Individual differences in the effectiveness of text cohesion for science text comprehension

Sophie Hall a,*, Jaskaran Basran a, Kevin B. Paterson a, Rebecca Kowalski a, Ruth Filik b, John Maltby a

a Henry Wellcome Building, College of Medicine, Biological Sciences and Psychology, University of Leicester, Lancaster Road, Leicester LE1 9HN, UK
b School of Psychology, University Park, The University of Nottingham, Nottingham NG7 2RD, UK

1. Introduction

There is growing awareness in many advanced societies of the need to encourage young people to study science in secondary levels of education and beyond, in order to increase the scientific skill base and maintain a strong workforce (e.g. Krajcik & Sutherland, 2010). However, students beginning compulsory science education often find science more difficult than other academic subjects (Jenkins & Nelson, 2005; Lyons, 2006; Osborne & Collins, 2001), and have particular difficulty in understanding scientific text (Bowen, 1999; Snow, 2002, 2010), which may dissuade them from following careers in science. Consequently, if we are to improve young students’ understanding of science, it is important to increase our understanding of the causes of these comprehension difficulties, and to make science more accessible to a broader range of students.

1.1. The importance of text cohesion

It is widely argued that successful text comprehension relies on the reader forming a coherent mental representation of the text (Ehrlich, 1991; Graesser, Millis, & Zwaan, 1997; McNamara, Louwerse, McCarthy, & Graesser, 2010). Text cohesion refers to the degree to which concepts, ideas, and relations within a text design are made explicit, and this influences our ability to form mental representations (Graesser, McNamara, & Louwerse, 2003; Graesser, McNamara, Louwerse, & Cai, 2004; O’Reilly & McNamara, 2007). However, science text is often structured so that logical connections and meanings between the sentences are difficult to infer (low cohesion text), making science text particularly hard to understand (Kamberelis, 1999). Specifically, ‘high cohesion’ text which explicitly links referents in sentences, by avoiding the use of pronouns (e.g. ‘them’, ‘it’) and instead using noun-repetition, improves comprehension (Graesser et al., 2003). Other cohesive text variables include explicit logical connections and signalling words that make relationships explicit. When these relationships are not explicit, readers have to infer relationships between different linguistic expressions, and this can be a source of comprehension difficulty (Graesser, McNamara, & Louwerse, 2003). Research on adults and college-aged students has shown that increasing text cohesion can benefit comprehension (e.g. Ehrlich & Remond, 1997; Ozuru, Briner, Best, & McNamara, 2010; Ozuru, Dempsey, & McNamara, 2009). In particular, text which is high cohesion increases recall and performance on multiple choice questions (McNamara & Kintsch, 1996), because it is easier to read and consolidate to memory (McNamara, Kintsch, Songer, & Kintsch, 1996). To further explain, successful language comprehension is thought to be strongly reliant on the development and retrieval of an accurate mental representation of the situation described in the text (see Zwaan & Radvansky, 1998). High cohesion text promotes the formation of coherent mental representations (e.g. Graesser et al., 2004) and therefore improves memory recognition and recall.

Text cohesion in science texts is particularly poor in comparison to narrative style text (Beck, McKeown, Sinatra, & Loxterman, 1991). Notably, academics typically use a high frequency of pronouns in preference to less ambiguous nouns and using repetition of nouns and phrases...
Therefore, students’ ability to comprehend science text is likely to be strongly mediated by the reader’s ability to achieve cohesion between the sentences. However, the effects of text cohesion have predominantly been investigated using an adult (undergraduate) sample. Although a review by Best, Rowe, Ozuru, and McNamara (2005) suggests that similar benefits may be observed with younger school children the experimental evidence to support this has primarily used children who have not started secondary science education (7–10 years) and have used narrative text styles (Cain, 2003; Cain & Nash, 2011). Two studies which have used science text with children have shown little effect of text cohesion in science comprehension, when text cohesion is modulated by a range of variables (avoiding pronouns, elaborating on concepts, use of connectives, conceptual overlap) (Best, Ozuru, Floyd, & McNamara, 2006; McNamara, Ozuru, & Floyd, 2011). However, a study, by McNamara et al. (1996), showed that 11–15 year olds’ ability to comprehend biology text (about mammals) was better when the text was expanded upon and had high cohesion. Although McNamara et al.’s (1996) study provides promise for the effects of text cohesion with secondary school children, only 12 children, with a 4 year age range, were tested on each text design. Additionally, the texts were revised to add information which explicitly identified that the subtopics in the paragraph were talking about traits of mammals, and did not look specifically at the effects of repetition of referential nouns and of phrases.

Despite the increasing policy concern that students starting secondary education regress in their interest and attainment in science (Galton, 2009), it is clear that this age group (11–13 years) has largely been ignored in science reading comprehension studies. In order to identify ways to promote science attainment and interest in science it is essential that we understand how to best support science education at the beginning of secondary school. Evidence suggests that text coherence, in particular the ability to achieve text cohesion (i.e. the ability to link the meaning between sentences with and without explicit links) is important to successful science comprehension (Beck et al., 1991). As such, this study focusses on beginning secondary school students’ comprehension of high and low cohesion science texts, as determined by the use of repetition of referential nouns and of phrases/concepts.

1.2. The role of individual differences

Social cognitive theory emphasises that general intelligence and learning (i.e. academic achievement) are not simply the product of taking in information, but instead result from active interpretation of information which influences learning experiences (Bandura, 1977). Within social cognitive theory self-efficacy and personality are key learnt behaviours which are integral to determining task achievement on academic tests. Self-efficacy is a learned behaviour of perceived task competence which explains how an individual approaches goals and tasks. For example, high self-efficacy is associated with greater motivation and perseverance to achieve tasks (e.g. Brochters, Hughes, & Morine, 2008). Specific to self-efficacy and science, evidence suggests that self-efficacy and competence in science are related to general science achievement (Wang, Oliver, & Staver, 2008), but this has yet to be examined in terms of learning from science text. With regard to personality, the conscientiousness facet of the five-factor model of personality has been widely reported as being a key personality-type predictor of academic performance (e.g. Noffle & Robins, 2007) particularly with children in the middle years of compulsory education (i.e. early secondary school) (Laidra, Pullmann, & Allik, 2007). Conscientiousness can be defined as the tendency to show self-discipline, act dutifully, and aim for achievement (Costa & McCrae, 1992). Recently, conscientiousness has been related to achievement in science (Elam, Zeidner, & Aharon, 2009; Fesit, 2012), but has not been explored specifically to learning from science text. A recent review appealed for more research to examine potential relationships between personality traits and reading comprehension in determining academic attainment (Sadeghi, Kasim, Tan, & Abdullah, 2012), making it appealing to investigate the role of conscientiousness to learning in science via reading. In support of the significance of the social cognitive theory model of learning in educational research, general cognitive ability (common performance on a range of cognitive tasks, see, Deary, Penke, & Johnson, 2010) and personality are well documented as being key factors in determining attainment (see, Chamorro-Premuzic & Furnham, 2005; Deary, 2012; Neisser et al., 1996), indeed, the primary objective of intelligence tests is to predict academic achievement (Ackerman & Heggestad, 1997). More pertinently to this research, general cognitive ability has been shown to predict reading comprehension of adults (Primor, Pierce, & Katzir, 2011) and children (Tiu, Thompson, & Lewis, 2003).

The rationale for focussing on intelligence and conscientiousness in this paper derives from the common sense notion that achievement is, broadly speaking, the result of ability and success (Gagné & St Pére, 2001). Given that science self-efficacy is learnt from previous successes and failures in the science classroom this factor is likely to be inherent to both ability and conscientiousness and therefore is important to include when considering individual differences in science learning. Accordingly, the aim of the present research was to establish the role of key individual differences (general intelligence, conscientiousness and self-efficacy in science) in predicting learning (as measured by comprehension) from scientific text in which the level of cohesion is varied.

2. Method

2.1. Participants

60 students (31 boys, 29 girls) from a general comprehensive secondary school in the East Midlands of England took part in the study. Participants’ ages ranged from 12 to 14 years old with a mean (M) age of 12.75 and a standard deviation (SD) of .65. Participants were told that the study was concerned with the design of science text books. Parental consent was obtained for all participants. Testing procedures complied with BPS Ethics Code of Conduct (2009).

2.2. Materials

To assess the influence of text cohesion on comprehension ability, students were presented with six high and six low cohesion texts (12 texts in total). Using a paired sample design the texts were counterbalanced so that no participant saw both high and low cohesion versions of the text, but each text was seen across participants in both versions. These were adapted from academic science text books used for working towards the General Certificate of Secondary Education qualification (e.g. Gallagher & Ingram, 2000; Pople, 1999; Williams, 2006). High and low cohesion versions of each text were created following previously used methods (Ozuru et al., 2009). High cohesion text avoided the use of pronouns to refer to previously introduced noun-phrases, and included using argument overlap to ensure referential clarity. In summary, high cohesion text used more repetition of key nouns and phrases. Low cohesion text did not repeat facts and used pronouns to refer to key referents (see Fig. 1). To clarify, low cohesion texts avoided the use of repetitive phrases. For each text (high and low cohesion versions), three multiple choice questions (MCQs) were used to assess text comprehension (totalling 36 questions, 18 for each condition). These were designed to assess inferential levels of comprehension that are a hallmark of good science text comprehension rather than more superficial aspects of the text. To explain by example using the first two sentences in Fig. 1; in the low cohesion condition the target word ‘Enzymes’ is later referred to by the pronoun ‘They’; ‘Enzymes have become very important in the industry. They are versatile and far more efficient than other catalysts.’ For successful comprehension the student must remember that the referent in the first sentence was ‘enzymes’ and that ‘they’ refers to the ‘enzymes’. To assess whether the student had correctly linked the two referents (‘enzyme’ and ‘they’) one of the multiple choice questions asked ‘Why are enzymes important..."
in the industry? with the correct response being 'they are versatile and efficient'. In the high cohesion condition the referent was repeated across the two sentences 'Enzymes have become very important in the industry. Enzymes are versatile and far more efficient than other catalysts.' Therefore, successful comprehension relies on the student remembering that the referent in the first sentence was the same as in the second sentence. As such these questions examined the importance of the 'repetition' element associated with text cohesion.

2.3. Individual differences

2.3.1. General intelligence

We used a measure of general intelligence derived from the Ravens Progressive Matrices (RPM) (Raven, Raven, & Court, 1998). Each item requires the participant to infer a rule which relates the elements together, and then to use this rule to identify the next element in the sequence by choosing from eight alternatives (Alderton & Larson, 1990). Raven Matrices are straightforward to administer and have well documented reliability and validity scores (Strauss, Sherman, & Spreen, 2006), with correlations with other intelligence test between .40 and .75 (Raven et al., 1998). Recent updates to the Ravens manual state that when time is limited, as with our relatively young sample, Set 1 alone (out of a possible 5 sets) provides a sufficient measurement (Harcourt Assessment, 2003). Indeed, shortened versions of the RPM have been shown to have similar psychometric properties to the full test (Hammel & Schmittmann, 2006; Van der Elst et al., 2013), with good Cronbach's alpha (Cronbach, 1951) scores of internal validity (.73; Bors & Stokes, 1998), good convergent validity scores consistent with the full item (Arthur, Tubre, Paul, & Sanchez-Ku, 1999), and high test–retest scores (.75; Arthur et al., 1999). In this study we gave students 10 min to complete Set 1. It is worth noting then that when using a timed condition, the measure of general intelligence is thought to reflect intellectual efficiency, an overall competency and ability to efficiently use one's general intelligence (Raven et al., 1998).

2.3.2. Conscientiousness

The short five (S5) measure of personality (e.g. see Konstabel, Lönnqvist, Walkowitz, Konstabel, & Verkasalo, 2012) was constructed to measure 30 facets of the five-factor model of personality (NEO-PI-R, Costa & McCrae, 1992) for use when time is limited. As this study was primarily interested in conscientiousness only 12 items (6 positively keyed, 6 negatively keyed) were selected for use. The questions measured the 6 facets thought to define conscientiousness; competence (e.g. I am sensible and competent; I can find practical, quick, and effective solutions to problems), order (e.g. I am a methodical person and I love cleanliness and order. I want everything to be in its right place), dutifulness (e.g. I am a reliable person, who values ethical principles; I keep my promises and work carefully and thoroughly), achievement-
striving (e.g. I know for certain what I want to accomplish and I work hard for it), self-discipline (e.g. When I have started something, I finish it despite fatigue or other distractions. I always finish my tasks on time) and deliberation (e.g. I consider things carefully before acting or deciding; I take the possible consequences of my actions into account). The statements were evaluated as to how they reflected the reader on a scale of one to five, ranging from ‘very inaccurate’ to ‘very accurate’. The S5 has good internal consistencies for the five broad factors (average \( \alpha = 0.87 \)) and for the facets (average \( \alpha = 0.69 \)). The S5 has good convergent validity with other measures of the big-five (average correlation with NEO and NEO-PI-R = 0.71) (Konstabel et al., 2012).

### 2.3.3. Science self-efficacy

The Sources of Middle School Mathematics Self-efficacy (MSMSE) Scale (Usher & Pajares, 2009) was adapted to assess self-efficacy in science. For the purpose of this study we reworded the MSMSE scale so that the scale measured science self-efficacy with questions being adapted so that ‘math’ was replaced with ‘science’; for example ‘I get excellent marks on science tests’ and ‘People have told me that I have a talent for science’. Additionally, some of the wording used in the scale was changed so that it was more appropriate for use with English children (e.g. ‘report card’ was changed to ‘school report’, ‘grades’ was changed to ‘marks’). Each statement is rated on a six-point scale (1 = definitely false, 6 = definitely true). The Cronbach’s alpha for the 24 items was satisfactory (\( \alpha = 0.91 \)) suggesting adequate internal reliability for the scale as a measure of self-efficacy of science.

### 2.4. Procedure

In a classroom, students were presented with one of two booklets. The content of the two booklets were identical apart from the text. The content in booklet A which was viewed was counterbalanced so that the text in booklet B (and vice versa). Thus, each booklet contained 6 high and 6 low cohesion texts that were intermixed pseudo-randomly. The booklets were arranged so that once a participant reads a text, they then completed a short distractor test (a number completion task). Following this, the three MCQs were presented on a separate page. The MCQs were identical for high and low cohesion versions of each story. Students were instructed to work through this booklet, reading the text for comprehension, and no time restraints were set. After completion of the booklet the individual difference tests were administered. The total testing time was 55 min.

### 3. Results

Two control measures were initially taken. First, to ensure that individual difference scales had acceptable internal reliability, Cronbach’s alphas were conducted (Table 1). All scales showed good internal reliability (\( \alpha \geq .77 \)), above the criteria of .7 suggested by Kline (1986). Second, in consideration of the reports of gender differences in students’ interest in science (Baram-Tsabari & Yarden, 2011) and reading abilities (Clark, 2012) we compared males’ and females’ performance on the tests used; no significant differences emerged (Table 1). Comprehension scores were higher for the high (total correct: 91.9%; range: 61.1–100%) than the low (total: 86%; range: 27.7–100%) cohesion texts (t(59) = 4.19, p < .001) demonstrating that repetition of nouns and phrases affected comprehension, and therefore how effectively participants learnt from these texts.

To establish which individual differences were suitable for cluster analysis we conducted Pearson’s correlations to calculate correlations between individual differences and text performance (Table 2) (see, Yoshioka, Kawase, & Ishii, 2002). Cognitive ability, science self-efficacy and dutifulness correlated with performance on both high cohesion and low cohesion text; therefore these variables were entered into the cluster analysis.

### Table 1

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High cohesion text</strong></td>
<td>αM 14.93 SD 1.99 15.28</td>
<td>αM 13.88 SD 0.65</td>
</tr>
<tr>
<td><strong>Low cohesion text</strong></td>
<td>αM 13.97 SD 2.85 13.83</td>
<td>αM 2.59 SD 0.96</td>
</tr>
<tr>
<td><strong>Cognitive ability</strong></td>
<td>αM 6.61 SD 1.93 7.48</td>
<td>αM 1.70 SD 0.15</td>
</tr>
<tr>
<td><strong>Science self-efficacy</strong></td>
<td>αM 7.13 SD 1.78 7.45</td>
<td>αM 1.74 SD 0.15</td>
</tr>
</tbody>
</table>

### Discussion

By comparing secondary school students’ learning from reading high cohesion and low cohesion science text we observed significant benefits, in terms of increased MCQ accuracy, from reading high cohesion
text, as defined by high degree of repetition. To explore associations between students’ comprehension of high and low cohesion science texts and individual differences we conducted Ward’s cluster analysis in relation to identify how these variables best grouped together. Three groups emerged from the analysis. We have chosen to label the groups in relation to their association with high, average, and low learning from science text, however, it should be noted that the labelling of groups from cluster analysis is an interpretative process. Successful comprehension with both high and low cohesion texts was related to high cognitive ability and high science self-efficacy (cluster 1), suggesting that these two factors may be key areas to target for achieving high levels of learning from reading in science. Middle of the range comprehension skills, with both high and low cohesion texts, were associated with low science self-efficacy (cluster 2), indicating that promoting science self-efficacy may be a key strategy for improving the performance of ‘average’ students. Finally, low comprehension of low cohesion text was associated with low cognitive ability and low dutifulness (cluster 3). This suggests that to best support science learning in lower performing students (i.e. those with lower cognitive abilities) science text should be structured so that it avoids the use of pronouns and instead uses noun-repetition. Additionally, increasing students’ sense of dutifulness may prove a key pathway to promoting science learning.

It is widely believed that text which is cohesive in repetition terms increases the readers’ ability to access knowledge streams which have been built up based on previously read text, this promotes the generation of a globally cohesive representation of the text (Graesser, Singer, & Trabasso, 1994). Evidence of improved comprehension with high cohesion text suggests that the use of repetition in science text may help young students develop a cohesive representation of the text to promote comprehension and learning. The importance of text cohesion on comprehension abilities support previous research with college-aged students (e.g. McNamara & Kendeou, 2011; Ozuru et al., 2009). However, the present research extends these basic findings in several ways that may be important in relation to science education. In particular, this is one of the first studies to investigate the effects of text cohesion defined by repetition on science text comprehension with children at the start of their secondary education (12–14 years). This time period is critical to decisions students make about the topics they enjoy and wish to study to secondary educational levels and beyond and any difficulty they have in understanding science during this period may be important to determining whether they pursue the subject further. Indeed, previous research highlighting the role of text cohesion in science comprehension has predominately used older age groups (e.g., see, Ozuru et al., 2009), and so is not directly informative about the influence of text cohesion on science text comprehension by this critical age group. Moreover, previous research has examined performance on science text comprehension without assessing the importance of individual differences between readers for predicting comprehension performance. Thus, the present research makes an additional and important contribution to the understanding of factors affecting science text comprehension by revealing key individual differences that are predictors of comprehension performance by this target age group.

With regard to the role of individual differences in text comprehension our study highlights the potential importance of cognitive ability, science self-efficacy and dutifulness as aspects of text comprehension. In support of studies with adult readers our study shows the consequence of cognitive ability in determining students’ learning from science texts that differ in cohesiveness (Primor et al., 2011). Specifically, we show that students who achieved high learning from both text designs were associated with high cognitive ability and students who demonstrated poor learning from low cohesion text were associated with low cognitive ability. In this study, Ravens Matrices were completed under a time limit, to provide a measure of general intelligence that reflects intellectual efficiency. This suggests that general competency and ability to efficiently use one’s general intelligence (ability to deduce, induce, problem solve, grasp relationships, and infer rules) is important for learning from science texts. In particular, the association between low cognitive ability and poor performance on low cohesion text indicates that when logical connections and relationships within the text are not explicit, it is important that the student is equipped with the cognitive abilities to infer these relationships. Therefore, developing these cognitive skills may prove a key pathway to improving science learning.

A novel relationship was identified with science self-efficacy and science text comprehension. High science self-efficacy was associated with good performance with both text designs, whereas low science self-efficacy was associated with poorer performance on both texts, suggesting an important role for science self-efficacy in learning about science from text. As self-efficacy is associated with task perseverance (Bandura, 1997) we suggest this as a likely explanation for the results and suggest that encouraging and rewarding persistence may improve science learning. High science self-efficacy was also coupled with high cognitive ability, suggesting a relationship between achievement and perceived competence. Although we cannot determine the nature of such relationships in this study, previous reports suggest reciprocal effects (e.g. Wang et al., 2008). However, we should also consider that the self-efficacy tests were completed after the reading tests. Although the very nature of self-efficacy means that it is partly formed by prior academic achievements (Shavelson, Hubner, & Stanton, 1976), in this

<table>
<thead>
<tr>
<th>Stage</th>
<th>Cluster combined</th>
<th>Appears</th>
<th>Coefficients</th>
<th>Cluster 1</th>
<th>Cluster 2</th>
<th>Next Stage</th>
<th>Change</th>
<th>Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>5</td>
<td>21</td>
<td>125.61</td>
<td>51</td>
<td>41</td>
<td>58</td>
<td>10.96</td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>1</td>
<td>16</td>
<td>137.37</td>
<td>52</td>
<td>50</td>
<td>59</td>
<td>11.75</td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>2</td>
<td>6</td>
<td>158.99</td>
<td>54</td>
<td>53</td>
<td>58</td>
<td>21.63</td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>2</td>
<td>5</td>
<td>186.67</td>
<td>57</td>
<td>55</td>
<td>59</td>
<td>27.67</td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>1</td>
<td>2</td>
<td>295.00</td>
<td>56</td>
<td>58</td>
<td>0</td>
<td>108.32</td>
<td></td>
</tr>
</tbody>
</table>

Coefficient change scores from the agglomeration schedule. It is evident that the largest change scores occur in the final three stages.
study it is possible that the measure of self-efficacy was influenced by how difficult the student found the reading task. Therefore, our measurement of self-efficacy may reflect specific efficacy to the task completed rather than general science self-efficacy. Nonetheless, this is still a noteworthy finding and highlights that the students were approximately accurate in their perceptions of experimental task competency and that such self-assessment is important in promoting learning (Andrade & Valtcheva, 2009).

Of further note is the relationship between dutifulness and science learning from text. This is consistent with the suggestion that dutifulness is one of the key conscientiousness domains in predicting academic achievement (Chamorro-Premuzic & Furnham, 2003). Low dutifulness was associated with poor performance with low cohesion text. Thus, the indication is that performance on the more difficult, low cohesion text is associated with working carefully and thoroughly on a problem (see, Konstabel et al., 2012).

The results from this study provide a valuable contribution to our understanding of how individual differences are associated with learning based on text comprehension with high and low cohesion texts. The results provide motivation for further investigations, including assessing the role of different text cohesion ties. As the purpose of this study was to examine text cohesion as defined by repetition of referential nouns and phrases, it provides motivation for future studies to assess whether similar results are observed with other cohesive ties, such as modulating the text by the addition of causal connectives. Additionally, whilst the use of MCQs to assess co-referential inferences has been shown to be effective at assessing a deeper understanding of the text (McNamara & Kintsch, 1996; McNamara et al., 1996), we cannot establish the durability of this comprehension. By testing students at delayed periods post-testing the sustainability of comprehension performance could be examined.

These findings have significant implications for both the design of science text books and for the teaching of science. As comprehension is considerably improved when referential cohesion is maintained it is important that academic publishers minimise the use of pronouns and maximise repetition of noun-phrases and key text meanings when designing science text books. Furthermore, in light of research highlighting the importance of readers having knowledge on text structure to achieve sound comprehension (e.g. Kendoue & van den Broek, 2007; Meyer, 2003; Snyder, 2010) it seems crucial that teaching strategies involve inferring relationships, grasping rules and identifying similarities and differences (components of the Ravens Matrices task) could enhance students’ comprehension of science text. The grouping of low dutifulness with poor performance with low cohesion texts suggests that education interventions could focus on increasing students’ sense of dutifulness (Essa & Burnham, 2009) to potentially improve learning about science in the classroom.

4.1 Conclusion

Students who are starting their secondary school education of science, show greater learning (comprehension) of science text when it is highly cohesive, as determined by the use of repetition of nouns and phrases. Comprehension is decreased when text cohesion is impaired when pronouns are used and the amount of repetition of nouns/phrases is reduced. This is an important implication for the design of science textbooks and the teaching of secondary school science. High cognitive ability was associated with good performance on both high and low cohesion texts, and low cognitive ability was associated with poor performance on low cohesion text. High science self-efficacy was also related to good performance on both text designs, whereas low self-efficacy was related to average performance on both texts. Dutifulness was associated with poor performance with low cohesion text. These results have significant implications for understanding the relationships between individual differences and learning in promoting science learning.

Acknowledgements

This research was financially supported by The Leverhulme Trust, Grant title ‘Improving Secondary School Students’ Science Text Comprehension’, grant RPG-094.

References


Table 4

Establishing the nature of the clusters.

<table>
<thead>
<tr>
<th></th>
<th>Mean ± standard deviation</th>
<th>p values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cluster 1</td>
<td>Cluster 2</td>
</tr>
<tr>
<td>High cohesion text</td>
<td>16.52 ± 1.15</td>
<td>14.27 ± 1.31</td>
</tr>
<tr>
<td>Low cohesion text</td>
<td>15.68 ± 1.24</td>
<td>13.68 ± 1.91</td>
</tr>
<tr>
<td>Cognitive ability</td>
<td>5.00 ± 1.80</td>
<td>6.50 ± 2.79</td>
</tr>
<tr>
<td>Science self-efficacy</td>
<td>107.48 ± 13.69</td>
<td>77.86 ± 14.42</td>
</tr>
<tr>
<td>Dutifulness</td>
<td>8.20 ± 1.50</td>
<td>7.50 ± 1.37</td>
</tr>
</tbody>
</table>

Mean ± SD performance for the three clusters across the variables. p values of multiple comparisons with Bonferroni corrections are displayed.