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# Attitudes towards Physics and Chemistry: insights from a questionnaire validation with music students

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## Abstract

*The purpose of this study is to explore the factorial structure of a questionnaire on attitudes towards Physics and Chemistry in academic artistic contexts and to study the relation of attitudes with gender and social context. The sample consists of 185 key-stage 3 students of two music schools (A and B), located in different social contexts. The sample of school A consists of 67 year 8 students (40 males and 27 females). The sample of school B consists of 117 key-stage 3 students, from which 41 were enrolled in year 8 (16 males and 25 females). A validated questionnaire was used. Factor analyses (generalized least squares method with varimax rotation) were conducted. The reliability scores were excellent (total sample, α=.95; year 8 sample, α=.93). The factor analysis retrieved four factors for the total sample, which were named after their content: (i) behaviours and achievement; (ii) cognitions and values; (iii) feelings about Physics and Chemistry; and (iv) feelings about studying Physics and Chemistry. The analysis of the year 8 sample retrieved six statistical factors, but the two new factors only included three items, reason why this solution was dropped. Music students seem to have negative attitudes towards Physics and Chemistry. Items associated with feelings about studying and behaviours showed lower means, while items associated with feelings about the subject and about values showed higher and positive means. Students seemed to acknowledge the social and pragmatic value of the knowledge and to enjoy the subject but also that they don't like and considered difficult to study it and obtain good grades. Almost none significant differences were found based on gender and social context. Implications include the discussion about the influence of variables other than gender or social context to understand the formation and change of students' attitudes. The current findings seem to encourage science teachers in contexts where students are strongly committed with other subjects to progressively move from an education paradigm that stresses the need to teach science, technology, engineering and mathematics to a paradigm that includes approaches based on students' interests, such as arts, in order to teach science.*

## 1. Physics, Chemistry and music students!?

Science literacy is a necessary tool to participate in contemporary society. Not all students have to become scientists or science experts but one can expect that every citizen, like a musician, must have a good scientific background. Thus, education should take into account the particular intelligence profiles [1] and interests to tackle science literacy. Teaching methods that uses personally relevant interest, such as music, can help teachers to be more effective in subjects, such as Physics and Chemistry. In this paper, we start by asking what the attitudes towards Physics and Chemistry among music students. The paper is organized as follows: after a brief review of literature on science attitudes, methods are described, results presented and discussed.

## 2. Research of attitudes towards science

The research of attitudes towards science has been developed to reverse the trend of decline in the interest of young people that choose to follow scientific careers and widespread scientific ignorance [2], since it is widely acknowledge that scientific knowledge is crucial for society and for the citizens

that want to take part of it [3],[4]. Furthermore, there is empirical evidence of a positive correlation between students' positive attitudes towards science and their achievement in science [3],[4],[5],[6],[7],[8]. Attitudes also play a role in the interest, attention and response to science and technology [3].

According to Eagly and Chaiken [9] an attitude is a hypothetical construct related "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor". Attitudes are always an evaluative judgment, whose evaluative responses have these possibilities of forms of expression: cognitive, affective and behavioral. The first case refers to thoughts, ideas, opinions, beliefs that bind the attitude object to their attributes or consequences and that express a more or less favorable evaluation; the second case refers to emotions and feelings caused by the attitude object; the last one refers to the behaviour or behavioral intentions that attitudes can manifest.

Generally, by "attitudes towards science" literature refers to products of students' experience of school science. Those attitudes are the sum of several sub-constructs that influence them in different proportions [2] and are formed in specific contexts [10]. Several factors can be identified that influence attitudes towards science: gender, family, attitude of peers and friends, classroom environment, teacher, curriculum, socio-economic class, students' perception of science, grade level, achievement [2], school, home, family and national culture and context [3].
According to PISA 2006 overall students, at age 15, on average across OECD countries, reported that appreciate science and support scientific enquiry. They believe that science is important for understanding the natural world and that advances in science and technology usually improve peoples' living conditions. However, different personal value of science is attributed: 75% agree that science helps them to understand things around them, but only 57% agree that science is very relevant to them personally. Students also reported confidence as science learners, but only 47% reported that they found school science topics easy. Students reported, too, interest in learning science, but only a minority see themselves using science in the future; a strong sense of responsibility for environment issues, supporting policies to promote sustainable development, but at same time believing that environmental issues would stay about the same or get worse over the next 20 years. There were no consistent differences between genders in attitudes that most students have towards science: the largest gender difference observed is in science self-concept. On average, girls had lower levels of belief in their scientific abilities than boys in all European countries, but boys had higher level of confidence in tackling specific scientific tasks. Results showed, too, that students' background influence their interest in science: students with a more advantaged socio-economic background or those who have a parent in a science-related career were more likely to show a general interest in science and to identify how science may be useful to them in the future [3] [4]. TIMSS results have suggested that attitudes towards science differ between school years, by comparing the attitudes of year 4 and year 8: the higher the school level the lower the attitudes towards science [4]. Classroom environment and teacher variables also play an important role. Positive attiudes are related with a high level of students' involvement, personal suport, strong relationships with classmates, the use of variety of teacher strategies, unsual learning activities, teachers being enthusiastic about their subject, setting it in everyday contexts, as also being sympathetic and willing to spend time talking about science, careers and individual problems with students [2].
The attitudes towards different science subjects aren't the same, being Physics and Chemistry two of the science subjects that students report less interest [3].

## 3. Method

### 3.1. Subjects

The sample consists of 185 key-stage 3 students, 112 females and 72 males (1 missing value), from two music schools (A and B). School A is located in the centre of Porto. Its 67 students are engaged in year 8, 27 females and 40 males. School B is from a village in the neighbourhood of Porto (118) and its students are engaged in year 7 (n=42), year 8 (n=41), year 9 (n=34), 45 females and 72 males. In Year 8, school B has 16 males and 25 females.

### 3.2. Materials

Attitudes towards Physics and Chemistry (AtPC) [11] uses a four point Likert-type scale, from entirely disagree to completely agree. Items 6, 9, 10, 15, 20, 23 and 24 were inverted so that higher punctuations express more favourable attitudes towards Physics and Chemistry.

## 4. Results

The scale reveals high internal consistency with an excellent Cronbach α value (α =.95). The factor analysis (unweighted generalized least squares method with varimax rotation) reveals 4 factors that are very coherent with the content analysis made two specialists. Factor 1 (Behaviours and achievement) includes all the behaviours and performance related with the subject (*e.g.*, "I easily have good grade in Physics and Chemistry"). Factor 2 (Cognitions and values) deals with the cognitive dimension of the attitudes towards the subject, including cognitions and values (*e.g.,* "I feel that solving Physics and Chemistry activities is useful for everyday life"). Factor 3 and 4 are related with feelings. In factor 3 (Feelings on the subject) those feelings are associated with the subject, and we call it (*e.g.*, "Solving Physics and Chemistry problems brakes me down"), while in factor 4 (Feelings on studying the subject) feelings are associated with studying (*e.g.*, "Studying Physics and Chemistry gives me joy").

Overall students evaluate positively their achievement in Physics and Chemistry (Factor 1: M=2.54) and acknowledge the value and usefulness of these sciences (Factor 2: M=2.76). They enjoy the subject (Factor 3, M=2.78) despite the fact they don't appreciate studying it (Factor 4: M=1.95). There are any statistically significant differences between male and female students (Table 1).

Table 1. Questionnaire structure

| Factor | Male | | Female | | Total | |
|---|---|---|---|---|---|---|
| | M | SD | M | SD | M | SD |
| 1 (items 2, 3, 6*, 13, 18, 19, 21) | 2.67 | 0.583 | 2.45 | 0.660 | 2.54 | 0.638 |
| 2 (items 8, 9*, 11, 14, 17, 25) | 2.89 | 0.542 | 2.68 | 0.632 | 2.76 | 0.605 |
| 3 (items 15*, 20*, 22*, 23*, 24*) | 2.90 | 0.575 | 2.71 | 0.714 | 2.78 | 0.668 |
| 4 (items 1, 4, 5, 7, 26) | 2.00 | 0.569 | 1.93 | 0.570 | 1.95 | 0.569 |

The questionnaire for the Year 8 sample reveals high internal consistency with an excellent Cronbach α value (α =.93). The factor analysis retrieved six (and not four) factors. Factor 1 and 2 are equivalent to those that we found for the total sample. Items associated with feelings reveal to be more problematic. Since the two new factors only included three items, this solution was dropped.

Although school A presents higher mean values, no differences were found between samples in the Year 8 (Table 2). However, a closer look into the items of Factor 1 (where the difference is larger), reveals higher mean values of School A students on understanding the subject and easiness to solve problems. Another statistically significant difference is found in the value given to solving Physics and Chemistry problems in daily life. Again in School A, students have higher mean values.

Table 2. Mean values between samples in the Year 8

| Factors | School A | | School B | | Total | |
|---|---|---|---|---|---|---|
| | M | SD | M | SD | M | SD |
| 1 | 2.69 | 0.646 | 2.48 | 0.556 | 2.61 | 0.619 |
| 2 | 2.95 | 0.463 | 2.80 | 0.541 | 2.90 | 0.497 |
| 3 | 3.00 | 0.563 | 2.93 | 0.493 | 2.98 | 0.536 |
| 4 | 2.10 | 0.543 | 1.98 | 0.500 | 2.05 | 0.528 |

Male and female students have very similar mean values and no differences were found between sexes in the Year 8. Statistically significant differences were found in the item “Pleasant to attend Physics and Chemistry classes” and “Studying Physics and Chemistry calms me down”. In the first item male students have higher mean values and in the second female students have higher mean values.

Table 3. Year 8

| Factor | Male | | Female | | Total | |
|---|---|---|---|---|---|---|
| | M | SD | M | SD | M | SD |
| 1 | 2.64 | 0.589 | 2.59 | 0.642 | 2.61 | 0.619 |
| 2 | 2.86 | 0.516 | 2.92 | 0.486 | 2.90 | 0.497 |
| 3 | 2.96 | 0.580 | 2.99 | 0.510 | 2.98 | 0.536 |
| 4 | 2.03 | 0.574 | 2.07 | 0.500 | 2.05 | 0.528 |

## 5. Discussion

This paper presented the results of an empirical study with a questionnaire to assess the attitudes towards Physics and Chemistry among music students. The factorial structure obtained in this exploratory research is different from the one given by the authors of the validated questionnaire. Originally, only three factors were considered, named “behavioral factor”, “affective factor” and “motivational factor”, being suggested, after careful analysis to the items of “motivational factor, to swap the name of the last factor to “instrumentality”. However, the authors, even so, expressed that a confirmatory factor analysis would be necessary [11]. The solution presented in this paper allows us to tell apart students’ attitudes on the subject from their attitudes on studying the subject.

Students recognized that Physics and Chemistry are important for society and for citizens’ social integration although they don’t like studying it and consider it a difficult subject. There seems to be no significant sex-based or context-based differences, except for the perception of self-efficacy [3] [4] that is higher among urban students.

It seems to be necessary to act at the level of strategies used in Physics and Chemistry classes to change the trend of unfavorable attitudes towards study these subjects. Strategies, such as analogies between Chemistry and Music, if students really love Music, can make science teaching more effective since that even them recognize the importance and the value of Physics and Chemistry. Future studies will focus on this subject and more data will be collected to confirm the structure of the questionnaire.

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