Smoking Consequences and Circulatory and Respiratory Systems, a Problem-Based Learning Approach to Life Science Education

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Abstract. The aim of this study is to investigate students’ feedback on a problem-based learning (PBL) approach used to deal with health education and human biology topics. Students in three classes of Italian secondary schools experienced PBL during a module concerning circulatory and respiratory systems and effects of smoking. Students' feedback was obtained with questionnaires submitted after the module was completed. Findings show that students appreciate the method and this appears to be related especially to a greater engagement with lesson activities and to the higher autonomy they have been given.

1. Introduction

Adopting correct behaviours towards one’s own health and the environment depends on values, but also on everyone’s awareness of the consequences of these behaviours.

School education must include information about these consequences to let everyone have tools and knowledge in order to decide how to behave.

In the Italian secondary school health education (HE) and environmental education issues need more attention and integration with curricular science topics. Natural sciences teachers should address their effort in order to let students acquire knowledge and develop reflective skills which lead to responsible actions towards themselves and the environment.

1.1. Objectives

This study is a part of a PhD project which aim is to give indication to teachers on a possible alternative way of organising the teaching-learning process during science lessons so that it can lead to the following.

- Integrate health education and environmental education / education for sustainability in the natural sciences (earth and life sciences) curriculum.

- Increase interest and engagement during science lessons.

- Promote students’ self-direct learning skills and autonomy.

- Let students have a better understanding of how science works.
1.2. Purposes of this study and research questions

The aim of this study is to see how students and teachers react to a module that integrates an HE issues with human biology topics using the problem-based learning (PBL) method. The research questions are the following.

- Which is the students’ feedback about a PBL experience used to integrate health education in a life science curriculum?
- What do teachers think about the method and its possible use?
- Could we expect any positive impact on students’ attitudes toward smoke?

2. Rationale

2.1. Health education


Viner & Barker (2005) stress that adolescence is a critical period for engaging the population in health as new behaviours are laid down and are maintained into adulthood and influence lifelong health. Neuroscience tell us that during adolescence brain undergoes important modifications (Rhoshel & Giedd, 2006), and according to Martin, Kelly, Rayens, Brogli, Brenzel, Smith & Omar (2002), sensation seeking, which is related more to pubertal stage than to the age itself, makes adolescents more vulnerable to nicotine, alcohol and drugs addiction.

These evidences show how much is important to deal with health education issues at the secondary school level. Knowledge of the physiological processes and awareness of the consequences that behaviours have on one’s own health might encourage people to avoid unhealthy habits. But, preaching what is good and what is not does not seem to be an effective educational strategy. School instruction should make possible the acquisition of scientific knowledge in a way that enables students to apply it for reasoning on the processes and the consequences.

2.2. Problem-based learning

The interest toward science is not high among young European people (European Commission, 2004; Sjöberg & Schreiner, 2005; OECD, 2008). Recent reports stress that for improving students’ engagement, teachers need to develop and extend the ways in which science is taught (Osborne & Dillon 2008) and suggest that the use of inquiry-based science education methods would improve student interest (European Commission, 2007).

An instructional method that could help in increasing students’ engagement would be the Problem-based learning (Barrows, 1986, 1998; Woods, 1995; Torp & Sage, 2002, Barrows & Wee Keng Neo, 2007). PBL can positively influence students’ motivation because, starting with a problem, students get involved in exploring the topic and in researching about it. Moreover it allows to develop self-direct learning skills (Schmidt, Vermeulen & van der Molen, 2006), and can give students the opportunity to better understand the nature of science. In addition, PBL can also help in developing argumentation skills, and science education research shows that argumentation is important for the appropriation of scientific practice (Jiménez-Aleixandre & Erduran, 2008).
In secondary school the authentic PBL has to be adapted at least because of the large number of students. The characteristics of PBL that have been kept in mind in the design of the instructional sequence are:
- students have to work also in small groups,
- the problem must be relevant,
- the teacher do not have to give lectures,
- students have to discuss among them and to search for information,
- the topic must not be previously known by students.

It is the problem itself that makes the students feel that they need to acquire new knowledge to be able to understand it, to give answers to questions, and/or to put forward possible solutions.

Health education issues can provide good scenarios for the PBL instructional approach, and the PBL could be an effective method to let students acquire knowledge related to the biology curriculum. This would increase students’ interest, and, at the same time, let them have more consciousness about healthy and unhealthy habits.

3. Methods

3.1. Participants, timing and data

During fall 2008, 62 students in three classes of Italian secondary schools (10th grade - 15 to 16 years old) experienced the module which will be described later on. Lessons, two hours per week, took place during a six weeks period and they were tutored by the author.

Students’ feedback was obtained by submitting two questionnaires. One, including multiple choices, yes or no, and open-ended questions, was submitted at the end of the module. The second one, containing a four-point Likert scale, was submitted a week after. Parts of the two questionnaires probed the same aspects to double-check students’ opinion.

The biology teachers were asked to act as observers and take notes of single students and whole class attitudes. At the end of the module they were interviewed to obtain their feedback about the activities.

3.2. Instructional procedure and activities in the classroom

The module regarding anatomy and physiology of circulatory and respiratory systems was introduced with a scenario regarding cigarettes smoking. During the module, scientific concept were not taught prior to the discussion among students.

The main problem regarded the prohibition to smoke in public premises, and, during the all module, students were given different focused inputs aimed at promoting brain storming activities and at raising questions. Inputs used are listed below.

- Warnings and smoke compounds printed in cigarettes packages.
- Experiments about solid particles and acidity of the smoke (Blonder, 2007).
- Pictures of a smoker’s and a non-smoker’s lungs and heart.
- Results of a smoker and a non-smoker arterial blood analysis.
- A text about cough of chronic smokers and whopping cough (pertussis).
- Data about breathing and cardiac frequencies during sport practice.
All this lead to discuss about:
- anatomy of respiratory system;
- physiological processes which can explain each of the warning (e.g. ‘Smoking during pregnancy is harmful for the baby’);
- what kind of scientific researches warnings can be based on (scientific experiments and epidemiology);
- smoke components and their effects;
- different types of blood, gases transported, and haemoglobin;
- relation between breathing, blood circulation, and cellular respiration.

During each discussion, some questions emerged, and eventually students, with the tutor’s help, chose what they thought to be important to learn and what kind of information they would need to search for the following lesson. Then retrieved information were compared and collaboratively elaborated within small groups (2-4 persons), and later presented and synthesized at the class level, with the tutor’s contribution. If information were considered incorrect or not exhausting, students were asked to go back to searching. Otherwise a new input was given to students. At the end of the module teachers submitted a test with open-answers questions for the assessment of content acquisition.

4. Results

The questionnaires were filled up by 62 students, with answers to 99% of multiple choice questions and 89% of open-ended questions.

The analysis of the students’ and teachers’ answers highlights the following findings.

4.1. Students’ contentment and engagement

We positively point out that 71.2% of students stated that they would like to use this method more frequently.

Feedback on students’ engagement comes both from open answers and from multiple choice questions. Two full examples of students’ comments are the following.
- “With this kind of lessons we were more interested and participated more. The whole class worked and in each workgroup everyone had his duty. Even people who usually don’t take part actively to lessons, gave their opinions and there was more collaboration among us.”
- “I liked that we started with a big problem and we ended up talking about a small thing like cellular respiration.”.

Other aspects are mentioned by students in the open answers. For example, they dislike:
- “having more homework to do than usual”;
- “having too much information to search for”.

But aspects they like are more frequent and deep:
- “discussing among students and with the teacher”;
- “having the possibility to express my opinion”;
- “being more engaged than usual during these lessons”;
- “looking for information by myself and not only studying on textbook”,
- “the autonomy and the responsibility given during this module”,
- “be able to reason on the topic”,
- “laboratory activities”,
- “having dealt with a topic of high concern to me”,
- “the health related topic”.

Some of these perceptions were confirmed also by the second questionnaire, which allows us to add some quantitative data. Results are listed in table 1.

Table 1. Students’ answers from the Likert scale questionnaire

<table>
<thead>
<tr>
<th></th>
<th>fully disagree</th>
<th>partly disagree</th>
<th>partly agree</th>
<th>fully agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The module has been made more interesting than usual because of the scenario used to introduce the topic</td>
<td>9,8%</td>
<td>16,4%</td>
<td>39,3%</td>
<td>34,4%</td>
</tr>
<tr>
<td>The topic was interesting</td>
<td>9,7%</td>
<td>8,1%</td>
<td>53,2%</td>
<td>29,0%</td>
</tr>
<tr>
<td>The work carried out during this module was interesting</td>
<td>0,0%</td>
<td>16,4%</td>
<td>52,5%</td>
<td>31,1%</td>
</tr>
<tr>
<td>The tasks given to me during this module allowed me to learn scientific knowledge that is useful for my daily life</td>
<td>1,7%</td>
<td>18,3%</td>
<td>41,7%</td>
<td>38,3%</td>
</tr>
<tr>
<td>Related social aspects helped me to understand the reason why we studied the topic</td>
<td>8,2%</td>
<td>16,4%</td>
<td>57,4%</td>
<td>18,0%</td>
</tr>
<tr>
<td>Dealing with scientific problems, coming for everyday issues, was important and useful for me</td>
<td>1,6%</td>
<td>14,5%</td>
<td>41,9%</td>
<td>41,9%</td>
</tr>
<tr>
<td>I would like to treat more topics related to health issues</td>
<td>6,5%</td>
<td>21,0%</td>
<td>32,3%</td>
<td>40,3%</td>
</tr>
<tr>
<td>This module provided me with opportunities to participate more actively than usual</td>
<td>3,3%</td>
<td>23,0%</td>
<td>45,9%</td>
<td>27,9%</td>
</tr>
<tr>
<td>This method encouraged me to share ideas with my friends</td>
<td>8,2%</td>
<td>23,0%</td>
<td>42,6%</td>
<td>26,2%</td>
</tr>
<tr>
<td>This module provided me with opportunities to get answers to my questions</td>
<td>4,8%</td>
<td>24,2%</td>
<td>45,2%</td>
<td>25,8%</td>
</tr>
<tr>
<td>The discussion was important to improve my reasoning skills</td>
<td>11,3%</td>
<td>11,3%</td>
<td>41,9%</td>
<td>35,5%</td>
</tr>
</tbody>
</table>

All these opinions are likely to have had a positive impact on students’ engagement, and the first questionnaire confirms this idea. For example, 40.7% of students reported to have worked more than usual at home, while 18.6% declared the contrary, and 61.7% think that the PBL approach aroused more interest than the usual lessons, while only 6.7% of them think the opposite.

Higher interest and participation, as well as less distraction, have been observed and reported also by teachers, especially for students who are usually lazier. Moreover all teachers acknowledged the positive response of students to this approach and they expressed the intention to use the method again, “often” or “sometimes”, because it may: “improve students’ skills and autonomy”, “make them reflect”, “engage them in science studying”, even though they think that the development of a module with this approach takes more time than usual and they could not always use it because of all the topics they are requested to accomplish according to the national life science curriculum.
4.2. Impact on studying

With regards to impact on studying and understanding, 86.7% of the students think they had a sufficiently clear understanding of what they learnt. Other answers to questions regarding the same matter are listed in table 2.

Table 2. Students’ perceptions on the impact on studying

<table>
<thead>
<tr>
<th>Comparing with other modules, in this one …</th>
<th>yes</th>
<th>no</th>
<th>as usual</th>
</tr>
</thead>
<tbody>
<tr>
<td>… I think the understanding was made easier by the method used</td>
<td>51.7%</td>
<td>13.3%</td>
<td>35.0%</td>
</tr>
<tr>
<td>… I used memory studying less than usual</td>
<td>63.4%</td>
<td>13.3%</td>
<td>23.3%</td>
</tr>
<tr>
<td>… I can remember better than usual the topics I studied</td>
<td>66.7%</td>
<td>6.6%</td>
<td>26.7%</td>
</tr>
<tr>
<td>… I was stimulated to deepen the study of the topics more than usual</td>
<td>55.0%</td>
<td>10.0%</td>
<td>35.0%</td>
</tr>
</tbody>
</table>

Students report difficulties in information searching (44.1%) and in selection and synthesis of the important aspects (26.7%). About the latter, however, they think that the method have been useful for improving the related skill (68.3%). Difficulties are reported also in some open answers, where students wrote: “it is not very clear what we had to study” and “too much material made me confused”.

Teachers reported that results of the final text were in the average, but that some students who usually get bad marks achieved better results in this module.

4.3. Attitudes toward smoking

With regards to pupils’ smoking habits, 38.3% of the students of these classes smoke, although one third of them smoke less than once a day. Among smokers, 32% of them declared they will stop smoking, and 40% of them declared they want to reduce the number of cigarettes they smoke.

Obviously, questionnaire answers are not enough to foresee students’ attitudes in the long term, but it’s interesting to underline that 93.3% of them say that after the module they know more than before about smoking consequences and 72.2% of them affirm that the module made them think about their attitudes towards smoke.

5. Conclusions and Implications

Results suggest that a health related issue and Problem-Based Learning approach can increase students’ interest and engagement during biology lessons. Teachers are aware of that, but they believe that the main obstacle for an extensive use of PBL is the longer time needed for this kind of approach, which contrasts with the number of topics included in the national curriculum.

It’s important to notice that students appreciated those aspects of the teaching-learning process that required a more active participation in which they feel more responsible of their own learning.

However, further adaptation should be experimented to reduce the problems evidenced by students, especially concerning the evidenced lack of clarity. This point can be critical in compulsory secondary school, where students are used to a teacher-directed method and may not have developed appropriate self-direct learning skills.
5.1. Educational implications
Difficulties may gradually be reduced if an active learning approach is used more often. A curriculum centred on abilities that students are expected to develop, more than on contents that they have to acquire, would allow teachers to a more extensive use of inquiry-based approaches.

At the beginning, to let students familiarize with PBL, teachers could:
- use smaller and more focused problems (Grover, 2004);
- give suggestions on where to search, but preferably only when students don’t find correct and exhaustive information;
- help students selecting and summarizing important information;
- can answer to specific questions, but only when students have already searched for information first.

5.2. Research implications
More studies should be done to test further adaptations of the PBL method which could reduce the difficulties encountered by compulsory secondary school students. Experimental studies would be needed to investigate the impact of these adaptations on contents and skills acquisition at the secondary school level.

References


Sjøberg S., Schreiner C. (2005). How do learners in different cultures relate to science and technology? Results and perspectives from the project ROSE. *Asia Pacific Forum on Science Learning and Teaching, 6*, 1-16.


Woods, D. R. (1995). *Problem-based Learning: resources to gain the most from PBL*. Waterdown, ON, Canada: Donald R. Woods Publisher.