STUDENT'S BELIEFS IN PSEUDOSCIENCE

This paper reports from a study about knowledge and beliefs in science and pseudoscience in health related issues. A web based questionnaire about knowledge in human biology and beliefs in pseudoscience has been answered by students in upper secondary school in Sweden. The aims of the study are to examine students' beliefs in pseudoscientific phenomena related to the body and our health and if there is any relationship between those beliefs and knowledge of human biology, studied science courses or education programme. The survey measures relationship to science and scientists, beliefs in pseudoscience and knowledge in human biology. Results from the study show a correlation between science education and knowledge in human biology. However, no strong and clear correlation between science education or human biology knowledge and scepticism against pseudo-science was found. Neither was there any relationship between sex and pseudo-scientific beliefs.

The increase of different types of information related to pseudo-science in media like New Age health related advertising and articles are the base for the study and importance of developing life-long skills to handle conflicting information are discussed. The paper is arguing for the importance of investigating and analysing students' beliefs in science contra pseudo-science as a means of achieving scientific literacy.

Mats Lundström, Malmö University, Sweden

Background

In today's society the public is increasingly exposed to information that is of a pseudo-scientific nature in the areas of health and nutrition. Some of this information closely resembles scientific information while also being related to treatments connected to New Age beliefs (Hammer, 1997). Science describes New Age ideas as pseudo-science. The concept *pseudoscience* and its border to science has been discussed by for example Bauer (2001) but according to Preece and Baxter (2000) pseudoscience is "a set of ideas or theories which are claimed to be scientific but which are contrary to standard science and which have failed empirical tests or which cannot in principle be tested". Despite a high level of general science education, pseudoscientific beliefs are common in the general public (Ede, 2000). Some pseudoscience as astrology and homeopathy are propagated by well-organized groups, often with commercial interests and through popular media (Ede, 2000; Preece & Baxter, 2000; Shermer, 2003). At first, beliefs in pseudoscience can be regarded as a small, harmless problem, but a deeper acceptance of such beliefs may cause passivity, wrong treatments, illness and economic utilization. Therefore, teaching in science must deal with this subject.

Females are often described as more gullible than men (Preece & Baxter, 2000; Sjödin, 1995) But according to Johnson & Pigliucci, (2004) the difference seems related to what kind of pseudoscientific or paranormal phenomena we are talking about In the study by Johnson & Pigliucci (2004) there were significant differences on pseudoscientific beliefs in only two questions of ten. Females believed to a higher degree that animals can sense ghosts and males believed to a higher degree to The Loch Ness Monster. In a similar study Preece & Baxter (2000) found females less sceptical than men with only one exception; beliefs that aliens from another planet had visited earth. Also age, education and culture seem to be of importance (McLeish, 1984; Shermer, 2003; Wiseman & Watt, 2004).

The map of beliefs in science or pseudoscience gives a very contradictory image. On the one side, people generally think that science will have a positive effect on our lives in the future, specially medicine, energy and ICT (EC, 2005; NSF, 2006). Especially younger people are interested in science and technology; particularly medicine and the environment. On the other hand people also are sceptical to science and interested in pseudoscience. About half of the population in USA and 45 % in Europe agreed to the declaration "we depend too much on science and not enough on faith". In Europe 37 % of Europeans think some numbers are especially lucky for some people; a common superstition. In a CBS News poll in 2002, 57 % said that they believe in extra sensory perception like telepathy. The analysis of what is science or not seems problematic; in Europe history and homeopathy reach the same level in the areas people think are scientific (34-35 %) (CBS, 2002; EC, 2005; NSF, 2006; VA-Rapport-2005:3, 2005).

What is the relationship between pseudoscientific beliefs and other factors? Research about relationships between beliefs in pseudoscience and other variables gives a very complex picture. A Gallup poll found a strong and negative relationship between education and belief in astrology but many other public opinion polls have found inconsistent relationship between education and classic forms of paranormalism, like belief in haunted houses (Goode, 2002). Preece and Baxter (2000) think that the growing and widespread acceptance of pseudo-scientific and superstitious beliefs should be a matter of concern to science educators. One goal of science education is to educate for a *scientific literacy.* One example of scientific literacy can be awareness of the difference between science and pseudoscience and also to develop a sceptical view, but some research points out that this goal is not achieved (Ryan et al.; Walker et al., 2002). Scientific literacy consists of three aspects; scientific knowledge or concepts, scientific processes and situations or context. To understand the latter two aspects above, individuals must be aware of the "nature of science" (NOS) (Driver et al., 1996). NOS has been defined in numerous ways, but it most commonly refers to the epistemology of science, science as a way of knowing, or values and beliefs inherent to the development of scientific knowledge (Abd-El-Khalick & Lederman, 2000; Lederman, 1992).

Context And Research Questions

The Swedish curriculum encourages all students to, find new information, think critically, see consequences and make decisions; learning how to use a scientific way of thinking and working. In Science A; a compulsory course in upper secondary school in Sweden, the aims for the student are to develop a capacity for critically examining different types of information, participating in discussions in different issues of the society and deciding from a scientific and ethical perspective (Skolverket, 1994). In the PISA-studies in 2000 and 2003, Swedish students had worse results compared to other parts in the study where understanding scientific methods are measured (PISA, 2001, 2003).

Based on these results, the following research questions are asked of Swedish students: What are the students' opinions about science and scientists? What common opinions and beliefs do upper secondary school students hold related to pseudoscientific health issues? What are the relationships between pseudoscientific beliefs and knowledge in human biology?

Design Of The study

Totally 293 students in upper secondary school answered a web based questionnaire. 175 were males and 114 females between the ages of 17-20 responded, almost all in the last months of upper secondary. 69.6 % of the respondents answered all questions. Respondents of the inquiry were chosen to resemble the population in Swedish upper secondary schools relating to education programme, sex and size of residential area. Educational programs are divided in four groups; theoretical- directed for university studies, practical traditionally most boys - directed for a career as for example car engineer or carpenter, practical traditionally most girls- like hairdresser or taking care of children. The fourth group is those students with individual solutions like more Swedish language or extra athletics or music.

In the first part (A) of the questionnaire, students were asked to consider their relationship to science and scientists. The questions were to some extent similar to those used in ROSE (http://www.ils.uio.no/forskning/rose). In part B students were asked to make decisions about different statements dealing with health and diseases, where some are scientific solutions and some are pseudoscientific. Among the statements in part B there were 10 statements initially classified as pseudoscientific that the students should make a response to on a Likert scale with four alternatives from totally agree (4) to totally disagree (1). Part C in the questionnaire consisted of thirteen questions about physiology, health and nutrition. The questions were of multiple choice types and some times more than one answer was correct. Correct answer gave two or three points with a maximum of 36 points. Two indexes were constructed; a PseudoScientific Beliefs Index (PSBI) and a Human Biology Knowledge Index (HBKI).

Results

In the first part of the questionnaire students demonstrated that science is important for society; 67 % of them agreed totally or agreed almost totally to the statement: "*I think science and technology are important for society*". But there were also some doubts about science. About 35 % agreed or totally agreed to that "*science can solve almost every problem*" and only one of five meant that we always can trust scientists. These numbers can be interpreted as a type of scepticism towards science and scientists but also as an ability to see that science is not able to solve all problems in society. Furthermore, students thought that science education is important; 55 % agreed. But science is more important than fun and interesting, only one of three totally agreed or almost totally agreed in the statement "*science is fun and interesting"*.

As seen in Table 1 the statement about acupuncture relieving pain received the highest score. This result was expected, acupuncture today is an accepted and used treatment in Sweden. More surprisingly are students' strong belief in telepathy. Telepathy is not a treatment or cure but is exposed more and more in media.

Table 1. Pseudoscientific statements. n= 293

Statement	Mean	SD
Acupuncture can relieve pain	3.20	0.86
Some people can transfer thoughts (telepathy)	2.32	0.98
Phases of moon can affect a persons health	2.27	0.95
Rheumatic pain decreases if carrying a magnetic bracelet	2.16	0.74
Many diseases can be discovered through iris diagnostic	2.14	0.80
Some people can move objects with their mind	1.85	0.92
Some people can heal putting their hands on the sick	1.84	0.97
Inflammations can be cured by placing noble crystals on the skin	1.80	0.79
It is possible to decide the sex of a foetus by swinging a pendulum above the pregnant persons stomach	1.60	0.81
[Astrology has no impact on what diseases a person gets)	2.67	1.23]

A reliability analysis of the ten items of pseudoscientific beliefs confirms that nine of the items have an internal consistence. Cronbach's alpha coefficient is 0.758. The astrology statement was excluded; probably has the negation an effect. Those other nine items form a pseudoscientific beliefs index (PSBI); mean PSBI is 19.15 (SD 4.58). Minimum PSBI is 9 points and maximum 36. A human biology knowledge index (HBKI) consists of 13 items in part C. The maximum on the 13 knowledge items was 36 p. Mean is 13.53 (SD 6.55). Cronbach's alpha is 0.664. (Table 2)

There is a very strong relationship between both science education and theoretical programs related to HBKI but not to PSBI. A theoretical education in upper secondary school gives more knowledge in human biology than other education but not automatically a more sceptical view to pseudo-science.

Table 2. Pseudo-Scientific Beliefs Index (PSBI) and Human Biology Knowledge Index (HBKI)

	Mean PSBI	Mean HBKI	n
Total	19.15	13.53	293
SD	4.58	6.55	
Boys	18.88	12.99	175
Girls	19.43	14.35	114
Theoretical programme	17.91	17.62	90
Practical programme traditionally most girls	20.12	12.32	108
Practical traditionally most boys	19.33	11.83	48
Individual/Special programme	19.21	10.35	43

Even there are small differences in PSBI points; there are no significant differences between boys and girls. Only one statement appeared a significant difference between the genders; girls believed more in acupuncture than boys. ($p = 0.047$)

Table 3. HBKI and PSBI related to number of studied science courses.

Number of science courses	Mean HBKI	Mean PSBI	n
0-1	11.39	16.36	178
2	13.03	16.76	33
3	15.69	14.10	16
4-7	17.27	15.13	66

Students in educational programs which are theoretically directed have indisputably higher HBKI than other students. There are tendencies that students that have studied many science courses have lower PSBI, but it is not a strong and clear correlation. Girls have higher HBKI but the difference is small and not significant ($p = 0,258$). There is no correlation between PSBI and HBKI; Pearsons $r = - 0,094$. Students with high HBKI do not seem to be more sceptical towards pseudo-scientific claims.

Contributions

For many years one goal of scientific education has been to achieve scientific literacy in the population. Initiatives like Project 2061 and PISA purpose to develop and evaluate a science which is useful in the future for all citizens; a public understanding of science. Results of the study may indicate that critical thinking and reasoning about facts and evidence does not occur or seems to have no impact on some students. Like Ryan et al., (2004), Shermer, (2003) and Walker et al. (2002), no clear and strong relationship between science knowledge, in this case human biology knowledge, and low pseudoscientific beliefs could be found. The reason to why students do not develop critical thinking can be that in science classes teachers teach about technical skills rather than critical thinking and data are accepted uncritically (Ede, 2000; Johnson & Pigliucci, 2004; Ryan et al., 2004; Walker et al., 2002). This knowledge can be trained in school where students can develop "scientific literacy" if they are trained to draw conclusions from evidence (Driver et al., 1996; Kolstoe, 2000). The study indicates that health is a field where there is no gender difference in pseudoscientific beliefs. The lack of a divergence between males and females confirm the research by for example Johnson and Pigliucci (2004). As one of many important areas in the field of scientific literacy, "health literacy", must also be important. Reason for this is that people must be able to handle different information about their own and other's health. According to Nutbeam (1999) a health literate person is not only able to read health-related materials such as prescriptions or medicine labels but also a person able to participate in everyday activities making informed choices. In media different types of science information are common and people have to deal with this. This type of information is brief, widely available to the public (Korpan et al., 1997; Pettersen & Solberg, 2003). This type of information and commercial must be discussed and analysed in school if we are going to have health literate persons in the future.

In northern Europe research about how science education impacts on pseudoscientific beliefs is not common. An explanation may be the lack of interest among well educated scientists and science teachers for subjects without science content. This study has aimed to broaden knowledge in the area and awaken an interest for this topic among science teachers and researchers. More studies where not only what types of pseudoscience students believe but also peoples reasoning and argumentation in this subject should be of interest.

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