Measuring the environmental literacy of teachers

C.H. Swanepoel,* C.P. Loubser and C.P.C. Chacko
Faculty of Education, University of South Africa, P.O. Box 392, Unisa, 0003 South Africa
swanech@unisa.ac.za

* To whom correspondence should be addressed

The crucial role that teachers’ environmental literacy plays in realising the goals of environmental education and the importance of the ability, to determine their level of environmental literacy, are argued. A measuring instrument was developed in this regard and was applied to a sample of teachers. An analysis of the results revealed that the instrument meets the necessary psychometric requirements and that it can be considered a valid and reliable instrument to measure the level of environmental literacy of teachers. The research also revealed interesting results regarding the relationship between the level of teachers’ environmental literacy and their field of academic training, accompanying learning area involvement, and general environmental education training.

Introduction and background

The potential of environmental literacy as a vehicle to realise the educational agenda of sustainable development cannot be over-emphasized. According to Disinger and Roth (1992:165), environmental literacy is a prerequisite to maintaining and improving the quality of the environment and life as such. The development and fostering of environmental literacy need, therefore, to be a key objective in any general education programme (Roth, 1992:2).

Apparently, the term ‘environmental literacy’ does not mean the same to everyone. Since the first general reference to the concept ‘environmental literacy’ appeared in 1969 (Roth, 1992:ix), various researchers have made an effort to define it or to refine descriptions of it. Examples can be found in, inter alia, Clacherty (1992:26), Roth (1992:1) and Subbarini (1998:245). Although we are aware of the possibility of being labelled positivistic, a definition of environmental literacy was developed from the various efforts of researchers such as Leeming, Porter, Dwyer, Cobern and Oliver (1997), Loubser (1994), Smith-Sebato and Smith (1997), Pohlirile (1985) and Beuthe and Smallwood (1987). Details about the development of the definition and the supporting information and literature can be found in Loubser, Swanepoel and Chacko (2001:318-319). This definition was used for the purposes of this research and it stated that:

Environmental literacy is the ability to be aware of one’s environment. It enriches one with the knowledge to realise the imbalances and threats the environment faces and enables one to form positive attitudes towards it with the aim of developing skills to resolve and prevent environmental problems and urge to protect and improve the environment for the present and future generations by active participation.

A study was also made of various models comprising concepts researchers regard as important to environmental education and environmental literacy. From these attempts by, inter alia, Munson (1994:31), Odum (1992:542-544), Roth (1992:37-38) and Loubser (1994:37-38), we identified ten concepts that we regard as necessary for teachers to have a grasp of before being able to really do justice to environmental education. The ten concepts are in line with the definitions, aims, objectives and guiding principles of environmental education and the preceding definition of environmental literacy. Each of the ten concepts is a cluster of related subconcepts representing aspects of environmental literacy. These ten concepts were selected mainly from major environmental areas such as ecology and interactions in the environment, participation in the identification and prevention of environmental problems, decision making on environmental issues and environmental ethics. The ten concepts are biosphere, ecological perspective, interrelationships in an ecosystem, environmental changes, basic human needs, resources, maintaining environmental quality, the ability to make choices, decision-making on environmental issues, as well as environmental ethics. Loubser, Swanepoel and Chacko (2001:319-322) can be consulted for more details on the identification and justification of the concepts.

In most of these concepts there is a close link between knowledge, affect, skills and behaviour. Environmental literacy, therefore, is considered to be a continuum of competencies ranging from zero competency to very high competency. There is a broad spectrum of environmental literacy, from complete unawareness to deep, thorough understanding and concern. For the purposes of this research a few distinguishable, but not separable, disposition levels on this continuum were identified, namely awareness, knowledge, attitude and participation.

Teachers — more than any other professional group — can probably promote environmental literacy, by virtue of their interaction with society (more specifically learners, parents and colleagues). Teachers at all levels and subject areas have a role to play in this regard, i.e. contribute to the development of citizens who possess the basic understanding and skills to make informed decisions in matters affecting the environment and whose personal lifestyles support sustainable development. Teachers can, however, hardly assist learners to become environmentally literate if they themselves lack environmental literacy. Despite the important role teachers play in educating students, research into teachers’ level of environmental literacy has been extremely limited. The few studies that were reported indicated a relatively low level of environmental literacy. An example is a study by Beuthe and Smallwood (1987:40) which stated that the environmental literacy of Indiana teachers is far from optimal. In addition several researchers, for example, Schreuder (1995:2), Braus (1995:46) and Papadimitriou (1995:88-89), mentioned that most teachers are not trained to do justice to environmental education. It seems, therefore, imperative to be able to determine the state of affairs regarding the environmental literacy of the teacher corps.

Formulation of research problems

The following research problems were formulated with reference to the preceding exposition:

• Is it possible to develop an instrument to measure the level of environmental literacy of teachers?
• What is the relationship between both pre-service academic teacher training and general environmental education training and the level of environmental literacy of teachers?

Hypotheses

The following hypotheses, which follow on the research problems, were formulated:

1. A reliable measuring instrument can be developed to measure the level of teachers’ environmental literacy.
2. The nature of pre-service professional teacher training, accompanying field of tuition and general environmental education
training, relate to the level of environmental literacy of teachers and have, therefore, an influence on their disposition towards environmental education.

Research design
Measuring instrument

Different data gathering techniques, which could possibly be utilised to determine the level of environmental literacy of teachers, such as interviews, observations and questionnaires, were considered. After investigating the merits and deficiencies of the various techniques, the questionnaire was identified as the most suitable instrument to be used in this regard.

The questionnaire developed in this study consisted of two sections — section A which comprised 12 items on background information and section B which comprised 135 items dealing with the various aspects of environmental literacy. Section B initially consisted of 370 items which were reduced to 135 in the process of content validity determination. The items were developed according to a matrix with the ten central concepts representing environmental literacy (see introductory paragraph) on one axis and the disposition level of the respondent (see introductory paragraph) on the other axis. A 4-point scale ranging from 'strongly agree' to 'strongly disagree' was used as a response-measuring scale.

Sampling

The sample area selected for this study comprised the Northern province, North West province and Mpumalanga province of South Africa. This area covers 26.2% of the total area of South Africa with a population which constitutes 25.9% of the total population of the country (Luiüs & Oberholzer, 1994; Republic of South Africa, 1997).

Of the 53 schools randomly selected from the three provinces, 420 teachers were selected to represent teachers teaching in the foundation phase, intermediate phase, senior phase, and further education and training phase. Questionnaires were adequately completed by 352 teachers. These respondents were representative of gender, age, learning area taught and qualifications obtained. The majority of respondents were from rural areas.

Analysing techniques

The data obtained from the questionnaire, was analysed using the Statistical Analysis System (SAS) version 6.1.2. In order to test the first hypothesis, it was necessary to determine whether the questionnaire met certain psychometric requirements. To accomplish this, the homogeneity of each of the four disposition level (dl) fields of the questionnaire (Awareness, Knowledge, Attitude and Participation) was scrutinised and the reliability and the construct validity of the questionnaire determined. This was done by means of an item analysis (item field total correlation and alpha coefficient for each item), a Cronbach alpha coefficient for each dl field, as well as the questionnaire as a whole, inter-correlations between the four dl fields and between each dl field and the total of the questionnaire. Testing of hypothesis two was done by stating corresponding null hypotheses and testing these by using analysis of variance (F tests and t tests).

Results and discussion
Hypothesis 1

The aim of the item analysis was to obtain clarity on the homogeneity of each dl field. In this regard, it was determined whether each item contributes to the total of the field it belongs to. If an item does not show a considerable correlation with the total of the particular field, or contributes negatively to the alpha reliability coefficient of the field, it should be omitted.

The item analysis revealed that only one item of the Awareness dl field, two of the Knowledge dl field, one of the Attitude dl field and three of the Participation dl field should be omitted. The Cronbach alpha coefficients, obtained for the four dl fields after the above items had been omitted, were 0.793 (Awareness), 0.839 (Knowledge), 0.867 (Attitude) and 0.861 (Participation). These coefficients served as further confirmation of the internal consistency of the four dl fields of the questionnaire, since the Cronbach alpha coefficient algebraic equals the mean of the bisection reliability coefficients which are calculated on every possible bisection of the instrument.

The reliability coefficient calculated for the questionnaire as a whole was 0.945. This is quite acceptable and the questionnaire could, therefore, be considered a reliable instrument.

Content validation of the questionnaire was done by submitting it to eight specialists in environmental education, ecology and sustainable development. (Refer also to the second paragraph of ‘Measuring instrument’).

Although the questionnaire consists of four different dl fields, these were related to one another and to the total construct of the questionnaire, since they all dealt with the disposition of teachers towards environmental education. One would, therefore, expect to find significant positive correlations between the dl fields. To be construct valid each dl field should display — on the one hand — a high correlation with the questionnaire as a whole and on the other hand a relative independence regarding the other fields. The inter-field correlations are indicated in Table 1.

<table>
<thead>
<tr>
<th>Disposition level field</th>
<th>Aw</th>
<th>K</th>
<th>At</th>
<th>P</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness (Aw)</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge (K)</td>
<td>0.799</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude (At)</td>
<td>0.727</td>
<td>0.673</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participation (P)</td>
<td>0.705</td>
<td>0.694</td>
<td>0.701</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Questionnaire as a whole (Q)</td>
<td>0.895</td>
<td>0.882</td>
<td>0.885</td>
<td>0.877</td>
<td>1.000</td>
</tr>
</tbody>
</table>

All coefficients were highly significant (p < 0.01)

It is evident from Table 1 that there was a high correlation between each dl field and the questionnaire as a whole. The lowest coefficient was ± 0.88. As far as the questionnaire’s relative independence of dl fields was concerned, Table 1 reveals that the highest inter-field correlation between individual dl fields was 0.799. This implies that the biggest collectivity between any two dl fields was approximately 64%, which indicates that the questionnaire displays the necessary internal independence of dl fields. It could, therefore, be considered construct valid.

From the preceding discussion of results, the conclusion can be made that the questionnaire met the necessary psychometric requirements and that it can be considered a valid and reliable instrument to measure the level of environmental literacy of teachers. Norms were subsequently determined by converting the raw scores into stanines.

Hypothesis 2

In order to test the second hypothesis, three null hypotheses were formulated. The first to be verified was:

‘There is no significant difference between the level of environmental literacy of teachers with different academic qualifications’.

The respondents were divided into five categories based on highest academic qualification as indicated in Table 2. In order to compare the mean scores of the five groups an analysis of variance (F test) was carried out.

The results of the F test, which appear in Table 2, revealed that the null hypothesis could not be rejected (p > 0.05). It can, therefore, be concluded that there is no significant difference between the average environmental literacy of teachers with different academic quali-
fication. It appears that this result contradicts research results reported by Buethe and Smallwood (1987), if one assumes that almost all secondary school science teachers in the USA have a BSc degree. According to them, science teachers had higher levels of environmental literacy than other teachers.

Table 2  Level of environmental literacy of teachers with different qualifications

<table>
<thead>
<tr>
<th>Qualification group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard 10</td>
<td>103</td>
<td>416.31</td>
<td>35.71</td>
</tr>
<tr>
<td>B A</td>
<td>64</td>
<td>418.88</td>
<td>37.62</td>
</tr>
<tr>
<td>B Sc</td>
<td>24</td>
<td>417.50</td>
<td>51.44</td>
</tr>
<tr>
<td>B Com</td>
<td>12</td>
<td>446.00</td>
<td>41.59</td>
</tr>
<tr>
<td>Other</td>
<td>149</td>
<td>422.58</td>
<td>40.48</td>
</tr>
</tbody>
</table>

$F(4,347) = 1.70; \quad p > 0.05$

The second null hypothesis stated that:

‘There is no significant difference between the level of environmental literacy of teachers if they are divided according to learning area in which they offer tuition’.

In order to test this null hypothesis, the respondents were divided into eight categories (refer to Table 3 for the categories). According to an analysis of variance ($F$ test), the null hypothesis cannot be rejected when the means of the total score obtained for the questionnaire are compared [$F(7,344) = 1.81; \quad p > 0.05$]. This result is in line with a finding from a study by Abraham and Chucko (1999), according to which teacher training college lecturers have average environmental literacy, irrespective of the subjects they teach. An analysis of the mean scores ($F$ test) obtained for the four d1 fields in the eight categories revealed, however, an interesting picture. The results for the Knowledge d1 field are indicated in Table 3.

Table 3  Knowledge d1 field scores of teachers in different learning areas

<table>
<thead>
<tr>
<th>Learning area</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language, literacy and communication</td>
<td>133</td>
<td>98.62</td>
<td>11.09</td>
</tr>
<tr>
<td>Human and socio sciences</td>
<td>47</td>
<td>100.49</td>
<td>9.60</td>
</tr>
<tr>
<td>Mathematics, maths literacy and maths sciences</td>
<td>66</td>
<td>99.36</td>
<td>8.69</td>
</tr>
<tr>
<td>Natural sciences</td>
<td>76</td>
<td>103.66</td>
<td>10.89</td>
</tr>
<tr>
<td>Arts and culture</td>
<td>12</td>
<td>100.42</td>
<td>4.40</td>
</tr>
<tr>
<td>Economic and management sciences</td>
<td>9</td>
<td>103.33</td>
<td>16.12</td>
</tr>
<tr>
<td>Life orientation</td>
<td>7</td>
<td>90.43</td>
<td>5.06</td>
</tr>
<tr>
<td>Technology</td>
<td>2</td>
<td>100.00</td>
<td>2.83</td>
</tr>
</tbody>
</table>

$F(7,344) = 2.74; \quad p < 0.01$

According to the data included in Table 3, the null hypothesis cannot be rejected as far as knowledge, as an aspect of environmental literacy, is concerned ($p > 0.01$). A further analysis of the data by means of applying a $t$ test for independent groups, showed a significant difference between the mean scores of teachers teaching in the learning area ‘Natural sciences’ and both those teaching in the “Language, literacy and communication” and “Life orientation”($t > 3.14; \quad p < 0.05$) learning areas. In the other three dl fields (Awareness, Attitude and Participation), no significant difference was found between the mean scores obtained for teachers involved in the eight learning areas.

The third null hypothesis stated that:

‘There is no significant difference in the level of environmental literacy between teachers who received training in environmental education and those who did not receive any training’.

A $t$ test for independent groups was utilised for each dl field, as well as for the questionnaire as a whole to test the null hypothesis. The results are indicated in Table 4.

According to Table 4, the null hypothesis can be rejected on at least the 0.05 level of confidence for the questionnaire as a whole, as well as all the dl fields, except the Knowledge dl field. It appears, therefore, that the environmental training teachers received did not contribute significantly to the ‘knowledge level’ of teachers, but definitely to their level of awareness, attitude and willingness to participate in environmental actions.

Concluding remarks

Developing environmental literacy is a major challenge for our school system. It is the disposition of teachers towards the environment and environmental education which determines to a large extent whether learners are educated to become adults who take the responsibility to maintain the environment and improve quality of life. A measuring instrument to determine whether teachers themselves demonstrate the necessary environmental literacy, was developed by this research. It was established that the instrument is indeed a valid and reliable instrument to measure the level of environmental literacy of teachers and that is could be utilised in further research for this purpose. Norms were subsequently determined for future use.

The results of this investigation have also revealed a tendency regarding the impact of training of teachers on their environmental literacy. It seems that the field of academic training, as well as the field of tuition involvement do not make a significant difference in the environmental literacy of teachers in general. Teachers involved in the teaching of the Natural sciences appear, however, more ‘environmentally knowledgeable’ than teachers involved in some of the other learning areas, but do not have a significantly more positive attitude towards or intention to participate in environmental actions. On the other hand, those teachers who received training in environmental education do demonstrate a significantly higher level of awareness, attitude and participation intention than those teachers who did not receive such training. These findings reiterate the recommendations of a number of researchers such as Shongwe (1992:18), Simmons (1993:8) and Papadimitriou (1995:85-86) regarding the need for pre-service as well as in-service environmental education training of teachers.

References


Loubser CP, Swanepoel CH & Chucko CPC 2001. Concept formulation for

**Table 4  Environmental training and environmental literacy**

<table>
<thead>
<tr>
<th>DL Field</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>$t$ value</th>
<th>Df</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness</td>
<td>1*</td>
<td>114</td>
<td>82.71</td>
<td>9.81</td>
<td>2.23</td>
<td>350</td>
<td>$p &lt; 0.05$</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>238</td>
<td>80.44</td>
<td>8.47</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge</td>
<td>1</td>
<td>114</td>
<td>101.65</td>
<td>11.80</td>
<td>1.89</td>
<td>350</td>
<td>$p &lt; 0.05$</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>238</td>
<td>99.39</td>
<td>9.77</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude</td>
<td>1</td>
<td>114</td>
<td>114.44</td>
<td>12.66</td>
<td>2.77</td>
<td>350</td>
<td>$p &lt; 0.01$</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>238</td>
<td>110.45</td>
<td>12.64</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participation</td>
<td>1</td>
<td>114</td>
<td>112.25</td>
<td>12.24</td>
<td>3.30</td>
<td>350</td>
<td>$p &lt; 0.01$</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>238</td>
<td>107.85</td>
<td>11.47</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Questionnaire</td>
<td>1</td>
<td>114</td>
<td>429.14</td>
<td>42.11</td>
<td>2.85</td>
<td>350</td>
<td>$p &lt; 0.01$</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>238</td>
<td>429.14</td>
<td>37.84</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 1 = Received training; 2 = Did not receive training