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The arts in science? Using poetry to teach Chemistry in Grade 9

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Modern science education the world over deliberately remains in the objective, rational, positivist paradigm. In South African classrooms, this paradigm is often alienating for young learners who then stop learning science at the end of Grade 9. Literature indicates that an arts-rich education improves learner engagement, attitudes and test scores, as evidenced by science Nobel laureates who engage more with the arts than other scientists. The research reported in this study involved the presentation of a lesson on acids and bases to 222 Grade 9 learners in 4 schools in the greater Tshwane region to establish whether their interest levels in the subject would improve when using a poem and video that characterise, describe and demonstrate scientific concepts. An in-class intervention of 40 minutes was used with identical Likert-scale, pre and post-tests analysed using the Wilcoxon and *t*-test. The results showed that the arts-rich lesson engaged learners in a manner which holistically improved their interest levels. The results were independent of gender, home language and the type of large, urban, government school that they attended. The results were not significant for the small, semi-rural, private school research site.

Keywords: art-infused education; holistic education; science education; science poetry

Introduction

Early into the South African democracy, universities and government were investigating policies and practices with the hope of improving learner engagement and success in science education at school level (Department of Education, 2001; Kahn & Levy, 1994; Savage & Naidoo, 2002). These efforts included improving science teaching through study incentives for new and existing teachers, promoting science and technology through the media, the inclusion of indigenous science content in the syllabus, improving resources and facilities for science education, creating dedicated schools for science and maths, promoting "science week", and more. The results of these efforts have been disappointing (Campbell & Prew, 2014; Schwab, 2017) with a continuing low percentage of learners who choose to do physical science, as well as those who excel in it, being evident.

The ultimate concern of the South African government, as it is in most developed and developing countries, is not about matric results. It is about having a scientific community to drive science and technology development to improve the country's industry and economy. The literature shows that the use of the arts in science is not as uncommon as might be thought. It indicates that at the cutting edge of science the arts seem to play a significant role (Root-Bernstein, 2011). This article will also illustrate that the use of the arts in a chemistry lesson had an immediate and holistic effect on improving learner interest in the content under consideration. The challenge of improving learners' attitudes towards science is not unique to South African classrooms (Denessen, Vos, Hasselman & Louws, 2015; Emdin, 2010; Jenkins & Nelson, 2005; Lyons, 2006) and fusing the arts with science in the classroom may be a way of improving learner engagement and results.

The clear relationship between the arts and the cutting edge of science has apparently not been researched or reported on in South Africa, thus reinforcing our interest in investigating possible changes in South African learners' interest and engagement levels when using the arts.

Background

As a high school teacher of physical science for almost thirty years the principal researcher has not experienced an increased readiness among learners to engage with the abstract and demanding ideas of the subject. This experience is shared by others (Denessen et al., 2015; Guthrie & Davis, 2003). From our experience, it is not that the learners are unable to engage as much as that they do not find enough subject material that they can relate to. The principal researcher learnt this in his second year of teaching when he taught a group of high achieving Grade 9 girls in natural science. None of them had decided to continue to Grade 10 physical science because they said, "it is boring." At least half of these girls obtained an "A" in the subject. This demonstrated that aptitude with no personal interest may lead to learners who could contribute to our scientific community not doing so because of a lack of interest.

The research reported in this article was spawned by a critical incident in which the principal researcher found that learners responded well to poems that he had created to explain subject content. Learners who usually showed no interest in the work became more engaged when hearing or dramatically acting out the poetry. The research aim was to establish whether learners in other schools would show similarly improved levels of interest.

The poem used in this research, like a lot of poetry, carries information in a brief and easy-to-access format. It has artistic elements like rhythm and rhyme which are comfortable on the ear, and the use of metaphor invites the reader to use their own imagination to make sense of the content. The use of video was not originally intended.

The poem describes two experiments, one of which has 10 parts, which require three days to complete. When approaching schools to do the research it was clear that no teacher was prepared to allow so much time for this research. As a result, the principal author made a 15-minute video of the experiments to be used during a single 40-minute lesson.

Doing experiments is best, but watching chemistry experiments is also very interesting for learners. The formal, abstract ideas that science usually extracts from these experiments lack the same degree of interest for the learners. The topic of acids and bases is a prime example of this, where chemical symbols and formulae are the main basis for explaining experimental results. The use of poetry was used to form a bridge for the imagination between the experiment and the theory to be learnt.

Literature Review

The use of science poetry in the science class is not commonly practised. Research on the use of poetry in science education is scant (Padel, 2011). Other art forms, like dance (the technology, entertainment, design [TED] talk, "Dance vs. PowerPoint, a modest proposal – John Bohannon") and science songs which contain rhyming lyrics on YouTube ("Mr Parr's science songs", "Mr Pazzo's Science songs", "sciencemusicvideos" or "acapellascience"), have been used to explain scientific concepts, yet the use of the arts or creative imagination in science education is not an encouraged practice. This is puzzling since learners require a great deal of imagination to conceptualise the ideas of science. Most likely, the answer to this is that the arts use words metaphorically and science requires the exact and unambiguous use of language. This is so much the case that some research indicates that the use of the creative arts in the science class can confuse or distract the learners from understanding the key ideas or learning the hard facts (Daston, 1998; Harp & Mayer, 1998). Lorimer (2011), on the other hand, argues that art-infused education benefits learners but that only posters and short quotes were the preferred and commonly used teaching strategies in the science classroom.

The relationship between the arts and modern science goes back to at least Charles Darwin's grandfather. His poem "The Botanic Garden" (Darwin, 1798) represents photosynthesis as a dramatic marriage between oxygen and light. In the early 1800s there was a German movement that fought to keep the arts connected to science (Harrington, 1999; Seamon & Zajonc, 1998; Von Goethe, 1840; Zajonc, 1998) which spread to England (McFarland, 2014; Wordsworth & Rogers, 1980) and the United States of America (Thoreau, 2015).

More recently, many top scientists engage in poetry or other arts. Richard Feynman, the Nobel Prize winner for physics in 1965, put the broken relationship between modern science and the arts best when he asked:

> Is nobody inspired by our present picture of the universe? The value of science remains still unsung by singers, so you are reduced to hearing – not a song or poem, but an evening lecture about it. This is not yet a scientific age. (Feynman, 1955:14)

What Feynman expresses so clearly here is that he believes that science will only come of age when it can be reunited with and expressed through the arts. Exploring the relationship between the arts and Nobel Prize winners in science further, we encountered the following extraordinary statistics:

> Nobel laureates in the sciences are 25 times as likely as the average scientist to sing, dance or act, 17 times as likely to be an artist, 12 times more likely to write poetry and literature, eight times more likely to do woodworking or some other craft, four times as likely to be a musician, and twice as likely to be a photographer. Many connect their art with their scientific creativity. (Root-Bernstein, 2011:para. 5)

A 12-year longitudinal study from 1996 to 2009 in the United States of America (US), which focused on the progress of high school graduates from lower income backgrounds who attended arts-rich high schools, showed multiple positive results in comparison to graduates from similar backgrounds who attended arts-poor schools (Catterall, 2009). Catterall's study does not discuss the effects on the graduates' engagement in science when they were in school, but the President's Committee on the Arts and the Humanities report in 2011 does (Dwyer, 2011). In the foreword, the then US Secretary of Education, Arne Duncan, expressed this relationship in clear terms.

> Working with the Chicago Arts Partnership in Education (CAPE), we brought local artists and teachers into the schools to integrate arts curriculum with other academic subjects. Studies showed that students at the CAPE schools performed better on standardized assessments than students who attended schools that did not integrate arts and sciences. Perhaps as important, researchers found that schools working with CAPE's artists made positive changes in the school's culture, creating environments where students thrive academically, socially, and artistically. (Dwyer, 2011:2–3)

Their results showed that an integration of the arts and science led not only to improved test results, but also to the holistic development of the learners and to them playing a positive role in their community.

Theoretical Framework

Holistic education is the theory that when all the faculties of the learner are addressed in one activity, health and integration of mind occurs (Dwyer, 2011; Easton, 1997; Edelglass, Maier, Gebert & Davy, 1992; Emdin, 2010). Practitioners of holistic education thus strive to develop learners' thinking, feeling and doing while busy with a single activity (Easton, 1997). They see the human being as an integration of all these faculties. Child-centred education, such as Montessori and Waldorf schools, have been using holistic educational practices for over a century (Stephenson, n.d.). By using this theory as a framework, we acknowledge that people can use these faculties separately, but that our optimal functioning is to learn holistically. Vast, recent literature indicates that holistic education improves learners' overall engagement and/or mental health (Caruana, 2000; Catterall, 2009; Csikszentmihalyi, 1997; Daston, 1998; Easton, 1997; Harrington, 1999; Hidi & Harackiewicz, 2000; Lawrence-Lightfoot, 2005; Lorimer, 2011; Miller, 1997; Mirkin, 2017; Padel, 2011; Smuts, 1926; Stables & Scott, 2002).

Holistic education is constructivist in that it enables the learners to engage with multiple faculties and construct a meaningful whole for themselves out of the sensory, language and experiential stimuli. Poetry demands the use of our rational and artistic faculties and when used to describe an experiment as used here, it also incorporates observations from our senses and our previous understanding and learning. The use of poetry in the chemistry class is hence an example of holistic education yielding positive benefits for a broad spectrum of learners (Mirkin, 2017).

Methodology

A poem[i] written by the primary researcher, incorporating artistic devices such as story, characterisation, metaphor, rhythm and rhyme, for a class of Grade 9 learners was used at the time when the schools were teaching the academic ideas of acids, bases and salts. The research question was to see how the intervention would affect the target Grade 9 learners' interest in chemistry (Mirkin, 2017). Grade 9 was chosen because it is in this year that learners select subjects for their last three years of schooling.

Ethical considerations for working with minors were taken into account and clearance was gained from all the official role players: the issuing institution, relevant education department and participating schools, teachers, parents and learners. The teachers managed the handing out and collecting of the consent and assent forms prior to the data collection taking place.

The research sites were clustered in the geographical region of greater Tshwane in the Gauteng province of South Africa as a convenience sample. Of the five schools approached, four were willing to participate. Three were large, urban, co-educational government schools drawing learners from a similar broad range of socioeconomic backgrounds. One school attracted learners with an arts interest, one attracted learners wanting a practical/science focus and the third was a conventional academic school. The fourth school was a small, semi-rural private school which catered for learners only up to Grade 9. The schools all attracted learners from a predominantly middle to lower-income bracket.

The poem describes how an acid and a base will react together and destroy each other to form a salt ("*Children born of their parents' demise*"). Learners also hear that salts are nutrients for plants ("*To fructify the Earth*") and that acids ("*brighten, dissolve and boil*") and bases ("*Slower working, to hold and bind*") react in very different ways. We consider the poem as a holistic, artistic framework for learning, where the main elements that form acid or base can be found on the periodic table ("*Base born of metal*"; and the video shows the alkali metals on the far left of the periodic table) and allow for learners to develop an experience that will aid in the learning of further ideas such as pH.

The reactions described in the poem were captured in the 15-minute video where an acid and a base were separately reacted with five different substances. A further reaction was done to show how solutions of a strong acid and a strong base react (Mirkin, 2016). The original intention was to perform the experiments with the learners over three days. The pre and post-test instruments were developed to only include questions related to learner interest, similar to the questions used by Glynn's "intrinsic motivation" questions from their "Science Motivation Questionnaire II" (Glynn, Brickman, Armstrong & Taasoobshirazi, 2011). Research into studying learner interest (Hidi & Renninger, 2006; Krapp & Prenzel, 2011) was also used to develop and refine the instrument which was tested for validity and reliability in a pilot study by the principal researcher over three days.

The teachers who implemented the research intervention felt that they could not use three of their limited lessons for this research, so the video was made to be applied in a single, 40-minute lesson.[ii] The video was shot in June 2017 by the principal researcher's wife in their family home. It was performed by the principal researcher. The video comprises a short lesson showing first the poem, then the elements on the periodic table that form acids and bases. It then covers the separate acid and base reactions, showing the changes over a few days. Time-lapse photography is also used to show crystals growing. The video follows the poem verse by verse in a calm, explanatory manner.

The research intervention took the following form: The learner pre-test questionnaire was handed out, learners were given 5 minutes to complete them, and they were then collected (see Appendix A). Next, a copy of the poem was handed out to each learner, read through and discussed with the learners as a class, using the learners' questions and glossary (Appendix B) to address any unfamiliar words. The 15-minute video was then viewed, after which a class discussion was held using inquiry-based learning with a set of prompting questions to help the learners recall the content of the lesson and to create a whole story using its different parts. One question alluded to the possible gender stereotyping by the alchemists described in the poem. The final step was the completion of the post-test. The pre and post-test questions were identical except that the post-test included a question asking whether the poem, video, class discussion or their own learning was the most significant for engaging their interest.

The nine questions of the pre- and post-tests used a five-point Likert scale, ranging from strongly disagree to strongly agree. Learners' responses related to their cognitive and affective experiences, their interest levels and how relevant they found chemistry in their lives. The questions sought to establish whether the intervention had a holistic effect on them and to what degree their interest levels had changed. Differences between boys and girls were looked at to examine whether the intervention might be more significant for one or the other.

In total 222 learners participated – 122 boys and 100 girls.[iii] The results were analysed for statistical significance using a paired *t*-test and the non-parametric Wilcoxon test (due to the small sample size in each subgroup). The results of both tests showed the same levels of significance in each case. Statistical significance was set to reject the null hypothesis at the 5% ($p < 0.05$) level.

Results

Despite the briefness of the intervention, T for the whole sample ($p = 0.0088$), the arts-focus school ($p = 0.0019$) and the academic-focus school ($p = 0.038$) showed that the intervention statistically, significantly increased learner interest. See Table 1 that follows (Mirkin, 2017).

Table 1 Did the intervention result in a statistical significance?

Schools researched	All learners	Boys	Girls
Whole sample	Yes	Yes	Yes
Arts focus	Yes	Yes	Yes
Small private	No	No	No
Academic focus	Yes	Yes	No; Yes to 10%
Science focus	No; Yes to 10%	No; Yes to 10%	No

The science-focus school learners had very high initial interest levels, and although their interest levels increased by over 30% of the amount of increase available, this did not show itself to be statistically significant ($p = 0.077$). Figure 1 shows that the science-focus school has almost had the greatest increase in available interest relative to the actual increase in interest. The semi-rural private school showed a slight increase in interest levels among the learners, but this was very small compared to that of the large government schools.

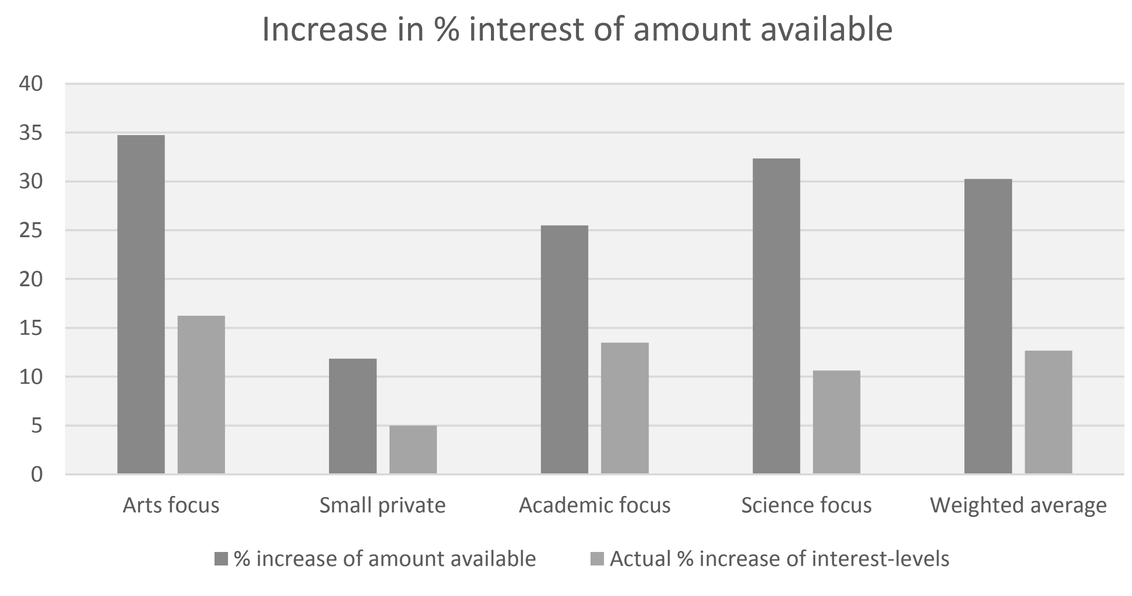

Figure 1 The percentage increase in interest levels of the amount of increase available

Further breakdown of the results showed almost no difference between the effect of the intervention on boys and girls seen most clearly in Figure 2. Marginal statistical differences in the results for the boys and girls appear to be due more to the fewer number of girls in the sample than actual differences in the effect of the intervention. Learner initial-interest levels and language background also had minimal influence on the results. One question asked the learners whether they felt that chemistry could teach them about themselves. This question was intended to see whether the use of the poem could bridge the gap between their personal experiences and the chemistry content, which it clearly did. Here their responses improved by 25% of the amount available.

Figure 2 shows the results of post-test question 10, which asked which stimulus each learner assessed as having the greatest impact on their own learning. The visual influence impact of the experiments in the video had roughly 80% impact with the poem being the most effective for almost 40% of learners. The impact of the class discussion was above 20% and those whose own ideas were the most significant was above 10%.

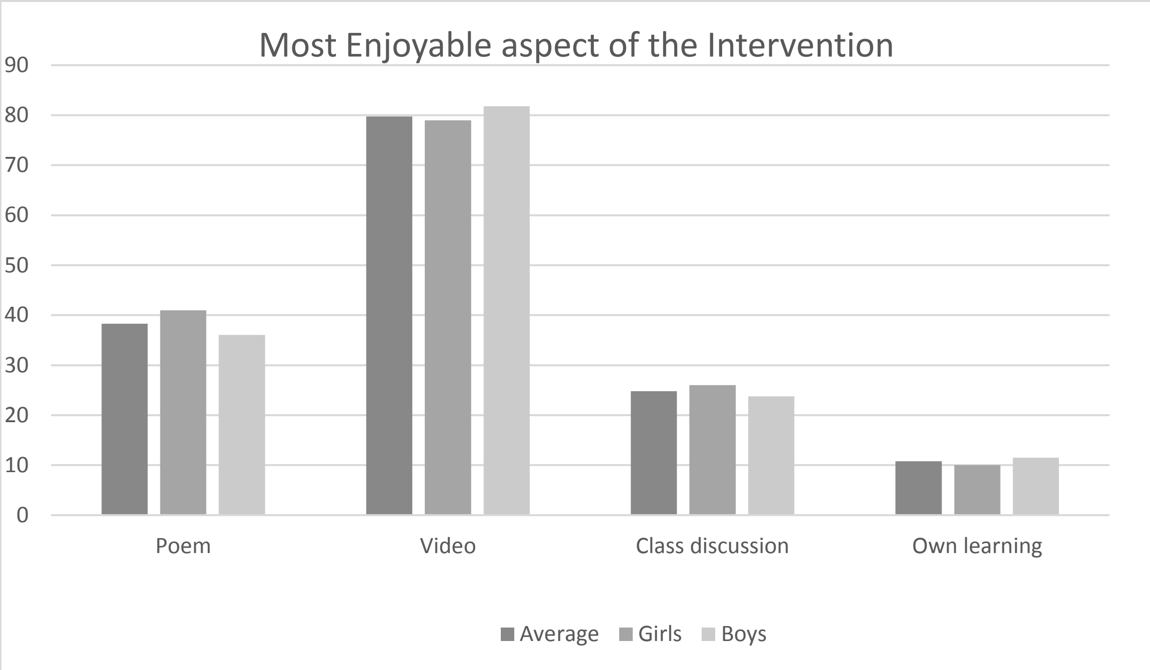

Figure 2 Most significant stimuli for the learners: Post-test question 10

For Question 10 the learners could give more than one response, so the total is greater than 100%. The total of 155% means that the average learner marked one and a half stimuli (Mirkin, 2017). (See Appendix C for the breakdown of the results of each school.)

Discussion

This research intended to only show the influence of using poetry to teach chemistry on learner interest. We believe this increase in interest was due to the interesting chemical reactions shown in the video as well as the use of the poem which helped them to contextualise this information. This was shown through the respondents' improved responses in all the questions on the questionnaire, indicating a cognitive, affective and practical improvement in interest. We believe that the holistic engagement allowed the learners greater scope for their own inner processing of the content, enabling them to think and feel more independently, and hence to engage more positively with their full range of human faculties.

The specific facts that were given in this lesson were the results of the reactions. The characterising of acid, base and salt in the poem helped them to make sense of these facts. By linking the facts with the periodic table, which they had already studied, new knowledge was integrated with old. The combination of the holistic engagement and the harmonising of new and old knowledge would have been a further reason for the increase in interest.

The learners improved their belief that chemistry could teach them about themselves by 25% of the increase available. This reveals the degree to which they had personalised their relationship with the work. This increased identification with the content indicates that a bridge was built between their experience of themselves and the content of the lesson. The role of the arts is to bring a personal experience to an audience. We hold that the artistic nature of the intervention had an impact on the learners in a way that helped them engage with the content in a more personal way.

Limitations and Suggestions for Future Research

The improvement in interest was measured over a 40-minute period. No test of how long this interest was sustained, or what follow-up activities would help to maintain this increased level of interest, was conducted. No test was done to check the learning or retention of the content or whether their test scores would be improved.

The various stimuli used in the intervention lesson were recorded as being almost equally important for boys and girls, with the poem and the class discussion featuring slightly more in their influence on girls, and the video and personalised learning being marginally more significant for the boys. We did not analyse these results and believe that a larger sample size would be needed to test for such differences.

The school with the least significant increase in interest levels was the small private school within a rural setting. The reasons for this will require further research. The research done here was conclusive for the large urban, government schools. To verify the results found here, this type of research would need to be repeated over a much larger sample. To broaden the implications of the results, private, rural and township schools will also need to be tested. Township and rural schools experience the greatest challenge with learner participation and academic results in South Africa (Department of Basic Education, Republic of South Africa, 2018). It therefore makes sense to test the effects of this intervention in these schools as a priority.

The poem used in this research, and the use of similar holistic, artistic devices to contextualise scientific content, should be repeated in a greater variety of contexts to establish the full possibilities of the effects of the arts in science education. The lack of opportunity for the learners to express their own insights creatively is recognised as a limitation to this study, and research should be conducted to determine the effect of this on their interest levels as well as learning of the science content. Many South African learners struggle with language comprehension, and the use of poetic devices like rhythm and rhyme could be applied to help them remember the terminology, which could improve their concept formation of these terms. This could be applied in other science lessons as well.

The high cost of arts-rich programmes is an issue that has been noted (Lorimer, 2011). In South Africa, the priority to get good academic results leaves little consideration to the overall effects on improving learner interest or their holistic engagement with the work. It is much quicker and cheaper to just educate traditionally. A set curriculum, textbooks, standardised tests, replaceable teachers and large classes do not cost as much as musical instruments, painting materials, smaller classes and specialist teachers, all of which could enhance a holistic, arts-infused science education. A start in this direction, however, could be made by encouraging the use of stories, poetry and other simple, inexpensive artistic devices.

This research did not test for improved knowledge or skills. The concern that the creative arts may improve interest but be distracting from the science content would need to be tested and the risks quantified. Here, qualitative research could be undertaken to interview learners about the positives and negatives of using creative arts in their science class. Neuroscience is now advanced enough to determine which parts of the brain are active when engaging in different activities. Further research could test the effects on learners' brain-functioning when engaging with science content within an arts context to understand how to maximise the personal integration of learning and minimise the elements of distraction.

Science teachers may lack the training and confidence to implement arts-infused science. The literature indicates that scientists at the top level are much more likely to use the arts to stimulate their scientific work (Root-Bernstein, 2011). By inference, those not at the cutting edge of science do not generally practise the arts and this would be true for many science teachers. In conversation with the principal researcher, all four of the science teachers who took part in this research needed convincing that the class time used would not be a waste of valuable teaching time. This was done by showing them the relevance of the science content in the poem and video. They also expressed a reluctance to present the poem to the learners themselves. If an arts-infused science education is to happen, a tested approach that could work is the CAPE solution which brought artists to work with the teachers in the classroom (Dwyer, 2011). An alternative would be to take science teachers, who would need to be convinced of the value of using the arts in science, through arts training during their teacher training programme. A third possibility would be to create an alternative teacher qualification for teachers to become "arts-infused educators" which would qualify willing teachers to implement an alternative or arts-rich science curriculum.

Conclusion

The use of the arts in the research undertaken here showed an immediate and significant improvement in learner interest in the content covered, as well as an increase in their perceived interest in chemistry overall.

The concern that learners may miss the hard facts through the use of the arts is real. We believe that this concern may be valid if our focus is on short-term test and matric results and not on the long-term goal of improving our scientific community, industry and economy. Regular use of the arts in science education would encourage learners to develop a holistic engagement with science. The literature indicates that it could be exactly this that leads to the cutting edge of science.

If we cast our gaze into the future of global science education and want to see a real difference in learner engagement and success, then we need to do things differently. If South Africa is looking to the long-term goal of developing a scientific community with scientists who are at the cutting edge in their field, then the use of the arts in science education needs to be strongly considered and investigated further. This article shows that one simple poem and accompanying video can awaken immediately improved learner interest. What might happen if we regularly did more of this in our science classes?

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Authors' Contributions

PJM conducted all aspects of the research, wrote the manuscript based on his masters dissertation, wrote the poem used in the research, developed the research questionnaires and provided data for the research, RE supervised PJM for the research project and edited the article, and JF conducted all statistical analyses. All authors reviewed the final manuscript.

Notes

i. "Acid Man and Lady Base" - see Appendix B.
ii. See the video on Deep Science Facebook page: https://www.facebook.com/334924460228786/videos/335065760214656/
iii. Five schools were originally approached of which one declined to participate in the research. The pupils of the classes of the participating teachers resulted in the random number of boys and girls who took part.
iv.
v. DATES: Received: 21 December 2018; Revised: 28 November 2019; Accepted: 28 January 2020; Published: 31 December 2020.

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Appendix A: The Research Questionnaire

	Grade 9 Learner Pre-Test Questionnaire	School:				
	Indicate with a cross if you are a Boy ◯ Girl ◯	Home language is English ◯		English and Other ◯		Other ◯
	Place a cross in the appropriate space provided	Strongly disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1	I understand what acids and bases are.					
2	I know how acids and bases are formed.					
3	I know how salts are formed.					
4	I enjoy learning about acids and bases.					
5	I want to know more about acids and bases.					
6	I find chemistry interesting.					
7	I love Chemistry					
8	I enjoy learning about Chemistry.					
9	I think that Chemistry can teach us about ourselves.					
10	Further comment (optional):					

	Grade 9 Learner Post-Test Questionnaire	School:				
	Indicate with a cross if you are a Boy ◯ Girl ◯	Home language is English ◯		English and Other ◯		Other ◯
	Place a cross in the appropriate space provided	Strongly disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1	I understand what acids and bases are.					
2	I know how acids and bases are formed.					
3	I know how salts are formed.					
4	I enjoy learning about acids and bases.					
5	I want to know more about acids and bases.					
6	I find Chemistry interesting.					
7	I love Chemistry					
8	I enjoy learning about Chemistry.					
9	I think that Chemistry can teach us about ourselves.					
10	Which aspect of the lessons did you enjoy most? (You may include more than one option)	Poem	Video	Class Discussion	Own Learning	
11	Further comment. (Optional)					

Appendix B: The Poem and Glossary Used in the Reported Fieldwork

Acid Man and Lady Base

Of these the ancient alchemists spoke
Who knew them both as active folk.
Base born of metal and acid her mate
Have needs that only the other can sate.

To find their nature, for what they strive,
We place in sets of test-tubes five
Magnesium, milk and copper sulphate,
Crushed chalk and oil, our sacrifice, our bait.

Acid brighten, dissolve and boil,
To lift from solid its heavy toil.
In one quick act his halide sword
Or brimstone fire has form destroyed.

Slower working, to hold and bind
Our lady's fruits, though soft in kind,
Take what is loose, unbound and free
And ground it. Give it presence to be.

When together these two we place,
The drive, the need, the hot embrace
Seems like a fight to dominate the lover.
Inanimate opposites attracting each other.

Then left to cool and crystallise,
As children born of their parents' demise,
Small shining beads, salt crystals delight,
To fructify the Earth as solidified light.

Glossary

Alchemists	Early experimental scientists who also looked for the qualities and properties of materials which related to human nature.
Folk	People
Sate	Satisfy
Toil	Burden or "to work hard"
Halide	A reacted halogen, e.g.: Fluoride, Chloride, Bromide or Iodide
Brimstone	An old name for Sulphur
Ground it	To make it solid and to take a form of its own
Inanimate	Not able to move of their own accord
Demise	Death
Fructify	To bring new life or ideas

Appendix C: Tables of Results

Table C1 Summary of results for the entire sample of 222 learners from all four schools, 100 girls and 122 boys

	Wilcoxon test		*t*-test	
	Test statistic	*p*-value	Test statistic	*p*-value
Entire sample	56	0.0078	2.98	0.0088
Girls	58	0.0142	2.73	0.0148
Boys	54	0.004	3.20	0.0084

Note. All p-values < 0.05, (< 5%) thus the intervention had a statistically significant effect on the entire sample.

Table C2 School 1 - A government school with an arts focus (84 learners - 58 girls and 26 boys)

	Wilcoxon test		*t*-test	
	Test statistic	*p*-value	Test statistic	*p*-value
Entire sample	52	0.0019	3.95	0.0011
Girls	51	0.0012	3.97	0.0011
Boys	51	0.0012	3.8	0.0016

Note. All p-values < 0.05, (< 5%). The intervention has a significant effect on school 1.

Table C3 School 2 - A small private school with an arts focus (20 learners - seven girls and 13 boys)

	Wilcoxon test		*t*-test	
	Test statistic	*p*-value	Test statistic	*p*-value
Entire sample	75.5	0.3994	1.25	0.2283
Girls	82	0.7686	0.93	0.368
Boys	76	0.4191	1.01	0.3298

Note. All p-values are above 0.20 (> 20%). There is no significant effect from the intervention.

Table C4 School 3 - A government school with academic focus (33 learners - 10 girls and 23 boys)

	Wilcoxon test		*t*-test	
	Test statistic	*p*-value	Test statistic	*p*-value
Entire sample	62	0.0382	2.65	0.0174
Girls	64	0.0588	1.96	0.0681
Boys	62	0.0376	2.78	0.0135

Note. $p < 0.05$ for the whole sample and for the boys; $p < 0.10$ (< 10%) for girls. There is a significant effect of the intervention for the entire sample and for the boys – but no significant effect for the girls.

Table C5 School 4 - A government school with science focus (85 learners - 25 girls and 60 boys)

	Wilcoxon test		*t*-test	
	Test statistic	*p*-value	Test statistic	*p*-value
Entire sample	65	0.0770	2.03	0.0595
Girls	69	0.1615	1.74	0.1132
Boys	63	0.0503	2.10	0.0592

Note. No significant effect after interventions – no p-values are smaller than 0.05.