Anthropomorphic graphics: How useful are they as an instructional aid to facilitate learning?[1]

Ts'ekelo Patrick Moremoholo, Central University of Technology, South Africa
Rudi W. de Lange, Tshwane University of Technology, South Africa

ABSTRACT

Research has shown that decorative graphics do not contribute to learning when combined with instructional text. Some recent studies, however, indicate that decorative anthropomorphic graphics may improve comprehension during learning tasks. This article reports on an experiment involving 151 Grade 11 learners to test the potential of anthropomorphised graphics in learning material. The aim was to determine if the anthropomorphic graphics contributed to learning and whether the learners experienced the material in a positive manner. One group received text only, another received the same text but with anthropomorphised colour graphics and a third group received the text with non-anthropomorphised monochrome graphics. The anthropomorphised group did not perform significantly better than the other groups regarding comprehension and no significant difference was found regarding the enjoyment of the material. These results differ from recent studies that suggest that anthropomorphised graphics may contribute to learning and are enjoyed by learners. The non-significant results could be due to the differences in the experimental method of this study and those studies that reported positively on anthropomorphised graphics. Further research is required for instructional designers to understand better how learners process and respond to anthropomorphic graphics with a view on optimising its appearance in learning material.

Keywords: anthropomorphism, decorative graphics, multimedia, positive emotions, learning

INTRODUCTION

In the current information and digital age, learners and students are expected to have the capacity to learn from and absorb information presented in different media and in varied learning environments (Sankey, Birch & Gardiner, 2011). Students, for example, could be exposed to – and are required to learn from – lectures, laboratory experiments, studio demonstrations, digital media presentations, computer software demonstrations, educational trips, and internships. A variety of visual representations in a learning environment can benefit and assist students with different and varied learning tasks (Ainsworth & Van Labeke, 2002). Some examples are the use of information graphics to present data using charts, maps, and graphs, and the use of static or dynamic visuals to explain or demonstrate a process. These representations clarify data, explain learning material, support the learning process, and enhance the students' engagement with the learning material (Sankey et al., 2011). The facilitating effect of these

1 Date of submission 15 August 2017
Date of review outcome 5 April 2018
Date of acceptance 30 June 2018

visual representations is, in turn, affected by the ability of the receivers of the material (Mayer, 2003) and their capacity to process visual information (Hollingworth, 2004; Brady, Konkle, Alvarez & Oliva, 2008). One such visual representation can be observed where educational designers, by means of a process termed 'anthropomorphisation', add a human or animal characteristic to non-living objects presented in static or dynamic graphics (Muzumdar, Schommer, Hadsall & Huh, 2013). Learners and students view anthropomorphised visuals as being similar to a living entity, and an item that possesses humanlike qualities (Gebhard, Nevers & Billmann-Mahecha, 2003). Viewing an object as having humanlike characteristics may change the way we perceive and value the object, even perhaps as something that deserves moral consideration (Gebhard et al., 2003). Humanlike characteristics of a child, such as big, oversized eyes and an engaging smile, and when transferred to an illustration of an animal, make it easier for us to identify with, and embrace the animal as 'human', i.e. as one of us. Anthropomorphism includes topics such as folklore, the 'personification' of deities and gods, talking animals and objects in comics and books, and the human voice in global positioning systems. Anthropomorphism in this paper refers specifically to the personification of decorative graphics found in picture-text learning material.

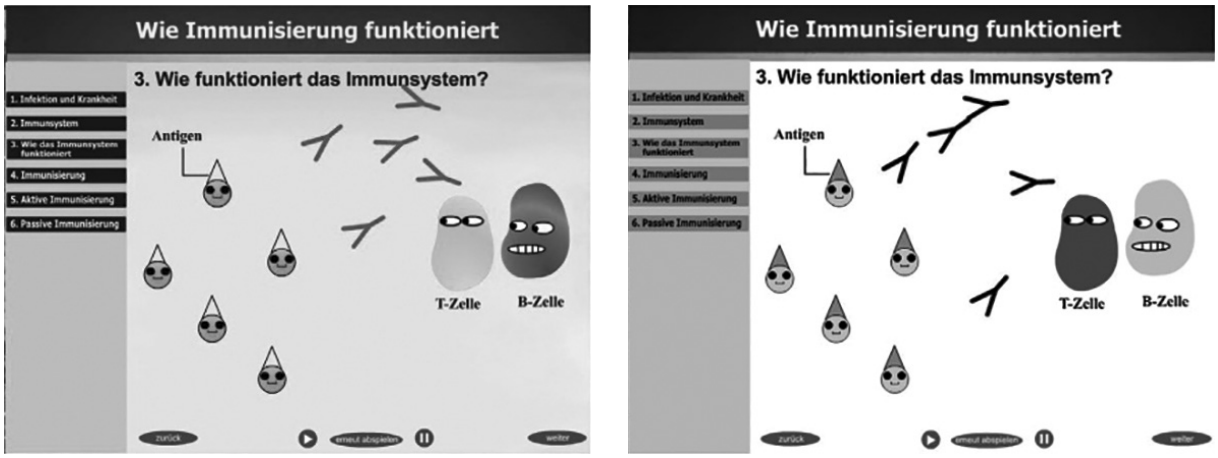
Terms such as decorative visuals or decorative graphics (as employed by several scholars, such as Samuels (1970), Concannon (1975), Levie and Lentz (1982), Solman, Singh and Kehoe (1992), and Solman and Wu (1995) refer to a visual representation that beautifies learning material. Decorative visual representations are typical illustrations that do not repeat information in the text, do not illustrate difficult-to-understand text, or refer to images that do not contain learnable information. Adding humanlike characteristics to an illustration of vegetables in a lesson pertaining to healthy food is an example of anthropomorphising a useful graphic that could convey information on a specific food group. Adding a smiling face, for example, to a graphic that does not convey any information, does not repeat information in the text, nor explain difficult text, is an example of antropomorphising a decorative graphic. Such a decorative graphic may be seen as frivilous in terms of facilitating learning as it does not contain any information that one can or needs to acquire.

PROBLEM STATEMENT AND RESEARCH QUESTION

This paper considers the use of anthropomorphic graphics in a learning environment and reports on an experiment where we examined how anthropomorphic graphics affect learners' comprehension following a multimedia lesson. Some scholars have called for more research on the use of anthropomorphic graphics and learning (Chen & Sun, 2012) as well as the use of anthropomorphism in different disciplines, for example languages (Sahragard, Ahmadi & Shalmani, 2016) and sciences (Dalacosta, Kamariotaki-Paparrigopoulou, Palyvos & Spyrellis, 2009; Tatalovic, 2009). As it stands, there is limited research to inform instructional designers and graphic designers regarding the use of anthropomorphic graphics in a learning environment (Triantos, Plakoyiannaki, Outra & Petridis, 2016). As such this paper is a deliberate attempt to contribute to the discourse of designing anthropomorphic graphics, and to contribute to the knowledge base for instructional designers.

Recent research has shown that anthropomorphising graphics may assist the learning process (Um, Plass, Hayward & Homer, 2012; Plass, Heidig, Hayward, Homer & Um, 2014). The independent variables for Um et al. (2012) and Plass et al. (2014) were graphics in the form of colour and shape which were given humanlike characteristics (by adding eyes and a mouth), as well as an external mood induction procedure. See Figure 1 below for an example of the graphics.

Figure 1:
Screenshots of multimedia learning materials neutral emotional design (ND), right, and positive emotional design (PD), left. Translation from German: 'How does Immunization Work?'



Study 1 by Plass et al. (2014: 130)

According to the abovementioned researchers, these graphics increased the learners' comprehension as well as their transfer scores (i.e. their ability to apply the knowledge), whilst the external mood induction procedure improved only their transfer scores. This induction process consisted of exposing the students to a nature-based video with soothing music to place them in a positive emotional mood.

The results of the above lead us to ask several questions. Is it the positive induction process, the 'humanlike' qualities in the graphics, a combination of these two variables, an experimenter-expectancy effect, or a motivational attention-holding effect that resulted in the improved learning? Although the graphics in their experiments are anthropomorphic in nature, they are merely decorative and do not contain information that a learner could use to gain knowledge of the topic under investigation. Earlier research has shown that such decorative graphics do not contribute to learning and that they may even distract from the learning process (Samuels, 1970; Levie & Lentz, 1982; Sung & Mayer, 2012; Lenzner, Schnotz & Müller, 2013). The difference between the earlier studies and the later work cited above (Um et al., 2012; Plass et al., 2014; Mayer & Estrella, 2014) is that the latter studies used a digital multimedia platform as opposed to printed learning material and included a motivational induction process. The question that we seek to answer is whether anthropomorphised graphics, in the absence of a mood induction process, can contribute to learning and if learners experience these graphics as a positive element in their learning material.

ANTHROPOMORPHIC GRAPHICS AND LEARNING

The section below provides a brief overview of anthropomorphism and its use in a learning environment.

The nature of anthropomorphism

Anthropomorphism is popular practice and is used in folklore and the 'personification' of deities and gods (Kracher, 2002), in advertising (Kalliat, 2013), in entertainment (Lahtiranta & Kimppa, 2006), with talking animals in children's books (Burke & Copenhaver, 2004), and talking objects such as regularly observed in comic books and animations. Anthropomorphism, traditionally, is associated with children, and its use is mostly seen in religion, philosophy, science, and the arts. It is also common for people to see human features in natural forms (Guthrie, 1995). In her book titled *Faces in the clouds: A new theory of religion* (1995), Guthrie refers to three levels of anthropomorphism. The first is partial and which occurs when

people partially associate human qualities with objects and events. The second is literal and occurs when people believe an object or animal to be a person. The third is accidental anthropomorphism and involves seeing parts of an object as being humanlike due to a chance structure of components, e.g. seeing a face in the clouds. Anthropomorphism shares similar characteristics with other forms of art such as storytelling (Burke & Copenhaver, 2004; Geerdts, Van de Walle & LoBue, 2015). Randolph Caldecott (1848-1886), one of the earliest and most influential illustrators during the Victorian era (1837-1901), used this approach for his children's books. This unique visual representation, commonly used for children's books and as an edutainment medium, continues to engage adults and children alike. One example of his illustrations is presented in Figure 2 below.

Figure 2:
Randolph Caldecott's illustration depicts two dancing, humanised frogs

A Frog He Would A-Wooing Go (1883: 3)

Elements of anthropomorphism are also applied to robotic forms, industrial machines, humanoid-type machinery, and are used to build brands (Duffy, 2003; Złotowski, Proudfoot, Yogeeswaran & Bartneck, 2015). One example of a well-known anthropomorphic brand is an illustration of a shark used by a South African rugby union team, the Sharks.

Anthropomorphism of inanimate objects can affect the manner in which consumers perceive a particular product and ultimately affect their purchasing behaviour. The work by Triantos et al. (2016), for example, found that the elements of anthropomorphism are effective when used in the packaging of grocery brands. A good example is the use of humanlike cartoon characters in the packaging design of breakfast cereal products. Such products, including examples such as the front of a car resembling a face, command a more positive response than a product that does not display humanlike features (Aggarwal & McGill, 2007).

It is especially with animation in film that anthropomorphism is popular. Inanimate objects and animals are easily given life and personality depending on the imagination of the animator and the style of the film. Anthropomorphism serves two roles in animated films: it facilitates an emotional or social relationship between the viewer and an anthropomorphised object and it may also help to convey a valuable life lesson (Leventi-Perez, 2011).

The practice of anthropomorphism is most commonly associated with animals. Chartrand, Fitzsimons and Fitzsimons (2008) explored whether subtle exposure to anthropomorphised domestic animals such as cats and dogs can stimulate interest and significantly influence behaviour. The results of their study suggest that such a procedure may indeed influence a person's social behaviour. In the aforementioned study, the participants were mainly presented with images of cats and dogs and the loyalty behaviour of the animals was subsequently measured. Participants who were exposed to images of dogs reported the trait 'loyal' for dogs while cats were not perceived as loyal. The researchers thus concluded that anthropomorphised images can influence social behaviour. Participants responded to images of anthropomorphised pets, unaware that these images influenced their behaviour. Similarly, Epley, Waytz and Cacioppo (2007) reported that people may look for alternative means to establish social connection by anthropomorphising objects or animals when they feel lonely.

Anthropomorphism in teaching and learning

There is a debate as regards the use of anthropomorphic visualisation across different learning situations. Some scholars found it to be beneficial whilst others are opposed to this practice. Blanchard and Mcnincth (1984), Byrne, Grace and Hanley (2009), and Dorion (2011) found that anthropomorphism can contribute to learning and may be used as a strategy to help the learner develop understanding. Dorian (2011: 1), for example, suggests that anthropomorphic language holds the 'potential for the assessment and teaching of anthropomorphic analogies in secondary science'. Anthropomorphism in the form of analogies and words are thought to make a learning experience engaging and memorable (Watts & Bentley 1991; Kattmann, 2008). One example is when an oncologist would state that cancer cells will 'die', instead of disappear. Another example is when we refer to a computer 'brain' instead of a central processing unit.

The experimental work conducted by Ganea, Canfield, Ghafari and Chou (2014) indicated that anthropomorphised animals in books influence how preschool children perceive animals. These researchers concluded that children are less likely to transfer anthropomorphic characteristics and a biological property from one animal to another when they read and see a realistic presentation of an animal. Children thus seem to learn more about animals when the images are realistic and the accompanying language is factual.

A study by Bautista (2015) has shown that primary pupils' interest and attitudes towards anthropomorphic images decline with age. The tendency to anthropomorphise is thus attributed to age and it diminishes through learning experience and the progressive ability to comprehend phenomena better.

Anthropomorphic graphics in multimedia learning

Multimedia learning refers to a type of learning which is delivered through words and pictures (Mayer, 2003; 2010). The rationale for using various forms of multimedia is that by generating relations between words and pictures, learners will create a better understanding than when information is presented with either words or pictures alone. However, it must be said that multimedia learning is not only accomplished by merely adding words to pictures. Multimedia learning material can consist of several elements such as sound clips, animated graphics, text that moves, to name but a few, and all combine to engage a learner and so address specific educational goals (Dong, 2010).

One of the theories central to multimedia learning is Mayer's (2010) cognitive theory of multimedia learning (CTML). This theory takes advantage of the capacity of humans for processing information (words as well as pictures). The idea is to create instructional media based on how the human mind works. In short, the best way to promote meaningful learning is through active learning in which the learner is actively involved in acquiring new knowledge.

Anthropomorphic visualisation is another form of communication in multimedia learning. As with the other multimedia forms like animation, the design of anthropomorphic images presents a combination of both word and image, and this therefore implies that the user would have to exercise both visual and verbal interpretive skills. It appears that the balance with anthropomorphism is how much reality and how much fantasy one chooses to employ or combine. The value of the human elements in the graphics is that they engage a viewer, and 'makes the learning experience a memorable one' and so helps a learner to remember the learning material (Hope, 2015). The anthropomorphised learning material employed by Plass et al. (2014) (see Figure 1 above) is a good example where humanlike faces and expressive eyes were added to otherwise non-human entities with a view on engaging the receivers of the material.

Emotional aspects in the design of multimedia learning environments

Some researchers maintain that anthropomorphism, or the introduction of visual graphics with humanlike designs, could arouse a participant's positive emotions (Bradley, 2010). Emotional design of multimedia instruction involves the extent to which visual design elements such as anthropomorphic or animated characters, shapes, and sounds in multimedia learning are used to evoke positive emotional reactions (Um et al., 2012). According to Um et al. (2012) and Mayer and Estrella (2014), the basis for incorporating design to evoke an emotional response in multimedia learning is accomplished by creating a relationship between positive emotions and the actual graphics, which could then influence the user's emotional state and so encourage deeper learning. Mayer and Estrella's (2014) work suggests that CTML and cognitive load theory (CLT) could be extended to integrate the role of motivation and affect. The experiment by Plass et al. (2014) has shown that positive emotional design could motivate learners, affect their emotions and possibly influence their cognitive abilities.

THE EXPERIMENT

This study sought to establish whether anthropomorphised graphics can contribute to learning and if learners experience these graphics as a positive element in their learning material. The experiment followed a quasi-experimental design with three participant groups. The subjects, upon arrival, received a briefing about the procedure, what they had to do, and how long the session would be. The experiment took place in computer laboratories and the learning material and test questions were presented via Blackboard. There were no time restrictions set for the participants to study the material and answer the questions.

Participants

The subjects consisted of 151 Grade 11 learners from two public schools in Bloemfontein, South Africa. Both conveniently selected schools are situated in residential suburbs in opposite parts of the city. These schools are well established and teachers use English as the medium of instruction. Apart from the gender and age groups of the participants, our ethical clearance did not permit us to collect any additional biographic information. The authors have no affiliation with the two schools, the teachers or the principals.

The subjects' ages ranged from 16 to 19; 79% were between 16 and 17 years of age (n = 120) and 21% were between 18 and 19 years of age (n = 31). There were 73 female and 78 male subjects. Sixty subjects came from an urban school, and 91 subjects came from a peri-urban school. The Tshwane University of Technology (TUT) Research Ethics Committee provided ethical clearance, and the Department of Education of the Free State Provincial Government and the two schools granted permission for the

research to be undertaken. The learners participated voluntarily and were offered a light meal following the experiment. The parents of the participating learners gave their written permission and signed consent forms.

The learning material

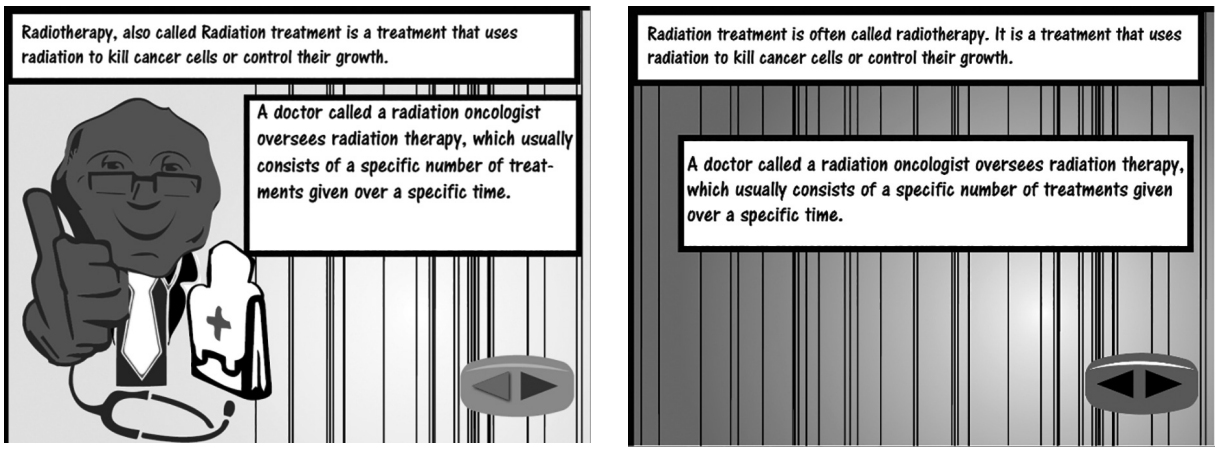
All the learners completed an unrelated pre-test with a view on exposing them to the procedure and the environment and which consisted of them answering 10 questions after reading a 486-word text on food safety issued by the World Health Organization (WHO, n.d.; 2006). The text for the pre-test contained five graphics. These images demonstrated the steps explained in the text – for example, the process of keeping raw food and cooked food separate.

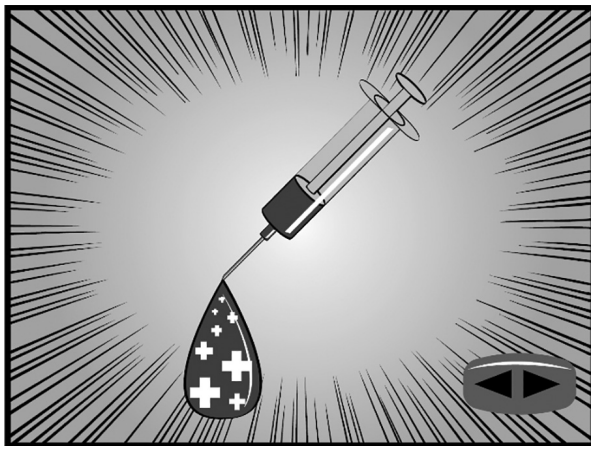
The learning material for the experiment consisted of 484 words and came from the National Cancer Institute at the National Institutes of Health (2009) as well as the National Breast Cancer Foundation (NBCF) (2012), and explained what radiation therapy is and how it is used in the treatment of cancer. The reason for choosing radiation therapy as a topic is that it is not a learning area covered at school level and learners are not likely to have prior knowledge about this topic. Prior knowledge is a variable that would have unduly influenced the post-test scores of the learners.

Participant groups

Subjects from both schools were randomly allocated to one of three groups and assigned a computer workstation in a computer laboratory. A facilitator demonstrated the procedure on a screen after which they were instructed to complete the pre-test. Learners received the learning material via a computer and then completed an online questionnaire. The control group received text-only material whilst the two remaining groups received graphics with the same text material. The Colour Anthropomorphic group was presented with the learning material in a 14-slide format that combined the text and graphics. The Monochrome group received the same material except that their graphics were limited to black and grey tones and the graphics did not contain any anthropomorphic elements. The Monochrome group's material was similar to the neutral material used in the experiments by Um et al. (2012) and Plass et al. (2014) (see Figure 3 below). The Text-only group condition contained 11 slides with text, but without any graphics.

Figure 3:
Screenshots of two slides for the Colour Anthropomorphic group (left) and two for the Monochrome group (right)





Measures

Comprehension tests

The comprehension questions consisted of 12 multiple-choice questions. This is the same mode and similar to the number of multiple-choice questions used by Plass et al. (2014), Schneider, Nebel, Beege and Rey (2016) and Um et al. (2012) in their experiments. Their measures consisted of 16, seven and 15 multiple-choice questions respectively. Multiple-choice questions are often used by institutions of teaching and learning in the assessment of students' knowledge or other academic activities.

These questions assessed the learners' comprehension and knowledge of the anatomy of cancer, what radiation therapy entails and how it is used in the treatment of cancer. One such question was: *Which of the following clearly describe how radiation therapy is used to kill cancer cells?* The learners had to select one correct answer from the following possible answers to this question:

A. Radiation therapy uses a pill that a patient must take every day or by an intravenous (IV) line on a set schedule.
B. A specialized type of a light source that slows the cancer development.
C. Radiation therapy uses high-energy radiation to kill cancer cells by damaging their DNA.
D. High-energy invisible light beams that kill cancer cells by slowing the growth of their DNA.
E. None of the above.

Emotional questionnaire

The emotional questionnaire consisted of eight statements on a 7-point Likert scale. The learners had to reflect on their feelings regarding the experimental session in general as well as the learning material. The learners were asked to indicate whether they 'strongly agree' to 'strongly disagree' with a particular statement. These statements were similar to those used by Um et al. (2012). One example of such a statement is: I would be willing to come back and participate in a future experiment that used this learning material.

THE RESULTS

A Normal Q-Q plot indicated that the scores for the unrelated pre-test were approximately normally distributed. The lowest score was 3, the highest 10, with a mean score of 6.64 out of 10. There were no procedural difficulties and the learners did not report any hindrances.

Comparing the means of the participant groups

The first objective was to determine whether anthropomorphised graphics can contribute to learning. This was achieved by examining the scores of the three groups and analysing the results with appropriate

statistical tests. A Normal Q-Q plot indicated that the data were approximately normally distributed for each group. Levene's Test for Homogeneity of Variance indicated that homogeneity of variances was violated (p = 0.008). It is for this reason that we used Welch's F-test to test for any difference between the scores of the three groups. Welch's F(2, 98.446) = 1.374, p = 0.258 indicated that there was no significant difference between the groups. The test showed adequate internal consistency reliability, with Cronbach's alpha = 0.588. The descriptive statistics are presented in Table 1 below.

Table 1:
The descriptive statistics of the comprehension scores for the three participant groups

	Normal	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Colour Anthropomorphic	52	8.3	2.24	0.31	7.64	8.89	4	12
Monochrome	46	8.5	1.95	0.29	7.87	9.04	3	11
Text-only	53	7.7	2.64	0.36	6.97	8.42	2	12

Effects of school and participant group

A further two-way ANOVA (Analysis of Variance) tested for differences between the schools as well as possible interactions between the schools and the three groups (i.e. if there were maybe differences between the three groups in one school but not the other). There was no significant interaction effect between schools and the participant groups, $F(2, 145) = 1.446$; $p = 0.239$. The effect of the participant groups on the test scores was not different for learners in different schools. There was also no significant main effect for School, $F(1, 145) = 1.162$, $p = 0.283$. Thus, ignoring that there were different groups, the post-test scores did not differ between the learners from different schools.

The subjects' motivation scores

The second objective was to determine whether learners experienced the graphics as a positive element in their learning material. This was done by analysing the results of the emotional questionnaire of the three groups with appropriate statistical tests. A Normal Q-Q plot indicated that the data are approximately normally distributed for each group. Levene's Test for Homogeneity of Variance indicated that homogeneity of variances was not violated ($p = 0.365$). A one-way analysis of the motivation score shows no significant difference between the groups: $F(2, 148) = 0.795$; $p = 0.454$. The test showed adequate internal consistency reliability, with Cronbach's alpha = 0.826. The descriptive statistics are presented in Table 2 below.

Table 2:
The descriptive statistics of the motivational scores for the three participant groups

	Normal	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Colour Anthropomorphic	52	44.03	9.08	1.26	41.5	46.36	12	56

	Normal	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Monochrome	46	42.13	9.55	1.41	39.3	45	14	56
Text-only	53	41.74	11.00	1.51	38.7	44.2	13	56

DISCUSSION

This article examined the influence of adding anthropomorphic visuals to a multimedia lesson on how radiation therapy is utilised to combat cancer. In our research we used anthropomorphised graphics of human faces to represent healthy human cells as happy faces and gave aggressive-looking faces to the cancer cells. The assumption was that facial expressions are relatively easy to recognise and may evoke emotional responses. The human faces seemed an appropriate choice for this purpose, although, as noted in the literature, there are potential limitations associated with this approach. One of the constraints in using anthropomorphisms could be the 'direct misunderstanding of the visual metaphors so that they can lead to reification of knowledge' (Kattmann, 2008: 9; Perry & Donath, 2004).

The results indicate that anthropomorphic graphics in learning material may not always be as effective as expected. The outcome of our experiment is, furthermore, in contrast to our initial assumption that learning material with anthropomorphic graphics would facilitate learning. A possible explanation could be a difference between the methodology of this experiment and the method used by others whose work indicated that these graphics do contribute to learning (Plass et al., 2014). The method for this experiment did not include an external mood induction process. The experiment by Plass et al. (2014) included two-minute videos that acted as a mood induction process. These videos intended to induce either a positive or a neutral emotional state. The subjects in the experiments by Plass et al. (2014), Schneider et al. (2016) and Um et al. (2012) were furthermore at a post-school level, while our learners came from secondary schools and who may not have had the same exposure to a computerised learning environment as compared to post-school individuals. Another speculative explanation could be the Hawthorne effect (Coombs & Smith, 2013). The Hawthorne effect is an experimental effect that influences subjects' actions and performance when they are aware that they are part of an experiment or are being observed.

The anthropomorphic graphics used in the current study were designed for secondary school learners in a particular grade (Grade 11) with the goal of increasing their comprehension as well as creating an emotional response. It could also be that the participants may have required some assistance in how to process these graphics. As suggested in the literature, the use of visual representations is widespread in instructional strategies (Anglin, Vaez & Cunningham, 2004) and their interpretation requires a certain level of visual literacy (Lowe, 2000). Visual literacy, according to the International Visual Literacy Association (IVLA, 2017) and Bamford (2003), involves the learner's ability and skill to understand and to make sense of information that is shown in a visual format. A person's visual literacy, in part, relies on the appropriate interpretation of design elements (line, shape, colour, proportion, and so forth), prior knowledge of the subject and of course the ability to comprehend the text that accompanies the images (Lowe, 2000). Visual literacy, similar to verbal literacy, is a learned skill.

Another reason for the non-significant results of the study could be that the learners did not pay sufficient attention to the anthropomorphic graphics, or they may have experienced difficulty in extracting relevant information from these representations. Here it is of special interest to note that Peeck (1993) supports the idea that learning from illustrated text can improve, if one can increase a learner's visual literacy, and

provide learning tasks that require a learner to use picture processing skills. Therefore, if particular visuals are to be used in the classroom, then teachers must help learners to interpret these images and so help them acquire and develop independent visual literacy skills.

The failure to find differences among the three groups could be that the degree of our visual information may not have been noticeable enough to create a variation. Future versions of this study may include visual images with more intense forms of anthropomorphism, i.e. graphics that should evoke stronger emotions.

LIMITATIONS AND FUTURE DIRECTIONS

A definite limitation of the study was the limited duration of the experiment and the immediate post-testing after the learners interacted with the learning material. This experiment was also restricted by assessing a single population (secondary school learners) in a specific geographic location (the city of Bloemfontein, South Africa) and using one educational topic (radiation therapy) in a particular educational setting (a computer laboratory setting). We believe that one or possibly a combination of some of these variables could have contributed to the non-significant results. It could also be that the anthropomorphic graphics did not facilitate learning because in essence they are decorative and do not contain any relevant information in support of the content of the learning material (Samuels, 1970; Levie & Lentz, 1982; Sung & Mayer, 2012; Lenzner et al., 2013). The experimental work by the aforementioned authors has shown that when one adds decorative graphics to instructional text, they do not facilitate learning. It is only when a graphic such as an illustration helps a reader to interpret difficult-to-interpret text, such as the working of an internal combustion engine, that they can facilitate learning. One reason why the learners' emotional scores of the three groups were similar, in contrast to the results found by Um et al. (2012) and Plass et al. (2014), is that the learners in all the groups could have experienced the visit to the university, and receiving learning material via a computer network, as quite unique and utterly new. As such this experience could have directly masked the possible positive emotional effect of the graphics. Future research on anthropomorphic visuals should investigate the issues using a variety of different educational contexts and domains. Additionally, any possible distractive effects of the visual representations could be considered by employing analytic techniques (e.g. eye tracking equipment).

The other possibility that the data did not yield support for the main hypothesis regarding the effects of anthropomorphic graphics may be due to variables like positive motivational procedures as applied in the studies by Um et al. (2012) and Plass et al. (2014). The current study did not employ a positive mood induction process in association with the anthropomorphic graphics. The reason for this decision was that we wanted to test the hypothesis that anthropomorphic graphics can contribute to learning without a positive mood induction process.

Future studies could investigate how learners process anthropomorphic information, and how learners' visual literacy affects their ability to use such graphics in learning material.

CONCLUSION

In conclusion, it seems as if the decision whether the use of anthropomorphic visualisation is appropriate for a particular lesson may be dependent upon a range of issues. For example, the visual appearance of a good instructional design plays a significant role in determining learners' response as most of the participants agreed that the material was interesting and fun. Other considerations include whether the presentation appears functional and complements the learning content. However, it is also apparent that our understanding of the contingent nature of the processes that surround anthropomorphic graphics is still limited. The challenge, then, is to find a balance between the visual style of the anthropomorphic graphics and the emotional effects of the visual information. Although there was no significant difference among

the three groups, it is hoped that this research will contribute to this particular field of research by further stimulating interest in the topic.

REFERENCES

Aggarwal, P. & McGill, A.L. (2007) 'Is that car smiling at me? Schema congruity as a basis for evaluating anthropomorphized products' *Journal of Consumer Research* 34(4) pp.468-479.

Ainsworth, S. & Van Labeke, N. (2002) 'Using a multi-representational design framework to develop and evaluate a dynamic simulation environment' International Workshop on Dynamic Visualizations and Learning, July, Tubingen, Germany.

Anglin, G.J., Vaez, H. & Cunningham, K.L. (2004) 'Visual representations and learning: The role of static and animated graphics' In D. Jonassen (Ed.) *Handbook of research on educational communications and technology* 2nd edition, pp.865-916. Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

Bamford, A. (2003) *The visual literacy white paper*. Australia: Adobe Systems.

Blanchard, J. & Mcnincth, G. (1984) 'The effects of anthropomorphism on word learning' *The Journal of Educational Research* 78(2) pp.105-110.

Bradley, S. (2010) *Building an emotional connection with your audience*: *Anthropomorphic forms Part I*. http://vanseodesign.com/web design/anthropomorphic-forms-part-i/ (Accessed 19 November 2016).

Bautista, R.G. (2015) 'Students' affordance of teleologic explanations and anthropomorphic language in eliciting concepts in physics' *Journal of Technology and Science Education* 5(1) pp.31-40.

Brady, T.F., Konkle, T., Alvarez, G.A. & Oliva, A. (2008) 'Visual long-term memory has a massive storage capacity for object details' *Proceedings of the National Academy of Sciences* 105(38) pp.14325-14329.

Burke, C.L. & Copenhaver, G. (2004) 'Animals as people in children's literature' *Language Arts* 81(3) pp.205-213.

Byrne, J., Grace, M. & Hanley, P. (2009) 'Children's anthropomorphic and anthropocentric ideas about micro-organisms: Educational research' *Journal of Biological Education* 44(1) pp.37-43.

Caldecott. R. (1883) Illustration from the children's classic 'A Frog He Would A-Wooing Go' Project Gutenberg. www.gutenberg.org/ebooks/14077 (Accessed 10 May 2017).

Chartrand, T.L., Fitzsimons, G.M. & Fitzsimons, G.J. (2008) 'Automatic effects of anthropomorphized objects on behaviour' *Social Cognition* 26(2) pp.198-209.

Chen, C.M. & Sun, Y.C. (2012) 'Assessing the effects of different multimedia materials on emotions and learning performance for visual and verbal style learners' *Computers & Education* 59(4) pp.1273-1285.

Concannon, S.J. (1975) 'Illustrations in books for children: Review of research' *The Reading Teacher* 29(3) pp.254-256.

Coombs, S.J. & Smith, I.D. (2003) 'The Hawthorne effect: Is it a help or hindrance in social science research?' *Change: Transformations in Education* 6(1) pp.97-111.

Dalacosta, K., Kamariotaki-Paparrigopoulou, M., Palyvos, J.A. & Spyrellis, N. (2009) 'Multimedia application with animated cartoons for teaching science in elementary education' *Computers & Education* 52(4) pp.741-748.

Dorion, K. (2011) 'A learner's tactic: How secondary students' anthropomorphic language may support learning of abstract science concepts' *Electronic Journal of Science Education* 12(2) pp.1-22.

Dong, C. (2010) 'Interface design, positive emotions and multimedia learning' In H. Song & T.T. Kidd (Eds.) *Handbook of research on human performance and instructional technology* pp.182-194. IGI Global.

Duffy, B.R. (2003) 'Anthropomorphism and the social robot' *Robotics and Autonomous Systems* 42(3-4) pp.177-190.

Epley, N., Waytz, A. & Cacioppo, J.T. (2007) 'On seeing human: A three-factor theory of anthropomorphism' *Psychological Review* 114(4) pp.864-886.

Ganea, P.A., Canfield, C.F., Ghafari, K.S. & Chou, T. (2014) 'Do cavies talk? The effect of anthropomorphic books on children's knowledge about animals' *Frontiers in Psychology* 5(283) pp.1-9. doi:10.3389/fpsyg.2014.00283

Gebhard, U., Nevers, P. & Billmann-Mahecha, E. (2003) 'Moralizing trees: Anthropomorphism and identity in children's relationships to nature' In S. Clayton & S. Opotow (Eds.) *Identity and the natural environment: The psychological significance of nature* (pp.91-111). Cambridge, MA: MIT Press.

Geerdts, M.S., Van de Walle, G.A. & LoBue, V. (2015) 'Learning about real animals from anthropomorphic media' *Imagination, Cognition and Personality* 36(1) pp.5-26.

Guthrie, S.E. (1995) *Faces in the clouds: A new theory of religion*. Oxford: Oxford University Press.

Hollingworth, A. (2004) 'Constructing visual representations of natural scenes: The roles of short- and long-term visual memory' *Journal of Experimental Psychology: Human Perception and Performance* 30(3) pp.519-537.

Hope, D. (2015) '*Anthropomorphic characters in e-learning*' https://hopedianne.com/portfolio/anthropomorphic-characters-in-e-learning/ (Accessed 20 June 2018).

International Visual Literacy Association [IVLA]. (2017) *What is visual literacy*? http://ivla.org/new/what-is-visual-literacy-2/ (Accessed 29 February 2017).

Kalliat, M. (2013) *Beneath the anthropomorphic veil. Animal imagery and ideological discourses in British advertising*. Unpublished MSc. London School of Economics and Political Science, UK. www.lse.ac.uk/media@lse/research/mediaWorkingPapers/MScDissertationSeries/2012/83.pdf (Accessed 20 December 2016).

Kattmann, U. (2008) 'Learning biology by means of anthropomorphic conceptions?' In M. Hammann, M. Reiss, C. Boulter & S.D. Tunnicliffe (Eds.) *Biology in context: Learning and teaching for the twenty-first century* pp.7-17. London: Institute of Education.

Kracher, A. (2002) 'Imposing Order: The varieties of anthropomorphism' *Studies in Science and Theology* 8 pp.239-261.

Lahtiranta, J. & Kimppa, K. (2006) 'The use of extremely anthropomorphized artefacts in medicine' *International Review of Information Ethics* 5(1) pp.13-18.

Lenzner, A., Schnotz, W. & Müller, A. (2013) 'The role of decorative pictures in learning' *Instructional Science* 41(5) pp.811-831.

Leventi-Perez, O. (2011) *Disney's portrayal of nonhuman animals in animated films between 2000 and 2010*. Published master's thesis. Georgia State University, Atlanta, GA, US.

Levie, H.W. & Lentz, R. (1982) 'Effects of text illustration: A review of research' *Educational Communication and Technology Journal* 30(4) pp.195-232.

Lowe, R. (2000) Visual Literacy and Learning in Science. *ERIC Digest*. Eric Database (ED463945). (10 March 2017).

Mayer, R.E. (2003) 'The promise of multimedia learning: Using the same instructional design methods across different media' *Learning and Instruction* 13(2) pp.125-139.

Mayer, R.E. (2010) 'Applying the science of learning to medical education' *Medical Education* 44(6) pp.543-549.

Mayer, R.E. & Estrella, G. (2014) 'Benefits of emotional design in multimedia instruction' *Learning and Instruction* 33 pp.171-173.

Muzumdar, J.M., Schommer, J.C., Hadsall, R.S. & Huh, J. (2013) 'Effects of anthropomorphic images and narration styles in promotional messages for generic prescription drugs' *Research in Social and Administrative Pharmacy* 9(1) pp.60-79.

National Breast Cancer Foundation, Inc. [NBCF]. (2012) *Radiation Therapy*. National Breast Cancer Foundation, Inc. www.nationalbreastcancer.org/breast-cancer-radiation-therapy (Accessed 30 July 2014).

National Cancer Institute at the National Institutes of Health. (2009) *About cancer*. www.cancer.gov/about-cancer/understanding/what-is-cancer (Accessed 5 August 2014).

Peeck, J. (1993) 'Increasing picture effects in learning from illustrated text' *Learning and Instruction* 3(3) pp.227-238.

Perry, E. & Donath, J. (2004) 'Anthropomorphic visualization: A new approach for depicting participants in online spaces' CHI'04 *Extended abstracts on human factors in computing systems* (April) pp.1115-1118. Vienna: ACM.

Plass, J.L., Heidig, S., Hayward, E.O., Homer, B.D. & Um, E. (2014) 'Emotional design in multimedia learning: Effects of shape and color on affect and learning' *Learning and Instruction* 29 pp.128-140.

Sahragard, R., Ahmadi, A. & Shalmani, H.B. (2016) 'On anthropomorphism in technology-enhanced language learning: Does modality matter in agent-based multimedia instruction on l2 idioms?' *Journal of Teaching Language Skills* 35(2) pp.123-160.

Samuels, J.S. (1970) 'Effects of pictures on learning to read, comprehension and attitudes' Review of Educational Research 40(3) pp.397-407.

Sankey, M.D., Birch, D. & Gardiner, M.W. (2011) 'The impact of multiple representations of content using multimedia on learning outcomes across learning styles and modal preferences' *International Journal of Education and Development using Information and Communication Technology 7*(3) pp.18-35.

Schneider, S., Nebel, S., Beege, M. & Rey, G.D. (2016) 'Anthropomorphism in decorative pictures: Benefit or harm for learning?' *Journal of Educational Psychology* 110(2) pp.218-232.

Solman, R.T., Singh, N.N. & Kehoe, E.J. (1992) 'Pictures block the learning of sightwords' *Educational Psychology* 12(2) pp.143-153.

Solman, R.T. & Wu, H. (1995) 'Pictures as feedback in single word learning' *Educational Psychology* 15(3) pp.227-244.

Sung, E. & Mayer, R.E. (2012) 'When graphics improve liking but not learning from online lessons' *Computers in Human Behavior* 28(5) pp.1618-1625.

Tatalovic, M. (2009) 'Science comics as tools for science education and communication: A brief, exploratory study' *Journal of Science Communication* 8(4) pp.1-17.

Triantos, A., Plakoyiannaki, E., Outra, E. & Petridis, N. (2016) 'Anthropomorphic packaging: Is there life on "Mars"?' *European Journal of Marketing* 50(1/2) pp.260-275.

Um, E.R., Plass, J.L., Hayward, E.O. & Homer, B.D. (2012) 'Emotional design in multimedia learning' *Journal of Educational Psychology* 104(2) pp.485-498.

Watts, M. & Bentley, D. (1991) 'An instructional man-trap: Anthropomorphic and animistic thoughts in constructivist science education' Annual Conference of the American Educational Research Association. 3-7 April. Chicago, IL, US.

World Health Organization (WHO). (n.d.) *Five keys to safer food poster.* Geneva. World Health Organization.

World Health Organization (WHO). (2006) *Five keys to safer food manual*. Geneva. World Health Organization.

Złotowski, J., Proudfoot, D., Yogeeswaran, K. & Bartneck, C. (2015) 'Anthropomorphism: Opportunities and challenges in human-robot interaction' *International Journal of Social Robotics 7*(3) pp.347-360.