.com/learning/ offers a lot of material for the sciences and SPU.
So does www.schooldiscovery.com/lessons/plans/programs
– Setting up your own visual 'library' can be very time-consuming. Exchange visual materials with SPU-colleagues from other schools.
– On the Internet you can find more and more short films. Ask the students to help you find digital materials via Grokster or other peer-to-peer programmes.
– Make use of modern techniques for the digitalisation of visual materials on CD or DVD. This saves a lot of time while searching for the right fragment.
– Give the students the short assignment to register a TV-recording and select a five minutes fragment to present in the class. Use the SPU-questions for a deepening of understanding of the topic.
- For the development of questions for an open book test imagine what kind of answers students give. Formulate the question such that the answer will be short and brief. For example: 'Mention the two most important objections against the inoculation programme for meningitis. Take medical, economic and religious factors into account. Clarify the reasoning behind your choice of objections.'
- Contact a colleague from a different school who uses the same book and also wants to incorporate an open book test. Arrange to send each other five questions. Edit the received questions according to the lessons given and exchange this version as well.
- For an open book test more table space is necessary for the students. If students share a table sometimes different test versions are required.
- During the lessons take into account that the lesson unit is concluded with an open book test. Let students make their own notes, and let them make summaries. This allows a more in-depth approach of the knowledge, because the knowledge as such does not have to be mastered. The summary can be marked with a stamp to indicate permission to be used during the test.

Video

More than just watching

Why

The subject SPU offers a lot of possibilities to make students learn through a media mix. The use of the textbook in alternation with the newspaper, TV, the Internet and a variety of assignments is one way of realising this. A video film offers more possibilities than just watching. SPU is not only about critical thinking, but also about looking critically at information. In this way they also learn to recognise how visual recording techniques can influence the message.
SPU-teachers use video films regularly. Pictures can tell you more than a thousand words. A short fragment can add a lot to the explanation in the textbook, and some things are more easily comprehensible when they move. Pictures appeal to a different form of intelligence, which supports students in making themselves familiar with the content of the subject.

What

There are more than sufficient video films on non-specialist scientific topics. The real art is to select short fragments for the lessons. A limited number of well-chosen fragments to introduce the solar system and the universe, or the production process of a nutritive substance, or the discoverers of the germs of a disease are indispensable. Recordings of TV programmes from the Discovery Channel, for instance, are useful for students who want to extend their knowledge on subjects like satellites, biotechnology or protection against contagious diseases. A programme of about an hour puts a topic on the screen in detail and presents scientific experts who go into the topic. Recordings of a discussion programme or a current affairs programme can be used to illustrate the correlation between science, technology and society. Opinions and people play a central role in such programmes, and a recent programme can guarantee the attention of the students. The recording of a drama production on a famous scientist such as Semmelweis casts a different light on scientific knowledge. This is also true for science fiction films and virtual reality.

How

– Students watch with more attention, if they have an assignment during or after watching the film. Observe their posture while they are watching and tell them that you expect them to watch actively. React if necessary if you get the impression that their attention is waning.
– The watching assignment has a better result when students know the aim of the assignment. Make a distinction between the information that is conveyed and the experience created by watching the pictures. It is important that while students are watching they learn to keep on observing their own watching behaviour, so that they can reflect on it.
– As a starting point for a whole-class discussion you can give them the assignment to write down facts and opinions while they are watching. It is interesting to see how students observe their involvement increasing to a point where they would like to take part in the discussion.
– In order to make them gain more in-depth knowledge while they are watching the video-film you can give them the assignment to make a summary, to write down some questions they would like to ask the experts or to write a review for a professional journal.
– If students choose the video-films they want to use in the lesson you can give them the assignment to write down a few questions beforehand, and to answer these questions while watching.

When

A short video-fragment can be useful as an introduction to a new topic, if the visual material and the objective of the lesson fit as a glove. You can have too much of a good thing, sometimes it's better to use a small number of well- chosen fragments than too much information from the start. Visualisations of complex terms and objects that are difficult to grasp help students form an idea for instance of moving planets in the solar system or of the order of magnitude of very big or very small objects. As a practical assignment the students can start to work with some visual material that they have chosen themselves. Formulate the assignment such that it is not necessary for the teacher to watch the video-material to give an assessment.
A video-assignment can also be a way to make up for the occasional absence of the teacher. In such a case it is advisable to make an assignment for small groups with different visual materials.

Tips

- For the development of questions for an open book test imagine what kind of answers students give. Formulate the question such that the answer will be short and brief. For example: 'Mention the two most important objections against the inoculation programme for meningitis. Take medical, economic and religious factors into account. Clarify the reasoning behind your choice of objections.'
- Contact a colleague from a different school who uses the same book and also wants to incorporate an open book test. Arrange to send each other five questions. Edit the received questions according to the lessons given and exchange this version as well.
- For an open book test more table space is necessary for the students. If students share a table sometimes different test versions are required.
- During the lessons take into account that the lesson unit is concluded with an open book test. Let students make their own notes, and let them make summaries. This allows a more in-depth approach of the knowledge, because the knowledge as such does not have to be mastered. The summary can be marked with a stamp to indicate permission to be used during the test.

A teacher's reflection

'I asked students to make summaries per section, hand written in an exercise book. The summaries were exchanged during the lesson and if necessary adapted. Quite a few students were not interested in doing this. They persisted in making summaries closely before the test. The students were allowed to use the exercise book during the test. In this way students learn from one another and they learn how to make summaries. Science for Public Understanding is more about the use of summaries than about the knowledge as such.
Students are more interested in the availability of a summary than in making one. They tried to push back frontiers in a well-argumented manner. However, allowing them to incorporate copies of pictures including the scanned notes, etc. leads to proliferation and unfair circumstances. The information density of the chapter on the universe is so high that making a summary proves to be difficult. In addition to this it is unreasonable and undesirable to demand students to draw copies of the pictures. It is necessary to be very strict about summaries written by hand in an exercise book provided by the teacher. For "the universe" I will hand out a sheet containing all the pictures of the chapter (instead of a summary).
I will be very strict myself when it comes to arrangements. I will give students time to look at each other's summaries and I will give them feedback while they are working. At the beginning of the chapter I will hand out the sheet with pictures and show students that they are doing fine if they understand the pictures well and can tell something about them.
In a test I will ask them questions to which the answers can be found in a good summary. Good summaries are thus rewarded.'

Open book test

Vary in questions

Why

A test for Science for Public Understanding concerns the assessment of reflection on and analysis of scientific knowledge. The students do not have to master all this knowledge themselves. During an open book test students can make use of one or more sources of information. The emphasis of the test is shifted to application of scientific knowledge in a new situation and the assessment of reliability.
An open book test neutralises differences between students with different knowledge levels as to science. Students with limited knowledge of science have to invest less in reproductive learning. Students of Science for Public Understanding use their knowledge in a different way during an open book test. The results can provide a different picture of the qualities of the students.
Students prepare differently for an open book test, which brings about variety in the lessons. An open book test incites the design of a different type of questions, refreshing for both the teacher and the student.

What

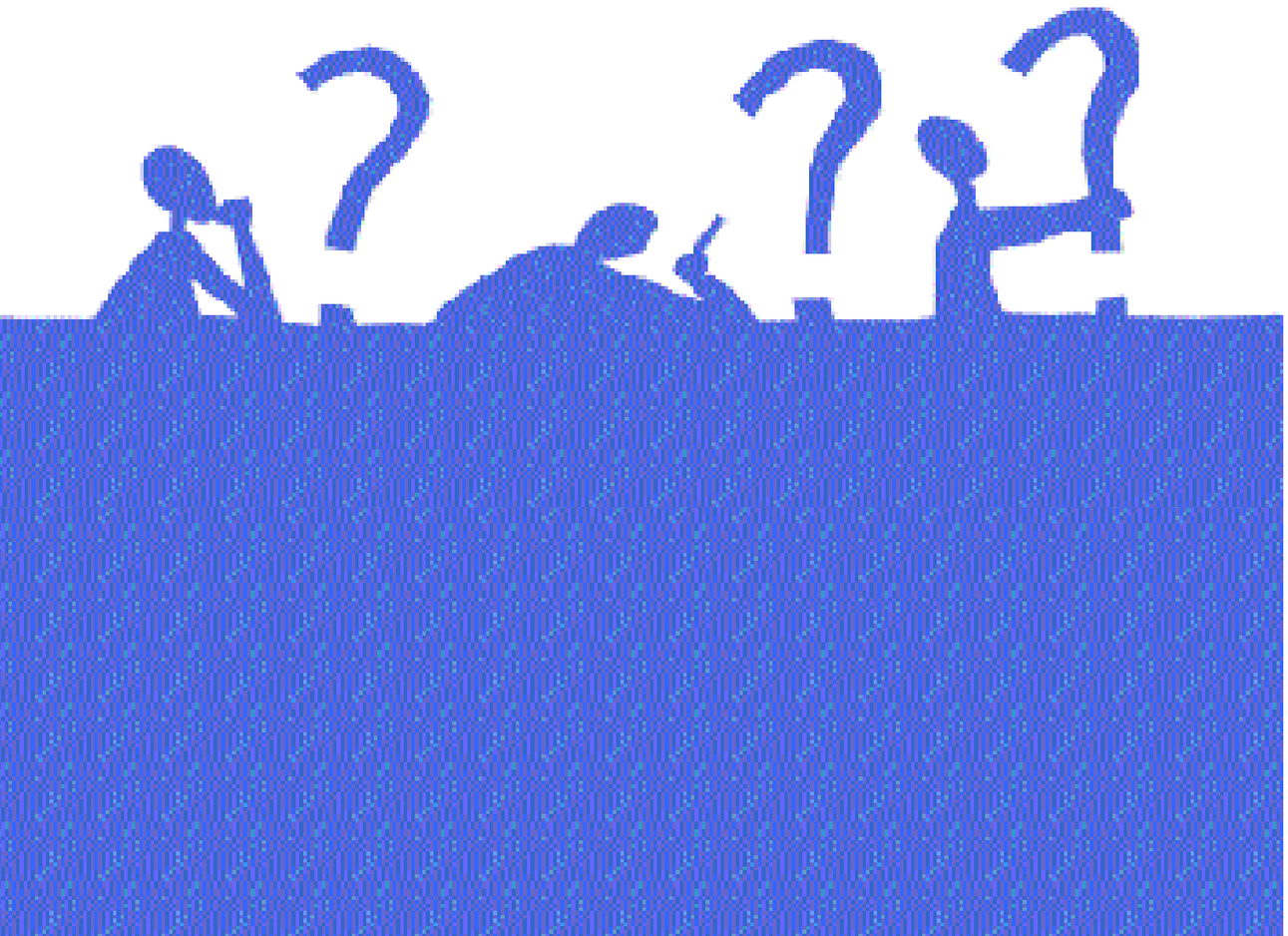
For the open book test not only books are allowed to be used as sources of information, but also a summary made in class, hand written notes, a sheet with keywords, charts drawn up by the student or copies of info graphics from the book.
Reports of assignments can be used as a source of information provided the key questions of Science for Public Understanding are related to these reports. For example: take your assignment to express in one sentence how scientific knowledge is applied. How do you know that a conclusion from the assignment is true? A printed answer sheet forces students to give brief answers. They are forced to get to the core of the topic, which in turn saves correction time. Current topics are a good start for questions in an open book test. Ask for example about the expected development in the future and let students justify this expectation by drawing on scientific knowledge from the approved sources of information.

How

- Determine fairly exactly which source of information is allowed to be used during the open book test. Take account of the way supervising colleagues can check this.
- Before administration of the test reserve a few weeks for practise with the open book dummy test. Allow limited time for the test. Discuss the pros and cons of this type of test and let students discuss the differences in preparation of an open book test.
- When information is requested refer to information in the book or in the notes.
- It is possible to combine a closed test and an open book test. Test basic knowledge in the closed part of the test. Let the student hand in this test. Then let students use the information sources and continue with the second part.
- Questions can start with 'compare', 'indicate similarities and differences between...', 'relate to….'

When

To make perfectly clear that Science for Public Understanding does not only concern scientific knowledge, but is also about establishing relationships between topics, after a few weeks a short (unannounced) open book test can be inserted. The questions may concern the relationship between the knowledge presented in the book and similar current affairs topics.
Often students do not like the first test to be an open book test if later tests are not. The prospect of an open book test on 'The solar system and the universe' stimulates students to pay more attention to insight and relations in the solar system than to trivial facts. As a final test an open book test can be suitable to cover about half of the content of Science for Public Understanding. This test can be given a higher weight factor.
If students of Science for Public Understanding follow an individual learning route with many individually chosen assignments, an open book test can link up with that.



Tips

– Let the students arrange the room in which the quiz is to take place. Ensure that the arrangement is different from that of a traditional classroom.
– Provide soft drinks and cookies.
– Allow the students to take care of the whole organisation. This does not take time, but rather saves time!
– Take notes during the quiz of things you want to come back to later in the lesson. Do not interrupt the quiz!
– Always test knowledge and skills in combination. The questions can make clear to the students what the learning objectives are. A test merely appealing to cognition could create a wrong picture.
– The quiz can also consist of assignments for teams to complete within a period of time agreed upon before. In that case the assignments appeal to the creativity of the students and will be assessed by a jury. For instance: 'Make a poster in which you make clear that .....'
– You can also organise a quiz for parents' evenings. The quiz will then be organised between teams of students and teams of parents or colleagues.
– Consider a quiz where two different grades can compete. If necessary, work together with a colleague to make a quiz consisting of questions from different subjects.

Quiz

Playing with knowledge

Why

Students appreciate playful working methods in the lessons. A quiz is an interesting working method, where students can play around with the subject matter. They make questions, put questions and answer questions. The questions can arouse their interest. Some students get really excited in their pursuit to win the game, others like the playful character and the variation. The quiz can be used to test knowledge and skills.
The teacher gains insight into the students' ways of dealing with scientific information. This insight will be increased, when students are involved in the organisation, for instance by formulating the questions.

What

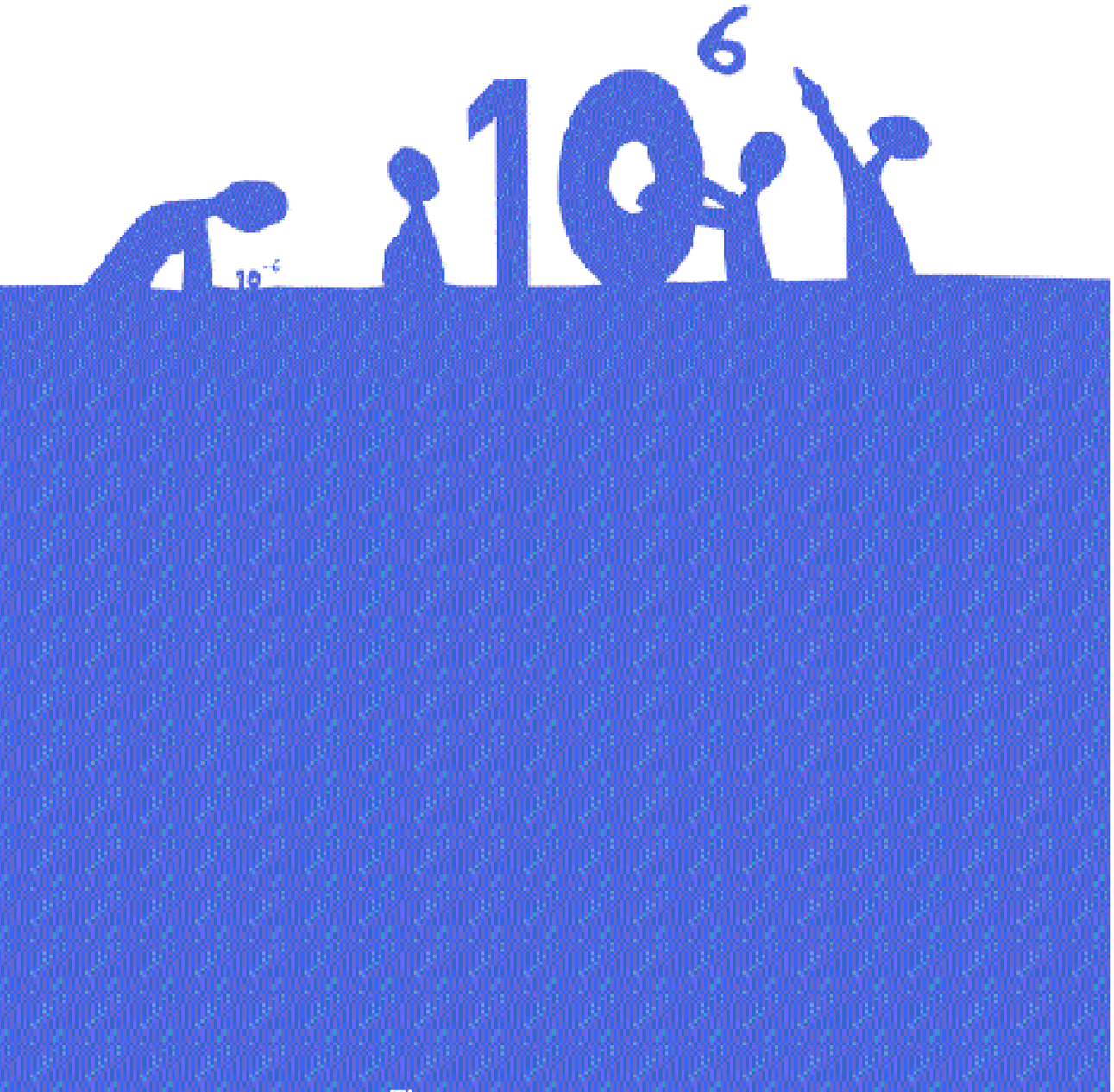
To start with we need questions and assignments, a quizmaster and a scoreboard. Imitating the context of a television quiz will increase the playful element. By using the computer (power point) the presentation of the questions can be prepared professionally with pictures, text and sound. Think of a prize beforehand, just something of symbolic value. It is not too difficult to install an electronic connection, so that a button must be pressed before the answer can be given.
Involve the students in formulating questions on a certain paragraph. You can for instance make them write questions on cards with the right answers on the back. Then the quizmaster selects questions and explains the rules of the game.

How

– It is important to determine the rules clearly beforehand, and to imitate the whole setting as authentically as possible: quizmaster, candidates, computer screen, answer buttons, assistant, jury. Some students find it frustrating if the game cannot be finished; finish with a score and the presentation of a prize. Discuss with the students which quiz is going to be played including the rules of the game!
– It is nice to record the quiz on video. Watching the videotape later can lead to some very useful reflections. It can also be conducive to the atmosphere if a student acts as camera person.
– The students formulate the questions themselves in small groups or individually.
– Remember that it is good to appeal to the students' knowledge and skills in the quiz.
– One way of inserting skills in the quiz is to make teams consult with each other, make them use the Internet, manuals or the mobile phone. Choose for a quiz with the possibility of looking things up or with assignments.

When

If you want to start with a new topic, it is useful to let the students experience that they do not know everything about the topic. The learning process can best be prepared by making them aware of the fact that there is something to be learned. Through the form of a quiz students can learn in a playful way that their ideas in many areas have been wrong (first day quiz). Teachers know that from experience!
If students have given a presentation from which their classmates were supposed to learn something, a quiz can be used to check the effects of this presentation.
At the end of a unit a quiz can be used as a (diagnostic) test to check the learning results. If the students formulate the questions themselves the teacher will experience how the students handle the subject matter. This method of working is suitable to be used at the end of a unit or halfway. The teacher can also use the questions made by the students for a later test quiz.
Sometimes variety is necessary, or a playful working method.



Tips

- Sometimes students have more fun in dealing with numbers if it does not concern exact and accurate answers, but global arithmetic. Emphasize this, just with the subject Science for Public Understanding; add for example: 'It is about the general size, not about an exact result.'
- An interesting mathematical technique is named after the physician Enrico Fermi: the Fermi-questions. The teacher asks a question that initially nobody is able to answer. Nevertheless a reasonable answer can be derived by reasoning and estimation. Add: 'It is not about the multiple of five or ten.' For example: 'How much solar energy can the roof of our school building collect per year?' or 'How many cans are thrown in the waste bin over de period of one year?'
- As a working method a play can be used in which all the students are asked some questions. A book with tables is at hand. The teacher says for example 'Hello Venus, Hello Venus. Earth speaking. Today my temperature is 30 degrees. How about you? Hot or cold? Tell me today's temperature on Venus.'

Coming to grips with numbers

Just imagine it

Why

Science for Public Understanding sometimes concerns large numbers, large sizes, the microscopic scale and the atomic scale. The power of imagination is hard to activate if it concerns one microsecond, a quadrillion atoms or a diameter of 10 nanometres. It is difficult to imagine the range of sizes. Teachers as well as students need some help in this respect. Techniques come to assistance. If thinking about numbers becomes more of an experience, gauges develop in one's mind. They serve as stepping stones for the size range of other numbers. One number instils an association with something else. Estimations and approximations are indispensable in Science for Public Understanding.

What

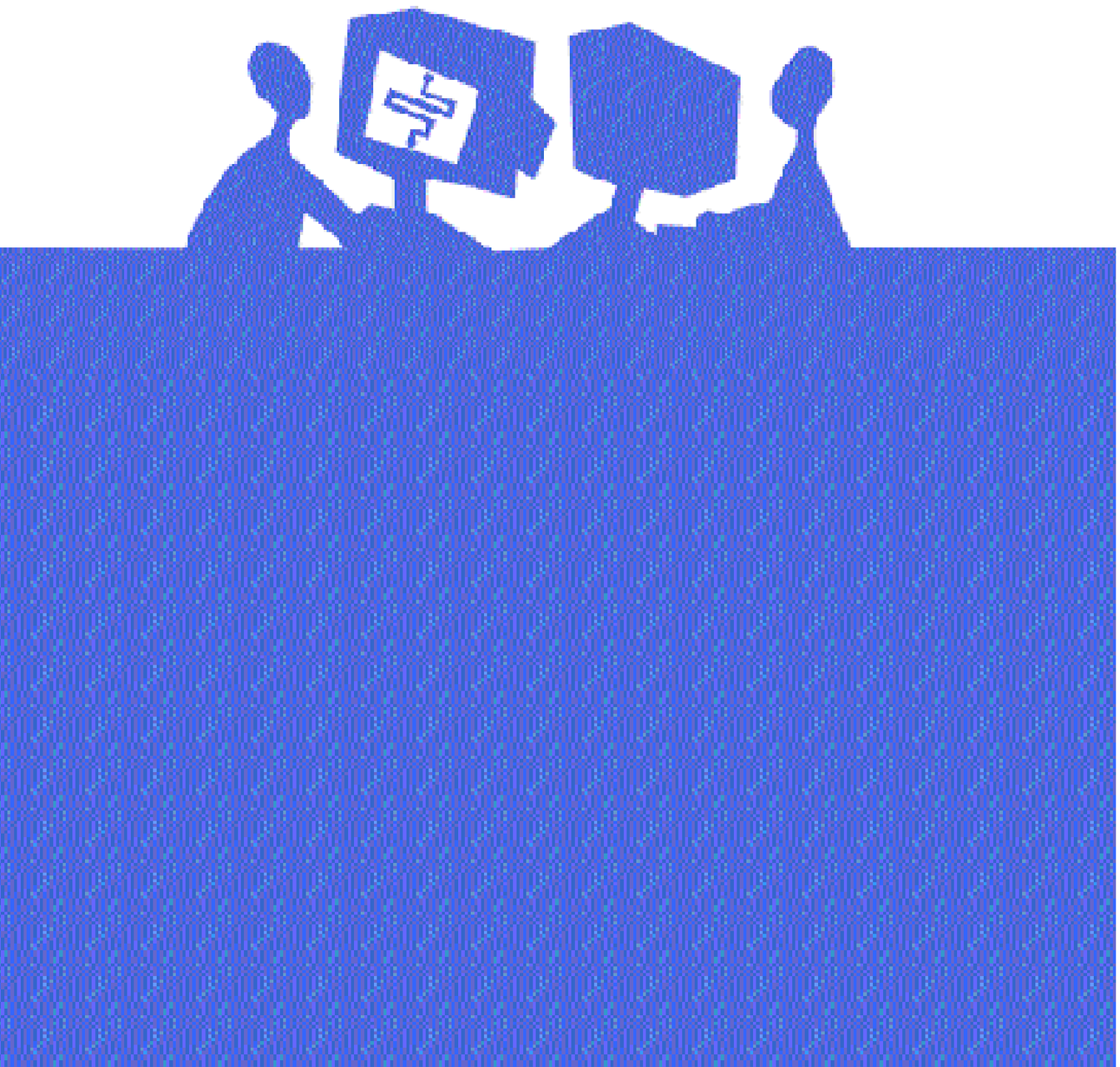
In a whole class lesson it is possible to spend some time on large or small numbers. A lesson with numerical information gains value if the teacher can provide impressive pictures with these numbers. A job to be prepared!
The teacher can also develop the habit to think aloud of associations with the numerical values. He/she can make students think aloud as well. Let students be actively involved in representing numbers. The pictures they think of themselves will make a longer lasting impression.
Visualise the pictures in playful and challenging assignments. Put a reel with 5 kilometres of thread on the table. The reel represents the evolutionary development of man in time. Ask a student to cut off his/her thread of life. Another example: imagine all your red blood cells in a row, this is to be a long thin thread. Roll out the thread over the earth and travel to the other end. Where do you end up?

How

Students feel supported if different working methods are presented simultaneously. For Science for Public Understanding it is useful to:
- Make a comparison. For example, the sun is given the size of a football on the centre spot of a football field. From this starting point and on this scale the size of the planets in the solar system are derived through comparisons.
- Making a number line or diagram. The 'big bang', the evolution of mankind and the development of language can be represented in lines and diagrams. The complete history of human evolution can be rolled out as a number line. The last millimetre will be extremely filled. This part can be enlarged.
- In processing numeric information simple meaningful arithmetic assignments can be administered. If one litre of air weighs for example 1.3 grams, your next remark should be: 'so in this classroom there is about ....' If one does not count with numbers, one will never be able to represent them.
- Some numerical values should be repeated more often and learnt by heart. They will become the ever-present gauges in the mind. Other numbers are larger or smaller than this gauge and are therefore easier to imagine.
- Let them experience and act out as much as possible. For example, ask one student to be the earth and another student to be the moon. Now a third student has to determine his/her position in his/her role as the sun.

When

The theme 'The solar system and the universe' confronts students with large numbers; the theme 'Life' confronts them with smaller numbers and the theme 'Matter' concerns even smaller numbers. A feeling for these numbers is important for all students.
Because this feeling concerns an attitude, it is a permanent item for attention in Science for Public Understanding lessons.
Determine which numeric values are crucial for the subject Science for Public Understanding. Look for gauges that should be ready knowledge for students. Think for example of the size ranges of an atom core, a cell, the diameter of the earth, the solar system and the Milky Way. Give permanent attention to numbers by putting posters and number lines on the wall (for example the power of ten).



Tips

– Follow the course for designing WebQuests on: www.webquest.com, where you can find more information on the recurring steps of a WebQuest.
– Browse through WebQuests of other subjects.
– Is your experience limited to the use of a word processor? Make a WebQuest in the form of a word document with horizontal lines to indicate the different steps.
– Copy an existing WebQuest with a suitable navigation structure, and save it as a html document. Open the WebQuest in 'Front Page' or another html-editor. Replace the text with your own text and pictures.
– On: webquest.sdsu.edu/matrix.htm you can find WebQuests from all over the world with quality marks.

WebQuest

Internet assignments structured

Why

Students often spend too much time searching on the Internet and have too little time left to process the information they have found. This is a shame, because the Internet offers current scientific and beautifully illustrated subject matter. Internet assignments therefor require a structure, which guides the students in their search for information and its processing. A WebQuest is a structured educational search on the Internet where students will not go astray. The WebQuest is built up around a task for the student. To complete this task the student has to search for information. Preferably this information is offered as a mix of sources, among which the Internet. In this way students only visit a limited number of authentic sites.
The task also comprises roles and challenges students to combine SPU-knowledge with social insight. The tasks, the roles and the step by step structure enhance the motivation and give them sufficient room for autonomous learning.

What

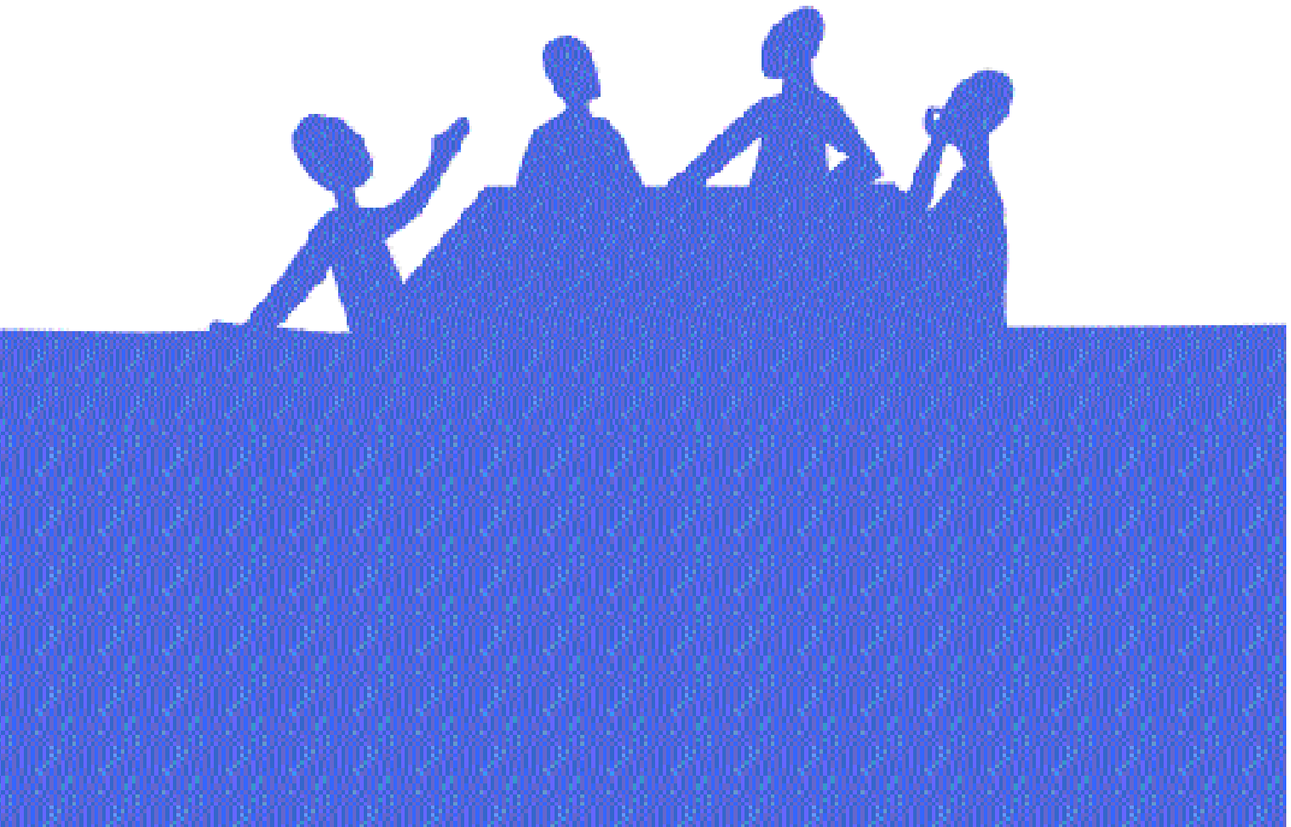
A WebQuest is a (group)assignment on the Internet offering a step by step structure. An introduction with some background information followed by the formulation of the task. The task can for instance be a problem that has to be solved, an opinion that has to be given a scientific basis, or a question that has to be answered. The formulation of the task comprises the roles, a scenario or activities to be simulated.
The task gives the students an aim as well as a direction to develop their thoughts and to organise their search. An example: in the role of a detective or a journalist the task is to find out the cause of an epidemic or an environmental crime.
A recurring part of the WebQuest is the step by step guide for assignments to help students cope with the task. This guide comprises the division of tasks, the time schedule, the requirements the results have to fulfil, as well as suggestions for the working method. There is a varied list of possible sources that can be used to carry out the assignment. There are questions to be used for the evaluation (and assessment) of the result, the co-operation and the quality of the approach. There are also criteria for the assessment. Students make a summary of their searching activities and of the results.

How

– Make use of existing WebQuests or make new ones.
– The teacher can easily make a new WebQuest by copying a good example. He or she can then work with an existing format and can design his or her own task (including the other parts).
– Remember the characteristics of a well-designed task: to be performed within certain time limits, attractive and inviting to autonomous thinking and working.

When

As one of the practical assignments of a school exam a WebQuest taking 10 hours to be carried out is an adequate framework for a varied elaboration of the same task for different students. The recurring steps give students something to hold on to during a process of autonomous learning, and at the same time they challenge students to carry out the task.
Suggestions for tasks:
– Let students find a solution to a given problem in the role of a designer.
– Let students find a connection between different points of view on the same news item.
– WebQuests that only take a few hours work can be a preparation for a more extensive practical assignment.



Tips

– Make use of the expertise of your colleagues who teach English. Try to build on what they have learned in English lessons.
– Motivate the students by starting the discussion with a video fragment, a film or letters to the editor of a newspaper.
– Practice the different discussion skills separately, for instance the rules of politeness like 'listening to each other', 'hearing someone out', 'reacting to what the previous speaker said'. Use pedagogical tricks. For instance: distribute cards; it's only after handing in a card that students can have their say. Introduce an object into the game. The student who has this object is allowed to speak.
– Practice skills like giving arguments separately. Giving proper arguments can also be practised in writing.
– Let students reflect on the discussion; this is a learning experience for them. Confront the students with the scientific content of their arguments. Analyse the arguments by means of questions such as: 'why was this argument brought up against that argument'? During the reflection you can make use of the remarks of the students that functioned as observers during the discussion. Instead of reflecting on the students' own discussion you can also use a TV discussion for purposes of analysis.
– Let students practice with the argumentation from different perspectives and roles. Give students for instance the same information to start with, but combine it with different roles, for instance a journalist, a consumer, a scientist, a policy maker. See also the paragraph 'Summary proceedings'.
– Incite those students who always have the same sort of contribution to do something different. For more information see also the paragraph 'Putting on thinking hats'.
– Try to join in with discussions on the Internet.

Discussion

Argue for a case

Why

SPU is not only about the world of facts in science, but above all about the world behind it. Should everything be possible? How do you know if something is true?
In SPU students can bring in their own experiences, and they can experience that science and technology also affect their personal lives.
Students learn to look at the same problem from different angles and different roles. This matures the formation of their judgement and develops their respect for the values of others.

What

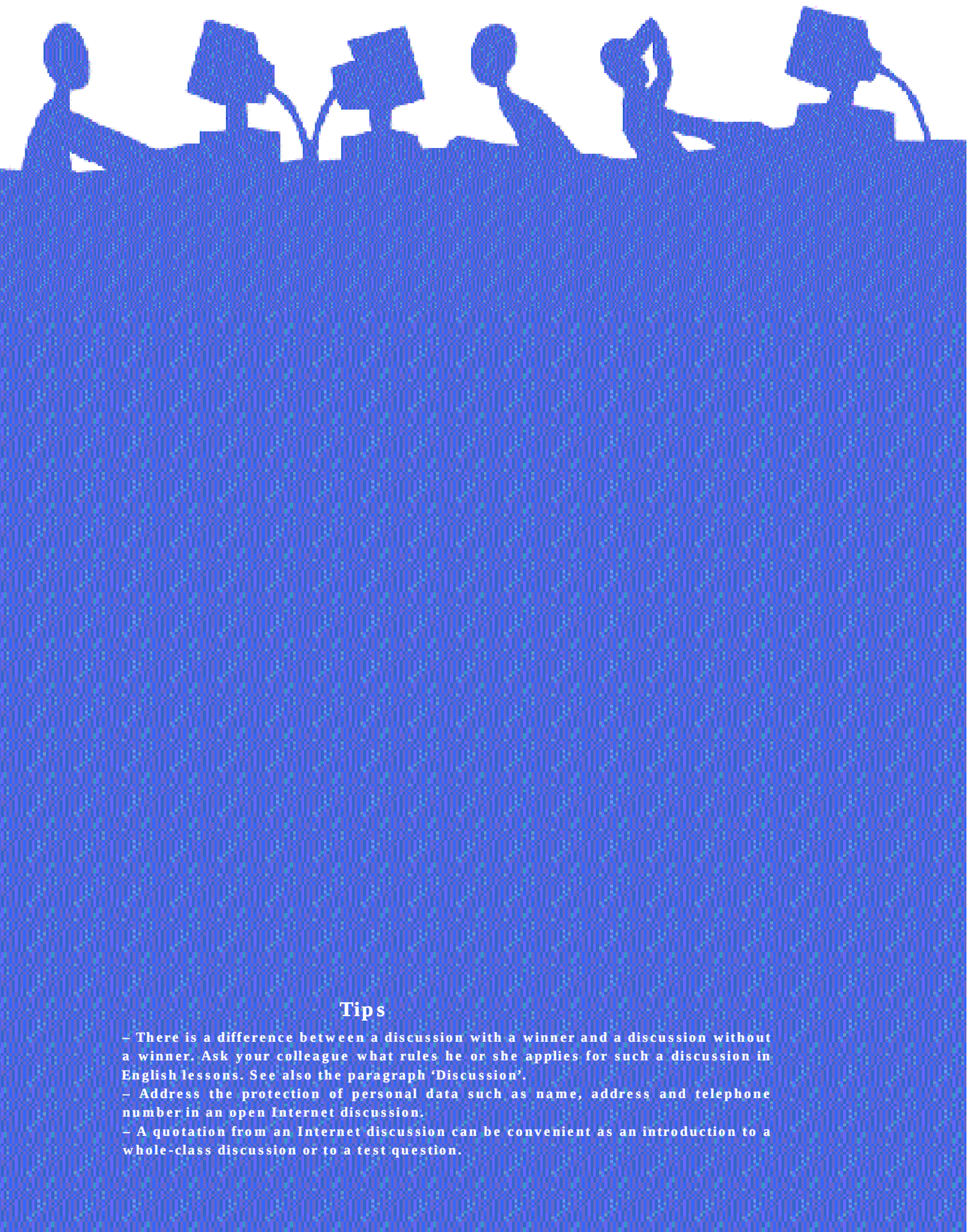
The problem is presented in the form of a case or a proposition. Students are challenged to find an answer or a solution. You can choose for two different approaches:
– Students get sufficient leeway to prove that they are right; there is one winner, and there is one solution. Working methods are: a policy debate, a debating game, summary proceedings, a role play, a proposition game.
– There is less leeway to prove that you are right; all is centred around the standards and values of the participants. There is no winner. Different solutions are possible. Working methods are: a step by step ethical discussion, dialogue, the Socrates discussion, a round- table discussion.

How

It is helpful to distinguish different phases:
– The starting- or confrontation phase. The topic is presented. The problem or the differences of opinion are determined. The leader of the discussion makes sure that the topic can be discussed in a safe atmosphere.
– The opening phase. The participants agree on the rules of the game for the discussion, both for the process and for the rounding off. During the discussion the leader sees to it that everybody keeps to the rules and that everybody can have his or her say.
– The argumentation phase. This is the phase that is often regarded as the real discussion. The leader of the discussion puts clarifying questions such as: 'Who can think of a counter-argument? Is this a good argument? Is this a new argument?' Besides that he observes the course of the mutual communication and anticipates what is coming.
– The rounding off phase. The solutions are examined. The leader of the discussion summarises and makes the group reflect on the process of the discussion.

When

If standards and values do not play a dominant role, a policy debate or summary proceedings are the most suitable working methods. This goes for topics such as: 'the greenhouse effect, the expansion of an airport, the foundation of a business, a space shield'.
A debate, especially if it is held in the form of a game, motivates students. They can play and win, which challenges them.
If standards and values do play an important role, step by step ethical discussions, dialogue, the Socrates discussion or round table discussions are the more adequate working methods. This goes for topics such as: 'organ donation, predicting genetic research'.



Tips

– There is a difference between a discussion with a winner and a discussion without a winner. Ask your colleague what rules he or she applies for such a discussion in English lessons. See also the paragraph ‘Discussion’.
– Address the protection of personal data such as name, address and telephone number in an open Internet discussion.
– A quotation from an Internet discussion can be convenient as an introduction to a whole-class discussion or to a test question.

Internet discussion

Your own opinion counts

Why

One of the SPU questions is: ‘What is your opinion of the applications of science and technology’?
In different places on the Internet people are asked to give their opinions and to take part in discussions, also on scientific applications. At any moment, at school or at home, students can take part in discussions. This is very convenient.
When they are alone or together with a classmate in front of the computer screen students are mostly less reserved than in a whole-class discussion, where there are more things at stake than mere points of view.
In an Internet discussion students learn by experience in a playful way, how to express their opinions clearly and how to give them a scientific basis. They can read how a virtual discussion takes place. They can then reflect on the exchange of points of view and the quality of the arguments. It is from other peoples’ arguments that they learn a lot.

What

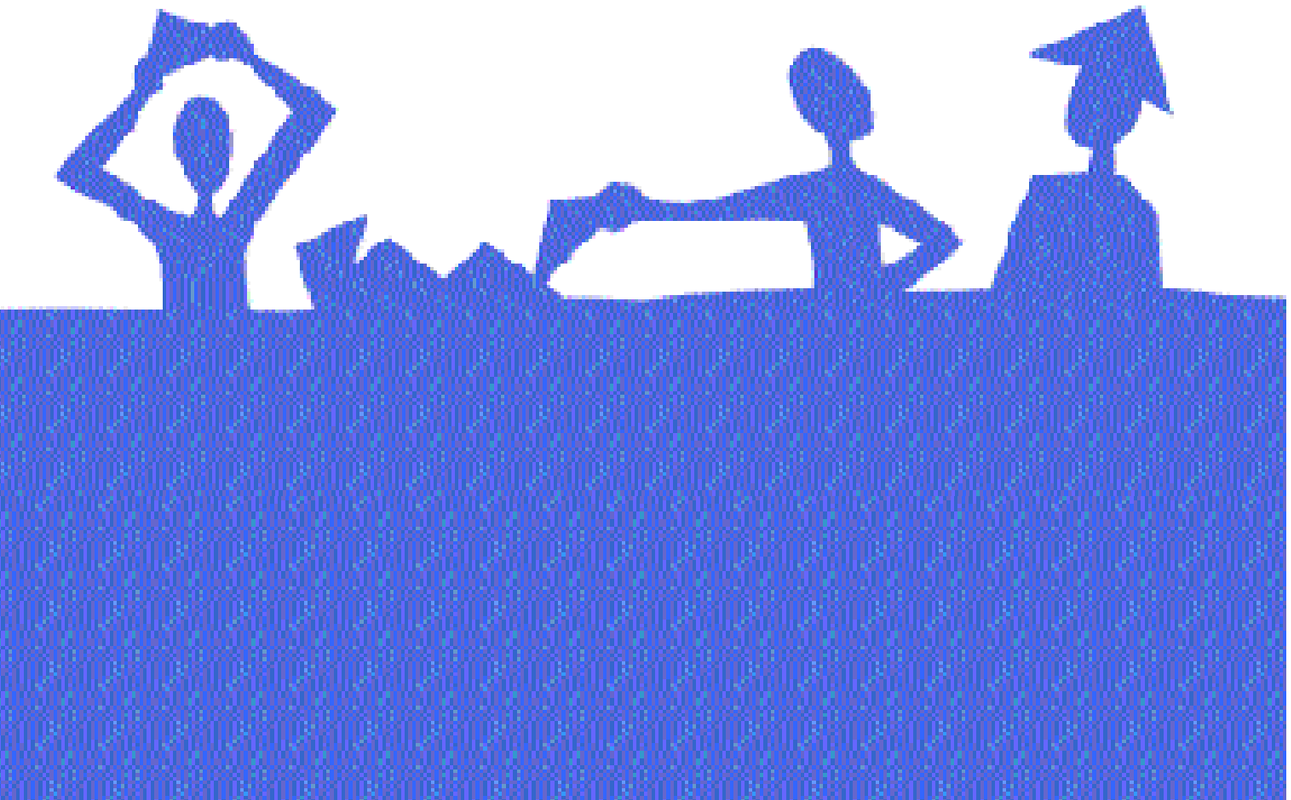
Websites of newspapers ask people to express their opinion in discussion pages specially designed for this purpose. Dilemmas evoked by the application of science and technology invite teachers and students to discuss these issues and to form their own opinion. For topics that lead to a lot of letters to the editor in the paper there are often also discussion pages on the Internet. As these pages regularly change they can be used in the first place for small assignments. Let students set up and keep up a forum page within a students’ site or a school site. You can also let them assess an existing forum page and formulate proposals for improvement.

How

– Discuss together with the students the course of an Internet discussion that has already started.
– Tell them beforehand the rules of the netiquette .
– Let the students decide for themselves whether they want to take part actively in an Internet discussion. If they don’t feel involved in the topic they will not have enough to contribute to a discussion.
– Taking part in Internet discussions can have different aims, which the students have to know beforehand. Is the aim the formation of an opinion of their own, is it the exchange of arguments or is it just following (and assessing) the discussion?
– Students who have ample experience with this sort of discussion can play a supporting role in the discussion, for instance by inviting others explicitly to add or clarify certain points of view or to make an interim summary.
– As a reflection assignment they can be asked to give an assessment of the soundness of the arguments used to found opinions.

When

If students find it difficult to express their opinion in a whole-class discussion or allow others to interrupt them, some experience with Internet discussions can increase their self-confidence.
If students have difficulty in following an oral discussion, because it is too fast, a forum page gives them the opportunity to follow and assess a discussion at their own pace.
If students missed a discussion through circumstances, a discussion on the Internet can be a substitute assignment.
If the aim is to list and investigate different opinions, the archives of discussion pages can be used for this purpose.
An Internet discussion can be an excellent assignment to complement a paragraph or article from the textbook, for instance on ‘life’ or ‘biosphere’.
If current topics from the news ask for an extensive political discussion in society, the choice of SPU-topics can be adapted to those topics.



Tips

- Try out the thinking hats in meetings and in contact with friends. Try and put on a different thinking hat on purpose. You can put on the colours that others omit! By experimenting possibilities for use in the lesson will show up.
- Collaborate with teachers of other subjects when introducing the thinking hats. The whole school will benefit if this method of reasoning, listening and watching will become part of the collective ownership of students and teachers.
- Check with the school management about working with thinking hats. In many training courses De Bono's thinking hats are introduced.
- It is certainly recommendable to read Edward De Bono's original book 'Six Thinking Hats'! (ISBN: 0316178314).
- With a little more feeling for drama you can go and buy some real felt hats in the right colours to hang up in the classroom! Apply the method in class when you are explaining something.
- To practise: watch a video of a class discussion and let students identify the contributions of the participants by raising coloured cards in the shape of hats.

Putting on thinking hats

Colouring the message

Why

During Science for Public Understanding students learn to look at topics from different perspectives. To learn this, the teaching method described here, which is inspired by Edward de Bono in his book ‘Six Thinking Hats’, can be used. The idea of De Bono is effective when people are to be made more aware of the strength of their input in a discussion and of the options for variation that everybody can exploit. Many people show stereotype reactions in discussions, making their input similar and predictable. It is a relief -even for yourself- if you consider coming up with a different input than you would naturally tend to. The thinking hats teach students to improve their reactions and base them on facts, feelings, optimism, creativity or reflection. Being more aware of these aspects considerably enhances the possibilities students have.

What

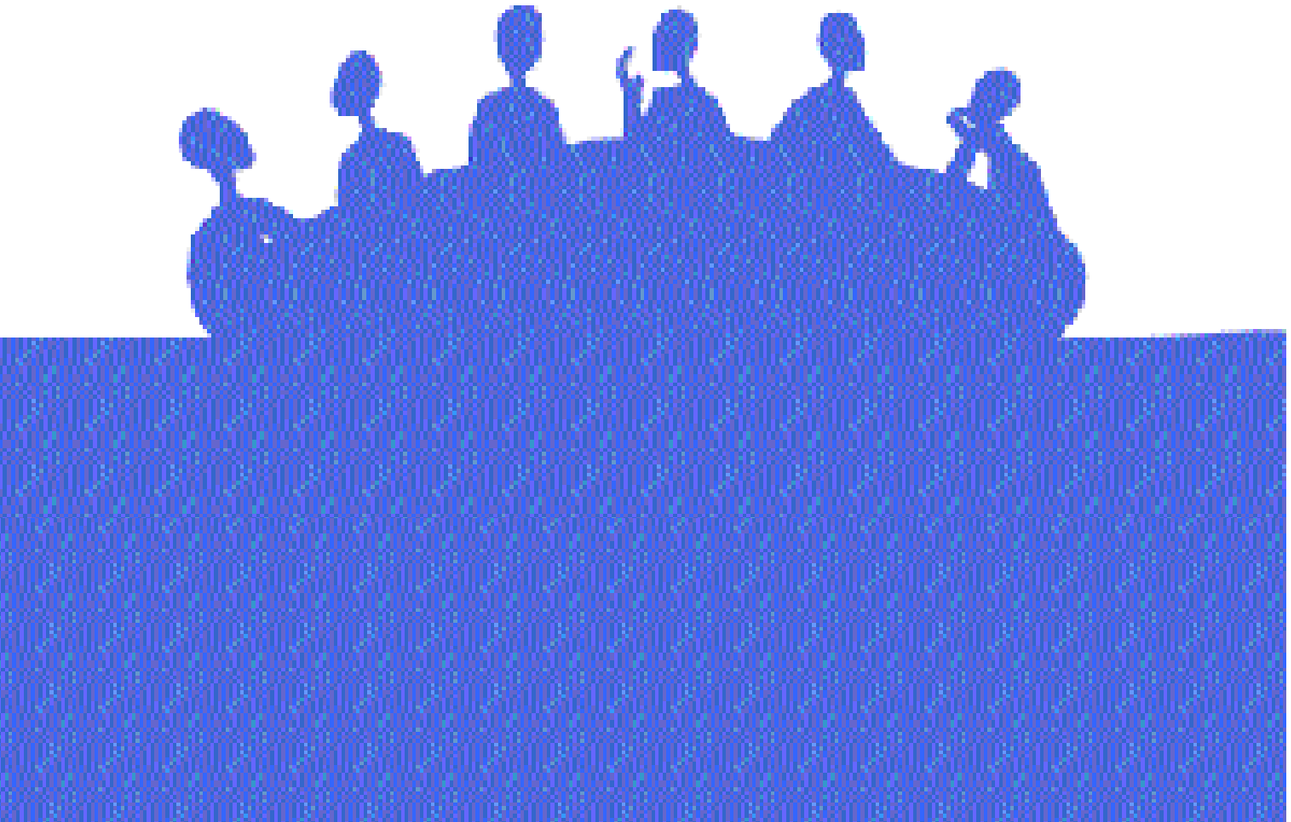
According to De Bono participants in a discussion can speak from six different perspectives. He therefore distinguishes six 'thinking hats'.
The white hat represents thinking as a virgin by means of figures, facts, data and proofs. It is a hat with a rational contribution.
The red hat especially stands for feelings and intuitions, emotions, allegations and inspirations.
The black hat is the devil's advocate. The bearer is a contra-thinker and will come up with negative judgments and he/she knows why something will not work.
The yellow hat represents the sun. Optimistic, clear, constructive contributions come from the person in the yellow hat.
The green hat symbolises creativity and creative power. The idea will grow or seed will propagate.
The blue hat stands for control, reflection and thinking about thinking.

How

- Let students make Chinese hats of coloured paper: white, black, red, yellow, green and blue. Make groups of six students with thinking hats of each colour
- Instruct the students by watching a video of a discussion together or by doing an exercise. A coloured hat is put on when a certain contribution to the discussion is made. First the whole group is involved: if somebody makes a contribution, the group will assess what colour hat matches with the contribution. Later on practising becomes less important. The student will put on a hat of a certain colour to emphasise the nature of the contribution. After some time the hats are not used any more. In some cases students can say: ‘I would like to make a blue remark on this.’
Finally you will go back to the natural form of discussion.

When

If there is a need of a more playful element in the lesson during group discussions and decision procedures, it is an option to turn to thinking hats. Sometimes students are slightly bored if 'another discussion in groups' is started. This is the moment for change! If the level of discussions should be raised or needs more engagement De Bono's strategy might help.
Perhaps the teacher is not satisfied with the discussions of the students. Maybe the outcome of their differences of opinion is rather one-sided or emotions and reflections are not sufficiently expressed. The thinking hats offer the opportunity to pay explicit attention to the value of different contributions. It can be extremely useful to confront a student who usually acts as the devil's advocate with the one-sidedness of this approach.



Tips

– The teacher is the leader of the discussion, and the group is often smaller than the whole class. This working method demands that the rest of the students can work autonomously on other assignments.
– Observe the behaviour of individual students and ensure a respectful way of communication with each other. Students who take too many turns get a hint. Students who don't say much get a little assistance.
– Label positively a large variety of sorts of behaviour. Somebody who doesn't say much but listens well does not necessarily need to change this behaviour. Somebody, who can formulate his of her contribution in pithy terms, does not need to make long sentences. If you choose positive formulations for different sorts of behaviour students will feel free to choose their own way of participating in the discussion and to develop their own personal qualities.
– Ask some students to formulate one positive aspect of everybody's contribution.
– Possible tasks and roles are: introducing the topic, animating the discussion, giving summaries, putting questions, functioning as a critic, journalist, assailant or defender. As soon as students are familiar with the working method a student can also function as the leader of the discussion.
– Make clear, if necessary, that a round-table discussion is not the same as a group discussion where the aim is sharing.

Round-table discussion

Being critical and respectful

Why

In SPU lessons students form their own opinion on topics of science and technology. Expressing your own opinion or giving a critical comment on other people's opinions has to be done with respect. The round-table discussion is a working method to practice this. All participants of a round-table discussion are equal!
The round-table discussion is a good working method to get to the bottom of the argumentation in a text. In a superficial discussion everybody seems to understand the content. The nuances, however, are often missed if the discussion stops before it is becoming interesting and challenging. A round-table discussion is not so much about achieving consensus, but rather to go more deeply into the differences and nuances! Differences are interesting and challenging.

What

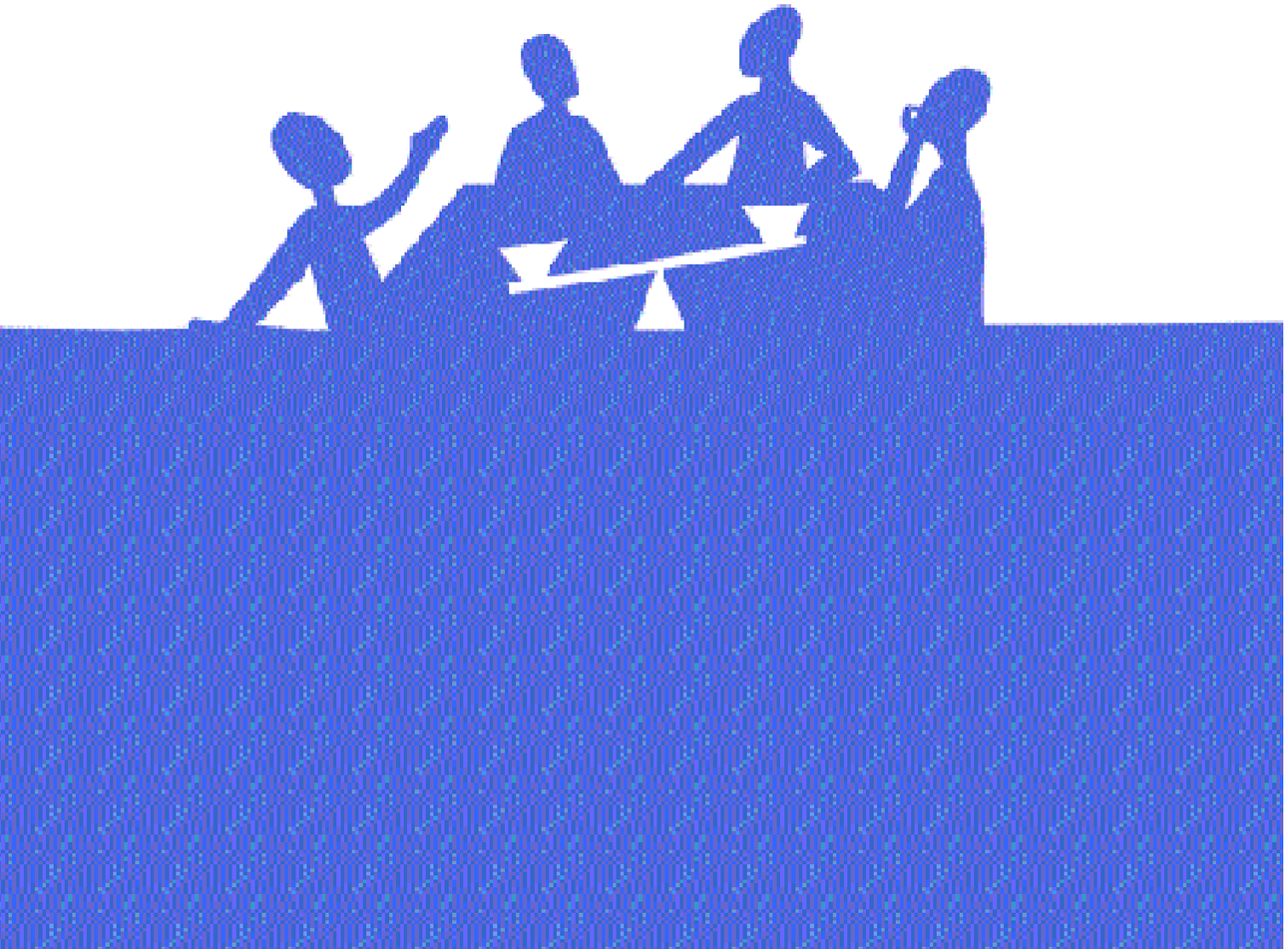
The teacher offers a text to the students – from the textbook or from a paper -, that they first study individually. The following aspects are important: understanding the text, forming your own opinion, taking a point of view and the preparation for special roles during a round-table discussion.
In the round-table discussions the students are expected to make contributions relating to all those aspects. Make clear what you mean by an adequate contribution. The teacher says for instance: 'I expect you to say something about this text, to react adequately to somebody else's contribution and to be able to start up the discussion.' A student who is not well prepared fails as a participator and is called to account for that: 'This shows that you have too little respect for your table-companions. This must not happen again.'

How

– Arrange the tables such that about twelve students can have a round-table discussion. You can do that with small tables or you can make a hexagon of tables for two. Make sure that you work in quiet surroundings. The other students work somewhere else, if possible, on another assignment.
– Cast the parts among the students. Ask two students to be prepared to get and keep the discussion going. Their part is to animate the discussion. By asking two students you have more chance that the discussion will eventually focus on the differences. Ask another student to put questions for clarification.
– You also need a neutral leader of the discussion, who does not intervene too often. This is the task of the teacher. This person keeps an eye on the process of communication and ensures respect for one another. The leader of the discussion also makes sure the students adopt a learning attitude. This can be done through an intervention and a thorough retrospective at the end of the discussion. If necessary, repeat several times what kind of behaviour is expected in a round-table discussion.

When

The round-table discussion can be used for topics where a whole series of texts has to be worked through and discussed. For instance a number of newspaper articles on biotechnology and its applications.
A repetition of the round table discussion enhances the learning effect. This can lead to a developing line of better achievements during the discussion. It is very important to keep up the level of your requirements for the preparation of the discussion! The round-table discussion must be the reward for a thorough preparation, as it were. Mention the methods and materials that make their individual preparation visible: marker pens, underlining, notes in the margin and concept mapping. Let students develop their own style during a series of round-table discussions and show them that this work will also be part of the assessment!



Tips

- As preparation for an ethical discussion zoom in on one of the steps. Suggestions include:
Present a research report. Let the students think of ethical questions.
Present a problem. Let them mention the groups that are involved in the problem and the interests of these groups.
Present an article about an ethical problem to the students. For example on hereditary diseases and letters to the editor. Ask questions from different perspectives such as from the perspective of a patient, doctor, nurse or member of the family.
- Create an open, safe atmosphere in which students are equal.
- Make use of discussions organised for education on the internet.
- Make use of theatre companies producing science theatre as a preparation for an ethical discussion.
- Collaborate with teachers of other subjects, such as Dutch, social sciences, biology and philosophy, because particularly for learning to use step 4 'Consideration of values' support from others is welcome. During step 4 students indicate how high they rate the values for themselves, which requires a well-considered approach. The often used method of plusses and minuses is too limited to achieve this well-considered approach; now professionalism of the coach is essential.
- Give all possible credit to the personal experience of the students; do not have a discussion at a technocratic level.
- Let students bring in elements for a case themselves. This will further their motivation.

Ethical discussion

A step-by-step approach

Why

One of the questions in SPU is 'Is everything possible also allowed?'
Lesson activities on this question are often very animated. Still, the discussion remains difficult, because something one student finds normal, another student may find intolerable. A student saying ‘I just think that this is the way it should be’ does not help the discussion along, for another student can have a totally different opinion on the same matter. If students are to exchange views in a fruitful way they will have to defend their opinion with arguments and will have to explain how important their arguments are to them, and to indicate the value of these arguments to them. In the process values of other students should be respected.
The challenge is to discover the students' arguments step by step and to let them give well-considered reactions to the arguments of others.

What

The test case concerns a practical problem that requires a solution. The problem is always about the question whether something is allowed or not. Groups with a personal interest and point of view are an implicit or explicit part of the test case. Interests may conflict.
The test case should be structured in such a way that an approach from different perspectives is possible. Examples include the legal, economic and/or global perspective.
The step by step approach is intended to let students distinguish between giving an opinion and considering values. Students are challenged to give arguments to support an opinion.
The aspect of a number of groups with their own interests teaches students to look from different perspectives. The students themselves would otherwise not look in any other way than from the relational perspective. The social perspective and the professional perspective also deserve attention: students are citizens in society and will be holding jobs.

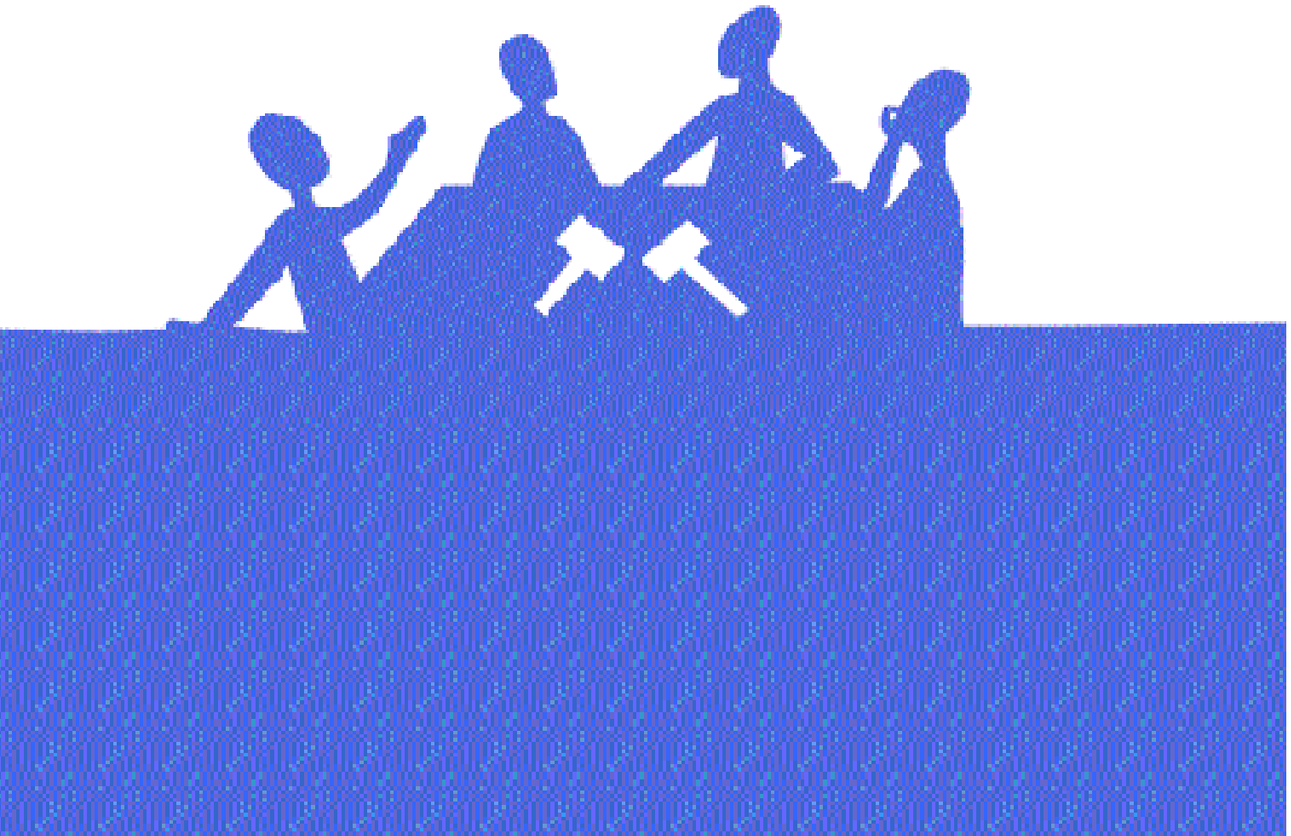
How

In groups:
- Step 1 Introduction: The case is administered to groups of six students. The case is read.
- Step 2 Elaboration: What is the problem? What are the answers to the problem at first glance? What more factual information is required? Which groups are involved in the problem? If necessary further information on the case is gathered.
- Step 3 Elaboration: Think about the answers for each group involved. For each of the groups involved think of arguments in favour of and/or against the answers. Indicate why a particular group would use that specific argument.

Plenary:
- Step 4 Consideration of values: Gather the results of the exploration and elaboration of all the groups. Indicate the value of each of the arguments. An often used method to do this is giving plusses and minuses. Weigh all the arguments up against one another. As a result of this consideration of possible answers, which answer is preferable?
- Step 5 Approach: What is the concrete decision that results (Yes, if... No, unless...)?
- Step 6 Review of the discussion.

When

This method is suitable:
when it concerns giving a personal opinion on applications of science and technology;
when the teacher wants to pay attention to forming opinions and to looking for arguments for these opinions;
when the teacher wants to make students aware of the reason why they have a certain opinion. Because of fear? Is this fear justified? Do they know enough about the subject? Do they realise what an issue entails?
In Science for Public Understanding many ethical questions present themselves. They are associated with biotechnology, application of science and technology in health care, developments in space technology, technical products for general use.
Examples include: Are limits exceeded if one or more human characteristics are transferred into animals? Or if embryos created through in vitro fertilisation... and superfluous material is destroyed? What should be the way of conduct?



Tips

– For optimal success start with a proposition of not more than ten words; do not use adverbs or negations in your proposition.
– Ask a colleague teacher of another subject or a parent or a retired official to function as the judge.
– The game takes two lesson periods, but can be spread over several days; the first interim consultation can therefore last longer; this gives the students – fully motivated and reacting to the start of the game - the opportunity to gather information. Ensure that you can keep up the pace of the game.
– Take part in the interim consultations as a coach and observer and give both parties stimulating hints.
– Make use of the competition element in the game; stimulate the students to get the utmost out of the consultations for their own party. Collect beforehand letters to the editor, video fragments, newspaper articles, and bring them along when the moment is right.
– Ensure that the descriptions of the witnesses are formulated such that the dispute is already included. The descriptions of the witnesses should contain indications and give students the room to come up with juicy interpretations of the details.
– Make the game lively by giving the classroom an adequate decor and by using suitable accessories: a hammer for the judge, an authentic positioning of the witnesses and the solicitors.
– It is possible that the students want to continue after the summary proceedings. You can let them do that by giving them assignments like: 'Give your own retort and compare it to that of others'.

Summary proceedings

Defending your own opinion

Why

SPU is about the interaction between science and society. The positive results of science can have side effects creating problems like the increased greenhouse effect and damage to the ozone layer, as well as the availability of advanced techniques in health care. The scientists make a contribution to the solution of these problems, often in a debate with politicians, ethicists and economists. These are complicated debates. Summary proceedings, where the arguments of scientists are heard next to those of others, are a suitable working method to make students experience this complexity.
Students become motivated to gather scientific information and to categorise it.

What

A proposition is put forward, for instance: 'Car owners should contribute to the reduction of the discharge of carbon dioxide'. This proposition is discussed in summary proceedings chaired by a judge. One party is pro, another party is con. Each party has a solicitor and three witnesses. Each of the three witnesses has a different expertise. Anyway, the scientist is represented next to for instance the policy maker and the consumer. Each of the witnesses receives a role description; during the game the students extend the role. It is only during the game that the two parties are introduced to each other's experts.
All students participate actively:
– In three phases of consultation – gathering information, preparation of the argumentation, elaboration of the witnesses' roles – they support either the pros or the cons;
– In the three sessions of the summary proceedings they act as the public and take notes for their own party.

How

– The teacher introduces the working method as well as the proposition and asks the students to choose one of the parties, the pros or the cons.
– The parties debate separately. The solicitor and the witnesses are elected.
– The opening plea and the roles of the witnesses are prepared.
– The summary proceedings start. The judge leads. The solicitors make their plea and call their witnesses to testify.
– The parties separate and prepare their final plea.
– The final pleas are made, and the judge gives a verdict.
– The judge can eventually make the public vote and evaluate the content and the process.

When

There are quite a number of topics in SPU, which are very suitable for summary proceedings. Think for instance of issues like granting permission for the establishment of a chemical plant or the launching of modified food onto the market. It is important to mention that in SPU the application of scientific knowledge plays an important role when dealing with this sort of issues. The students who can handle scientific knowledge well can do some pioneering work for other students.
The students co-operate intensely, and everybody is involved, even the public through the interim consultations everybody takes part in.

Tips

– If so desired you can let the participants as well as the audience answer questions like: ‘How did the discussion go?’, ‘What have I learned from this discussion?’ ‘What other aspects could I have brought into the discussion?’
– Put the first discussion out to a colleague teacher who is familiar with this working method.
– Gain experience in a Socrates discussion as a participant/observer.
Remember:
– Consensus is not necessarily the same as truth. A group can be mistaken and still achieve a consensus on the truth. In that case it is the task of the leader of the discussion to burst the false consensus by asking some more questions. The leader of the discussion must have a certain ascendancy over the participants’ knowledge to be able to see through this, but must never bring in this extra knowledge in the discussion.
– In ‘what is’-questions one should not try to find ready-made definitions, because that is a dead end.
– ‘Why’- and ‘how’ – questions asking for explanations on the basis of empirical facts are not suitable.

A teacher’s reflection (1)

‘I wanted to know whether the Socrates discussion would serve my purposes and which pitfalls could be expected, and if the students could work in smaller groups with their own chairperson?
The latter didn’t work. There were insufficient different ways to approach the topic, and there were insufficient active students. It is difficult for students to function as a chairperson in a Socrates discussion, because the chairperson has to summarise the essential points, to invite students to have their say, as well as to get and keep the discussion going.
I want to explore and become more familiar with this working method by organising a series of Socrates discussions in one or more classes and seeing how skilled the students can become in this method.
I want to find out whether it is possible in the long run to form smaller groups with their own chairperson, and whether the students will appreciate this working method more when they do it more often. I intend to follow a course or read some literature on this working method to gain some basic knowledge.’

A teacher’s reflection (2)

‘I wanted to know how to organise a Socrates discussion or a similar form of discussion. I expected to discover my students’ ‘level of thinking’ by experience.
Some of the students surprised me. They did very well.
I have learned that I have to take some time to prepare for the procedure and the aims of this working method. I intend to practice with this working method regularly and to build in an advancement of the students’ autonomous participation.’

The Socrates discussion

Collaborative knowledge building

Why

With the help of the teacher the students build up knowledge by developing an enquiring attitude.
The students learn to find answers using their own power of thought. We are talking about questions like: ‘How do you build up knowledge?’ ‘How do you know whether something is true?’ ‘Is everything possible also allowed?’
Without having to go deeply into the subject matter beforehand students learn to reflect on the sciences. The teacher should not worry too much about a personal lack of knowledge. The knowledge students bring in and share comes from their own experience. The leader of the discussion asks specifically selected questions.

What

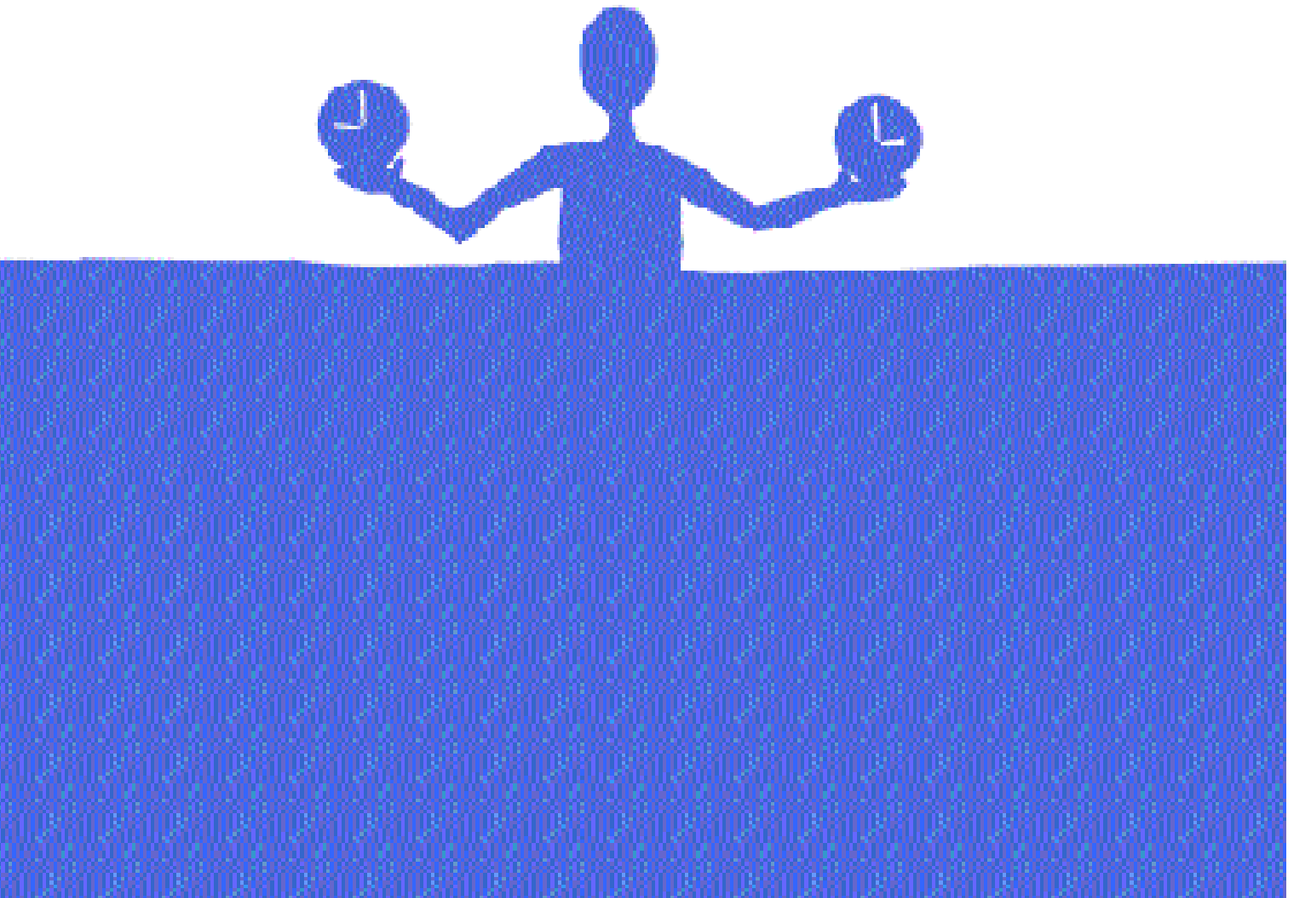
The students collaborate in the pursuit of the truth about fundamental problems. They explore a common theme by departing from one particular question. They test each other’s principles and fundamental convictions.
There are four components in the discussion:
– Truth; the essence of this concept must become clear,
– consensus; the participants of the discussion strive for consensus with every step,
– the participants; they bring in knowledge based on their experience,
– the leader of the discussion; as an ignorant party the leader starts a game of question and answer among the participants.

How

The leader of the discussion
– structures the process, and leaves the content of the discussion to the participants;
– urges the participants to clarify or improve their contributions;
– verifies if every participant still follows the discussion and agrees;
– interrupts the discussion when it flags or repeatedly wanders.
The leader of the discussion keeps to the following rules:
– Only one person speaks at a time.
– Every speaker reacts to what the previous speaker has said. If necessary, check if the previous speaker has been understood.
– Both the pros and the cons are addressed.
– Arguments should be supported by concrete examples as much as possible.
– Only the knowledge gained by experience is valid.
– Only after reaching a consensus among all the participants will the following step be set in the discussion.
– Participants have the opportunity to ask for a discussion about the discussion.

When

With students who like philosophical discussions, for instance, have the discussion at the start of a new topic to detect possible presuppositions.
Topics:
Conceptual issues: ‘What does health mean to us?’ ‘What does death mean to us?’ ‘What is our attitude towards nature?’
Find out about the necessary conditions for our knowledge: ‘How do we know whether something is true?’
Ethical questions: ‘Is everything possible also allowed?’
Derivations from certain facts: ‘How could extraterrestrial intelligence be constructed?



Tips

– Let the students correct their tests themselves. The teacher only carries out spot checks.
– Improve the output of correction work, and make students learn more from their own mistakes. You can do that as follows: a test corrected by the teacher leads to an extra assignment: 'Analyse your mistakes, correct your work, and hand it in again'. The analyses of the mistakes carried out by the students are included in the marks for the test.
– Don't regard your work as an accumulation of tasks that 'end up on your plate'. Try to work responsibility-oriented rather than task-oriented.
– If there is still some elasticity and energy left, use it for yourself, for your own personal and professional development, for your personal environment, your relationship with relatives and friends. Sometimes it is sensible to use it for your work in order to be able to avoid a peak load. Don't wear yourself out.
– Work can take up a lot of your energy. But if you organise it well, work can give you energy. Seek this situation!
– Choose your own spearheads and priorities in your work, and show them to students and colleagues. And then, just go for it.
– Make sure you challenge the students. Tasks, exercises and assignments (without a challenge) are a waste of time!

Time management

Creating opportunities

Why

The quality of SPU improves if teachers are not under too much pressure. It is to nobody's advantage if your programme is overloaded. Make well-considered choices of what to spend your time on, taking the following points into account:
– It is healthier for body and mind if you take sufficient time for relaxation.
– The pedagogical task requires relaxed people rather than drudges. Only then can you be a pleasant colleague!
– Things will be done better if you get your priorities right.
– Peace and quiet and reflection lead to important incentives for new ideas.
– Students and colleagues like to work with relaxed people, who have time for them.
– The teacher is a role model for independent, responsible and methodical workers.

What

– It is important to do the things you find important well. So you'd better take enough time for those things. Always try to find structural solutions to problems that arise, which demands creativity.
– Try to avoid predictable solutions, which create new predictable problems. Don't muddle on with things you are not good at.
– Try to learn by means of schooling, coaching and intervision. If this is not possible, try to find a balance between what you do and what you are good at.
– Sometimes it is better NOT to do things rather than do them poorly. Be assertive and dare to say no. Delegate as much as you can to the students. Avoid big piles of correction work, and never correct multiple choice tests yourself!

How

– Take enough time for your planning. Consider all actions that have to be taken carefully with respect to the consequences they have for the time you will have to spend.
– Plan above all the moments of rest, reflection and free time.
– Never fill your agenda for 100%. Say to yourself: 75% full means full.
– Don't fall for false arguments such as: 'A busy teacher is a good teacher'. 'A teacher who is busy is a teacher of merit'. 'Being too busy is a valid excuse for failure'. 'An overfull agenda proves your competence'.
– Observe your own behaviour thoroughly. Give some thought to the question: 'Is this what I want?' Working hard sometimes is an addiction or serves as an escape. Don't efface yourself for others. Self-effacing is just like forgetting the most important thing. Those who have no strength left, cannot give strength to others.
– Take sufficient time to tidy up and to administrate.
– Take the time to learn from your own mistakes.

When

When it is too late, it often means helping teachers who have been overburdened and self-effacing for too long. Colleagues can do a lot for each other in this respect. It can be very valuable for colleagues who want to support each other to use the ideas presented on this page. Besides that, it is important that each teacher gives sufficient attention to his or her own time management
Try to spend more time on planning and organisation while preparing the school year and the new time schedule.
In discussions with colleagues of your own subject try to find solutions, which lead to an optimal effect with the least possible energy. Take a constructive attitude when talking to the school management, and try to think along with them. Show your will to co-operate with things you find valuable. Mind, there are limits!
Always give the priority to tasks that can be done by the students. This saves time and they learn more. For instance: testing, making assignments, checking and marking papers.