# PEDAGOGICAL AND SCIENTIFIC BELIEFS OF FUTURE PRIMARY SCHOOL TEACHERS AND UNIVERSITY SCIENCE EDUCATION AND SCIENCE LECTURERS

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**Abstract**
The purposes of this study are: a) to investigate the pedagogical and scientific beliefs of primary school teachers in training (group 1, N= 60), and b) compare said beliefs with those of university lecturers in science education (group 2, N = 33) and science (group 3, N = 98). We applied the Inventory of Educational and Scientific Beliefs, INPECIP (Porlán, 1989), consisting of 51 items divided into three categories: Image of Science, Learning of Science and Science Teaching. The results show that science education lecturers are more "constructivist" in all categories than both their students and their science department peers. In the "Learning of Science" and "Science Teaching" categories, we can also see that students are more "constructivist" than science lecturers. We conclude that in order to help future teachers modify their beliefs, collaboration with science lecturers is indispensable.

*Keywords:* pedagogical beliefs, image of science, teacher trainers

## INTRODUCTION

The beliefs of future teachers embarking on their science education studies tend to be in line with the traditional teaching model, with the subsequent gradual incorporation of constructivist models, without the latter replacing the former (Martín del Pozo, Porlán & Rivero, 2011). Teachers' beliefs are psychological constructs widely acknowledged in Educational Professional Development. They are framed within the mediational paradigm of "teacher thinking", where the teacher's behaviour is guided by a private and implicit personal system of beliefs which act as non-rational mediators of their teaching planning. For science teachers, the important beliefs concern: i) Image of Science, ii) Learning of Science and iii) Science Teaching; the three categories that form the vertices of the didactic triangle. Table 1 synthesises the main ideas associated with the cited models.

Our aim in this work is twofold:

a) To examine the beliefs held by future primary school teachers (group 1; N = 60) at the onset of their science education course.

b) To compare said beliefs with those of university lecturers in science education (group 2; N = 33) and sciences (group 3; N = 98).

As a starting point, it is assumed that the beliefs of prospective teachers are closer to those of science lecturers than to lecturers in science education.

Table 1. Teaching models and main associated beliefs.

| | Traditional Model | Constructivist Model |
|---|---|---|
| Nature of Science | Science absolute and true | Science is paradigmatic, i.e. contextualized and subject to prior knowledge, techniques and structures. |
| Learning of Science | Cognitive structure as an "empty box". Learning by listening and repeating. | Full cognitive structure. Learning by reconstruction, through physical, vicarious and symbolic interactions. |
| Science Teaching | Teacher explains and students perform activities | Students solve problems (from their daily life, socio-scientific…) through research methodology, whereby they perform, think about and regulate their own learning and work in interaction with their peers, discussing and sharing ideas. |

## METHOD

We reviewed several instruments: the Inventory of Educational and Scientific Beliefs, INPECIP (Porlán, 1989), the Professional and Pedagogical Experience Repertoire (Loughran, Mulhall & Berry, 2004) and others (Martínez et al., 2001; Marín & Benarroch, 2009; 2010; Benarroch & Marín, 2011). Finally, INPECIP was chosen for its brevity and its widespread application.

The questionnaire versions used (in Spanish) may be found at:

- http://goo.gl/forms/YAsWyJtwHB, for future teachers;
- http://goo.gl/forms/1RbBvlVDQ9, for university lecturers in science teaching; and
- http://goo.gl/forms/qxT7izBWNh, for university science lecturers.

INPECIP (Table 2) consists of 51 Likert-type statements with 5 response options (1 = strongly disagree; 5 = strongly agree).

Table 2. INPECIP questionnaire structure.

| | Nº Statements | Statements |
|---|---|---|
| Nature of Science | 14 | 55, 51, 47*, 44*, 42*, 40*, 39, 38, 28, 23, 22*, 21*, 11, 4* |
| Learning of Science | 14 | 54, 50, 48*, 46*, 41*, 35*, 33, 32, 27*, 24*, 19*, 14, 8, 5 |
| Science Teaching | 23 | 56, 52, 49, 45, 43*, 37*, 36*, 34*, 31*, 30, 26, 25, 20*, 17*, 16, 15, 13, 10, 9*, 7*, 6*, 2*, 1 |
| Total | 51 | |

*items corresponding to the traditional model

The survey was carried out in March 2014 with future teachers who were taking a course at the University of Granada to further their studies from 180 to 240 credits. Teacher collaboration, extended to the whole of Spain, was achieved by means of an anonymous questionnaire, inviting them to take part in the research by e-mail in the first semester of academic year 2014-2015.

We analysed the answers provided by a total of 60 students on a Degree course in Primary Education, 33 Science Education lecturers, without any experience in the INPECIP test, and 98 university Science lecturers. Table 3 synthesises some features of the samples.

Table 3. Sample characteristics.

<table>
<tr><th>Sample</th><th></th><th>N</th><th>Characteristics</th></tr>
<tr><td>Group 1</td><td>Primary School Teachers in Training</td><td>60</td><td>66% are female and 33% are male.<br>15% had studied “Science Education” during their previous degree course.<br>70% had no teaching experience.<br>23% had less than 5 years of teaching experience.<br>5% had between 5-10 years of teaching experience.<br>2% had more than 20 years of teaching experience.</td></tr>
<tr><td>Group 2</td><td>University Lecturers in Science Education</td><td>33</td><td>66% are female and 33% are male.<br>58% had never heard of the INPECIP test.<br>42% knew about its existence, but had not worked with it.</td></tr>
<tr><td>Group 3</td><td>University Lecturers in Science</td><td>98</td><td>32% are female and 68% are male.<br>Include almost all the main knowledge areas:
<table>
<tr><th>Area</th><th>Number of participants</th><th>Percentage</th></tr>
<tr><td>Geology</td><td>40</td><td>40.8%</td></tr>
<tr><td>Chemistry</td><td>19</td><td>19.4%</td></tr>
<tr><td>Physics</td><td>14</td><td>14.3%</td></tr>
<tr><td>Pharmacy</td><td>11</td><td>11.2%</td></tr>
<tr><td>Biology</td><td>3</td><td>3.1%</td></tr>
<tr><td>Engineering</td><td>3</td><td>3.1%</td></tr>
<tr><td>Others</td><td>8</td><td>8.2%</td></tr>
</table>
55% had less than 18 years of teaching experience.<br>43% had between 18-24 years of teaching experience.<br>2% had more than 24 years of teaching experience.</td></tr>
</table>

## RESULTS

First of all, we calculated the basic statistical parameters of each item in every category. We transformed the results corresponding to the variables associated with the less constructivist sentences, as follows: “1” is transformed into “5”, “2” is transformed into “4”, “3” remains unchanged, and so on. After this transformation, a high score indicated, in all items, a more constructivist trend.

Our first objective is to calculate the global indexes that provide information on the thinking of the different groups of participants, for every category (Table 4).

As these variables are not normally distributed (confirmed using both Anderson-Darling and Kolmogorov-Smirnoff tests), we employed a non-parametric Mann-Whitney test (Table 5).

Table 4. Mean results by category and group.

| | | Mean | Estimated error of the mean | Standard deviation | Variance | Min. | Q1 | Median | Q3 | Max. |
|---|---|---|---|---|---|---|---|---|---|---|
| Image of Science | Group 1 | 3.07 | 0.03 | 0.24 | 0.06 | 2.50 | 2.93 | 3.00 | 3.21 | 3.57 |
| | Group 2 | 3.83 | 0.10 | 0.60 | 0.36 | 2.86 | 3.32 | 3.71 | 4.25 | 5.00 |
| | Group 3 | 3.05 | 0.03 | 0.27 | 0.08 | 2.07 | 2.86 | 3.00 | 3.21 | 3.86 |
| Learning of Science | Group 1 | 3.52 | 0.05 | 0.36 | 0.13 | 2.86 | 3.24 | 3.43 | 3.71 | 4.42 |
| | Group 2 | 4.02 | 0.09 | 0.54 | 0.29 | 3.00 | 3.61 | 4.14 | 4.43 | 4.79 |
| | Group 3 | 3.27 | 0.04 | 0.38 | 0.14 | 2.50 | 3.00 | 3.21 | 3.50 | 4.57 |
| Science Teaching | Group 1 | 3.09 | 0.02 | 0.18 | 0.03 | 2.52 | 3.00 | 3.09 | 3.22 | 3.52 |
| | Group 2 | 3.48 | 0.07 | 0.40 | 0.16 | 2.74 | 3.22 | 3.48 | 3.76 | 4.43 |
| | Group 3 | 2.94 | 0.02 | 0.23 | 0.05 | 2.48 | 2.82 | 2.91 | 3.09 | 3.52 |

In each category, Science Education lecturers are more "constructivist" than both their students and their colleagues from Science departments. In the "Learning of Science" and "Science Teaching" categories, students are shown to be somewhat more "constructivist" than university science lecturers, but less so than lecturers in science education.

Table 5. Study of significant differences between groups.

| | | Difference of means | Mann-Whitney test (p-value) | ¿Are there significant differences? |
|---|---|---|---|---|
| Image of Science | Groups 1-2 | -0.760 | 0.00 | Yes |
| | Groups 2-3 | 0.781 | 0.00 | Yes |
| | Groups 1-3 | 0.022 | 0.50 | No |
| Learning of Science | Groups 1-2 | -0.504 | 0.00 | Yes |
| | Groups 2-3 | 0.753 | 0.00 | Yes |
| | Groups 1-3 | 0.249 | 0.00 | Yes |
| Science Teaching | Groups 1-2 | -0.388 | 0.00 | Yes |
| | Groups 2-3 | 0.540 | 0.00 | Yes |
| | Groups 1-3 | 0.152 | 0.00 | Yes |

Results show statistically significant differences between all pairs of groups ($p<0.001$), except in the case of the "Image of Science" category of groups 1 and 3 ($p=0.5$).

## DISCUSSION AND CONCLUSIONS

The results show some coherence between Image of Science, Learning of Science and Science Teaching among each population group. Thus, university lecturers in science teaching are shown to be the most constructivist in the three categories, with university science lecturers the least. The data obtained are consistent with those of other studies (Martín del Pozo, Porlán & Rivero, 2011) in terms of the tenuous alignment of the beliefs of future primary teachers with the constructivist models of science teaching. It does not seem paradoxical that prospective teachers' beliefs are closer to those of university science teachers than to those of science education lecturers, as the former will have been the main trainers of secondary teachers who, in turn, have taught science to pupils prior to their admission to university. Moreover, pupils will probably have had less contact with science education faculties, or none at all to date.

It is striking that, overall, members of the university faculty of sciences turn out to be more traditional, not only in terms of teaching and learning, but also in the Image of Science category (they themselves are creators of science), where a significant difference is found with science education lecturers, although not with students.

In any case, these ideas are far removed from the most advanced proposals on science and its teaching-learning, so channels must be found that facilitate communication and understanding among the different stakeholders responsible for the beliefs of future teachers. To quote Claessens (2007, p.2), "It is perhaps scientists who should be the first to speak out and show the way".

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