‘Edutainment’: *Obtaining factual scientific knowledge from entertainment cartoons*

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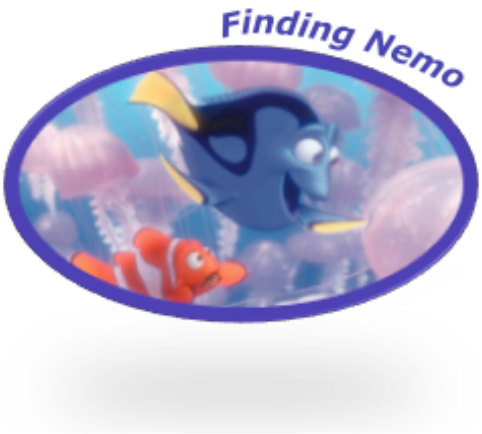

What we learn with pleasure we never forget.

~ Alfred Mercier ~

Abstract

This study aims to explore how people of different age groups learn, or perceive that they learn, biological science from entertainment cartoons.

There were two parts to this research. Firstly, an online survey was conducted, targeted towards all age groups (six to 65 years old; n=67), where respondents watched six two-minute video clips ranging from explicitly educational to pure entertainment and were asked questions about their preference and learning. Secondly, classroom-based research was conducted, where recall of scientific information was measured following the viewing of an entertainment cartoon clip (*Finding Nemo*) and live-action documentary (*Deep Jungle*) by 7-8 year olds (Year 3; n=24) and 10-11 year olds (Year 6; n=30), using pre- and post-viewing questionnaires and interviews.

The results, from the first part, suggest that whatever the age of the respondent, content (interest and information) is the most important aspect of enjoyment (and therefore learning) followed by format (style and tone). Results from the second part indicated that there were significant (Year 3, $p<0.05$; Year 6, $p<0.001$) gains in science knowledge after viewing by both year groups for the *Deep Jungle* clip, but not for *Finding Nemo*. Novelty and the students' belief that they were viewing a real situation played a large part in the recollection of scientific factual information. It was difficult for younger viewers to make inferences from cartoons; however when scientific facts were made explicit they were recalled better.

Results from this study suggest that the entertainment media has an important role to play in developing our scientific literacy and social learning, and young people and adults can learn science from entertainment cartoons.

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Contents

Chapter 1: Introduction

Working in creative science education, I have found that it can be useful to harness the power of the media to motivate young people to learn science or consider careers in science. With the number of young people studying for science degrees declining and the ever diminishing pool of scientific expertise in the UK, it would seem beneficial for teachers, scientists and media practitioners to work together to make science, technology, engineering and mathematics (STEM) more appealing to young people, as well as to indicate the advantages of having a general scientific knowledge.

1.1. The power of the media

The 'media' as a category includes broadcast (radio, television, cinema), print (literature, popular magazines, books, comics), electronic (video games, MP3s) and new media (Internet, Web 2.0[1] tools). For the purposes of my research I will concentrate on broadcast media, and in particular television and cinema.

One could argue that all television is educational, since we have the ability to subconsciously obtain knowledge from facts about the solar system to gender and racial stereotypes (Brown, 2008). Some organisations disseminate their messages through popular culture such as when Harvard Alcohol Project's National Designated Driver Campaign was included in *The Cosby Show* and *LA Law*, resulting in 97% of US 18-24 year olds being aware of the campaign within the first two years of operation (Kaiser Family Foundation, 2004). Choat and Griffin (1989) and Nightingale (2008) have suggested the great potential of television and cinema as an educational tool, especially since moving images can easily bring classroom subjects, such as history, to life. But even outside school, the potential informal learning from what children see in the media is the 'spontaneous, unstructured learning' that Coffield (2009, p. 9) talks about. Finding out how big the world is through the media can be humbling for young people (Reilly, 2007) and children will construct their own meaning and make connections based on what they understand from television and their past experiences (Turkle, 2007). Whilst news channels can lead to children being more fearful of terrorism and climate change (Reilly, 2007), the entertainment media may be having a greater impact on young people's learning and personalities. Some blame television and multimedia for the lack of communication amongst young people (Nolan and Darby, 2005; Byron, 2008), however the media can help promote scientific literacy and equip future scientists and citizens with the skills they need to critique and analyse new advances in science and technology (Bodmer, 1985).

Although programmes such as *Tomorrow's World*[2], *Horizon*[3], and more recently, *Brainiac*[4] and *Blast Lab*[5], can encourage people to learn more about science, and encourage scientific careers (such as ethnobotany in *Grow Your Own Drugs*[6]), it seems to be the fictional entertainment programmes which have the greatest effect on young people. *All Creatures Great and Small*[7], *ER*[8] and *CSI*[9] have contributed to the increased uptake of veterinary, medical and forensic science degrees respectively (Bone, 2004; Iddon, 2006). Popular shows now include scientists as main characters (*Friends*[10], *The Big Bang Theory*[11]), and whilst the storylines may have nothing to do with science, accurate science is often discussed by the characters.

In 1966 a survey showed that two thirds of people obtained their science news from television (Swallow, 1966). This reflects recent findings of the Eurobarometer report (Mochan, 2008) where documentaries presented by scientists rather than journalists (the former seen as more trustworthy, even though the latter made content easier to understand), were the preferred medium for obtaining information about science. Programme-makers often suggest that their films are about enthusing and challenging the viewers (Freeth, 2008) and to expose viewers to advances in science in the hope they will become motivated to learn more (British Science Association, 2008).

1.2. Where do ideas about science come from?

I have always been interested in where people get their ideas about science, and was surprised to find that facts discovered as a child can stay with people well into adulthood. A few years ago, at an event called 'Film and Phenomena' a clinical neuropsychologist, Dr. Sallie Baxendale, spoke about her research (Baxendale, 2004), warning doctors of Hollywood's misrepresentation of amnesia, and how patients believed what they saw. Even in cartoons.

Fig. 1. Scenes from *Nit-Witty Kitty*.

A *Tom and Jerry* cartoon (1951), *Nit-Witty Kitty*[12] (Fig. 1.) showed Tom losing his memory after being hit on the head, and start thinking he was a mouse. By hitting him again, he regained his memory and continued his feline behaviour of chasing Jerry. The family of some of Baxendale's head-trauma patients believed the same; their unfortunate loved one would regain their memory if they had another severe hit to their head. However, not all cartoons are inaccurate. Baxendale said that Dory, from Pixar's *Finding Nemo*[13] (Fig. 2.), was an accurate portrayal of someone with amnesia.

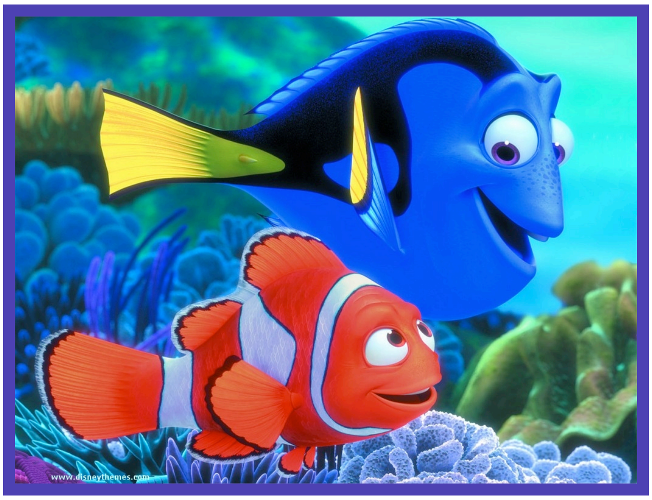


Fig. 2. Dory (above), and Marlin (below) from *Finding Nemo*.

This idea that people can gain knowledge from entertainment cartoons, led to my research interest. Can entertainment cartoons be educational? And what science knowledge can we gain from them? Before attempting to answer these questions, I must first make the distinction between 'animations' and 'entertainment cartoons'. Animations are popular in education, but are mainly animated computer graphics used to bring subjects to life, aid conceptual understanding such as electron flow and molecular movement (Yang *et al*., 2003; Frailich *et al*., 2007; Papageorgiou *et al*., 2008) or as interactive elements in games to teach aspects of science (Randomise[14]; Sandford *et al*., 2006). There are also educational cartoons. For the purposes of this research, I have defined educational cartoons as those where animated characters teach ideas and facts explicitly, whereas entertainment cartoons are those that young people would watch in their free time, purely for entertainment value, not to gain knowledge.

Children's and science programme-makers tell me that there is a marked difference between educational and entertainment programming in the UK and the USA (Swanson, 2007; Golia, 2008; Sanderson, 2008). US educational programmes (*Dragonfly TV*[15] and *Newton's Apple*[16]) could not work in the UK during a tea-time slot, as they seemed too 'good for you' for British children, whereas British factual television (*How2*[17]), was too entertaining to be taken seriously by Americans. In Britain, there are hardly any mainstream educational cartoons. British children's television is under extreme financial pressure and unless 'schools' programmes are made, tea-time programming consists of pure entertainment shows to attract ratings[18]. Entertainment cartoons in the US have a stronger educational slant than those in UK in order to catch a wider audience of children who could benefit from education by stealth.

1.3. Cartoons in education

Educational and science communication establishments have found a way to use children's entertainment media and cartoons to 'sell' their resources or products, such as the British Science Association's *Meet the Robinsons* competition[19] and The Institute for Civil Engineers' *Flushed Away* game[20] to encourage creativity and problem-solving. Animation companies have even taken on an educator's role. In the 1940s, at the request of the US government, Disney produced educational shorts on health issues for Latin Americans:

> *The pedagogical strategy used in these films is to didactically associate illness and poverty with particular bodily customs and health and prosperity with Western scientific standards of hygiene.*
>
> *(Cartwright and Goldfarb, 1994; p. 170)*

From personal experience I feel that cartoons do not need to be didactic to be educational. Entertainment cartoons can be just as educational. Colleagues have mentioned that cartoons such as *Asterix*[21] sparked an interest in how the Romans lived and resulted in frequent visits to Rome and Pompeii (de Jong, 2007). Cartoons introduced me to Western classical music, such as Wagner's *Ride of the Valkyries* in *What's Opera Doc?*[22] (Maltin, 1987) and Tchaikovsky's *The Nutcracker Suite* in Disney's 1940 feature, *Fantasia*[23] (Fig. 3.; Canemaker, 1996).

Fig. 3. Scenes from *Fantasia* (left) and *What's Opera Doc?* (right).

Other cartoons have brought famous literary pieces to young audiences, such as Looney Tunes' 1979 animation based on *A Christmas Carol*[24], and the cartoon series *Histeria!*[25], attempted to teach world history in a light-hearted manner. *Pinky and The Brain*[26] and *Futurama*[27] are written by those with doctorates in mathematics and quantum mechanics (Sanderson, 2009) which is why they feature many science in-jokes. But I have equally picked up on inaccuracies that I believed to be true. Cartoons such as *Alpine Climbers*[28], led me to believe that St. Bernard's dogs carried brandy in barrels around their necks to 'warm up' lost or injured explorers. However, it is known that alcohol would kill someone with hypothermia[29].

This is how my research interest began. Can people gain accurate scientific knowledge from entertainment cartoons, or is the information recalled purely pseudoscientific? Watching entertainment cartoons in preparation for this study made me realise how accurate cartoons can be. Cartoon DVDs now have accompanying educational material, for example *Ratatouille*'s *Remy: Your Friend the Rat*[30] contains information about rat species, the black plague and rat breeding, and *Finding Nemo*, as a film and its bonus DVD materials (*Exploring the Reef*[31]) have been used in educational projects to discuss ocean ecology (Haggerty, 2005).

Radford (2006) said 'it is more important to be right, but even more important to be read', but novelists, such as Lynda La Plante have mentioned that writing crime stories has become more difficult with the need to incorporate up-to-date information on forensic techniques[32]. Likewise, we could assume that cartoon writers and animators may have an innate desire to educate young audiences (and their parents), and disseminate accurate information in order to be credible. However the narrative will usually take precedence, which I will discuss in Chapter 2.

1.3.1. My categorisation of what we can learn from cartoons

It is possible that cartoons have much to teach us, and I wanted to test if this was true. Before beginning my research, I categorised some cartoons, and found that cartoons can:

- **Be character-building:** *Toy Story* (friendship, self-esteem), *Cars* (respect for elders), *Antz* ('think for yourself'), *Mulan* (skill, initiative, quick wit), *Captain Planet* (respect for the planet and other cultures), *Robots* (resilience, problem-solving), *Porco Rosso* (female engineer role models), *Wallace and Gromit*, *The Flintstones* (inventiveness, creativity; Fig. 4.).

Fig. 4. *The Flintstones*. Creative use of prehistoric animals in the kitchen (Mallory, 1999).

- **Provide accurate factual information (explicit):** *Valiant* (information about animals awarded for bravery in WWII), *Barnyard* ('If I have dairy, can I not be a vegan?'), *Meet the Robinsons* (accessing the hippocampus in the brain for memory), *Pinky and the Brain* (quantum physics, genetics), *Tarzan* ('Piranhas are native to South America'), *Hey Arnold!*, *Arthur*, *The Simpsons*[33] (any school-based cartoon often includes the teaching of accurate information).

- **Provide accurate information not spoken/written (implicit):** *Antz*, *A Bug's Life* (anatomically correct insects, surface tension of water, colony structure), *Ice Age* (evolution, climate change), *Bambi*, *Finding Nemo*, *Happy Feet* (animal behaviour), *Brother Bear* (salmon migration), *Osmosis Jones* (cells, motility), *Madagascar* (ring-tailed lemurs native to Madagascar), *Fantasia*, *The Cat Concerto* (classical music; Fig. 5.).

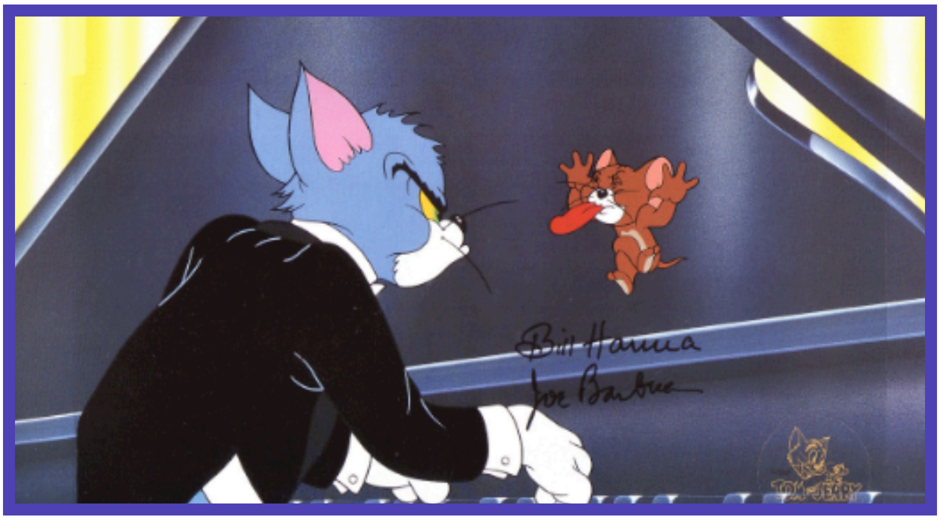


Fig. 5. Scene from *The Cat Concerto* (1946). Tom's finger-movements whilst playing classical music were accurate (Mallory, 1999).

- **Add to our imagination:** *Chicken Little* (UFOs, crop circles), *Meet the Robinsons* (time travel, inventions), *Wall-e*, *Jetsons*, *Futurama* (extrapolating current lifestyles to what they could be in the future).

- **Help us learn about literature/culture/traditions/folk stories/legend and myth:** *Alice in Wonderland* (Lewis Carroll's classic), *Spirited Away* (Japanese culture), *Ramayana* (Indian scriptures), *Prince of Egypt* (Biblical stories), *Cinderella* (fairytales), *The Raccoon and the Crawfish* (Native American folk stories).

- **Demonstrate inaccuracies/unbelievable situations for entertainment:** *Wile E. Coyote* (defying the laws of physics), *Barnyard* ('male cows' with udders), *Meet the Robinsons* (genetically-engineered frogs singing), *Kiki's Delivery Service*, *Sword in the Stone* (where magic is synonymous with science), *Cow and Chicken* (two different species as siblings), *Ratatouille* (a rat puppeteering a human) and other cartoons featuring speaking, singing and dancing animals.

- **Promote and challenge stereotypes:** Disney's Minnie Mouse as a domesticated female with Mickey Mouse doing the 'real work', Doctor Cockroach (*Monsters vs. Aliens*): 'brilliant, but mad scientist', *Mulan* (female warrior).

This last point could explain why students draw the stereotypical 'mad scientist' when asked (Balkwill, 2006; Frayling, 2006; Whitelegg *et al.*, 2008). However, whilst these images may be discouraging, young people support scientists:

> *Lots of cartoons have scientists in them and they are geeks, but they are not; they are just normal people…*
>
> *(Source: Armstrong, n.d.)*

1.4. My interest

Based on my interest in Baxendale's study (2004) and my work in creative science education and informal learning, I wanted to find out whether it is possible to gain accurate biological science knowledge from entertainment cartoons and if viewers prefer this genre as a source of learning? Or would people recall pseudoscientific facts, or other knowledge as mentioned in 1.3.1.

Although I am interested in learning informally from entertainment media, perhaps it can also play a part in motivating students to learn within formal science education? Science teachers have recognised the appeal of popular media to motivate students. Teachers such as Alan Liddell (2006) use clips from movies, such as *Predator*[34], as a hook at the start of a lesson to teach food chains and predator-prey relationships. His reason: 'If you can capture students in the first ten minutes you can teach them anything' (*ibid.*). This creative use of media within the classroom can promote curiosity through entertainment in the hope that the audience will be more receptive to the science content. Creativity in science education is important, and I shall discuss this further in the next chapter.

Chapter 2: Literature Review

Since my research is focused on the scientific knowledge gained from entertainment cartoons, it would be useful to discuss what constitutes learning, and in particular informal learning, since entertainment viewing occurs outside of the classroom. As Perales-Palacios and Vílchez-González (2005) explain, informal learning is what students 'acquire in a spontaneous way using different channels of information far removed from the mechanisms of formal education' (p. 1648). Although some say children waste their time watching television (Hughes, 2009), Perales-Palacios and Vílchez-González (2005) have described the importance of television and its possible use in developing scientific literacy. So, in agreement with Fisch (2004b), television can be thought of as an informal educator. Others have researched how children learn from a variety of sources outside school (Hofstein and Rosenfeld, 1996), and how these experiences can motivate children to learn science. I will discuss examples of these in this chapter.

2.1. What constitutes learning?

It is important to consider the work of cognitive development theorists to understand how and when learning develops. Jean Piaget's theories suggest that children's cognitive development must take place before any learning can take place, and that children cannot deal with certain concepts until a particular stage of mental development is reached (Parkinson, 2004). Young children (5-7 year olds) begin as egocentric (Driver, 1997), and what they know is all that matters (described as the pre-operational stage by Piaget; Parkinson, 2004). Our beliefs may grow with age, education and experiences (Lynch and McKenna, 1990), and between 8-14 years (Piaget describes this stage as early and mature concrete operational), a child's thinking becomes more logical. But young people often find prejudices from within the home interfering with their ability to form their own opinions from what they learn. This is known as proactive interference (Gibb, 2007) and is an example of Piaget's 'cognitive conflict' (Parkinson, 2004). Relating this to the viewing of media, by watching a variety of programmes a child's prior knowledge can be developed (promoting socio-constructivism; Donnelly, 2002), allowing them to assess what their own ideas are, based on the new information received.

This latter social aspect ties in with Lev Vygotsky's theory that social interaction can promote further cognitive development before a certain mental stage is reached (Parkinson, 2004). Vygotsky also describes the zone of proximal development (ZPD), which is the difference between unaided and aided learning (whether aided by teachers, friends, family, or even television). When a child has to think slightly higher than their developmental level, they will be thinking in their ZPD (*ibid*.). Programmes aimed at older children can possibly allow younger children to function in their ZPD.

Educational programming could fit in with David Ausubel's theory of learning, that learners are presented with information transmissively (Bennett, 2003), and television serves to explain this information to the viewer. I would argue that television viewing instead supports Jerome Bruner's theory of discovery learning (*ibid.*), since the learner is responsible for their own learning and establishing connections between what they already know and what they are gaining from television. Bruner (1977) has argued that 'any subject can be taught effectively in some intellectually honest form to any child at any stage of development' (*ibid*., p. 33), which is evident in McCrory's (2004) findings on 6-7 year olds' discussion of complex socio-scientific issues from the news media. This active process of 'making meaning' (Driver, 1994) by continually assessing and either accepting or rejecting information can result in learning we may not expect.

Piaget also looked at the balancing between two processes in learning: assimilation (how children break down information and interpret it within their current understanding) and accommodation (modifying their existing knowledge to accommodate new learning). Too much assimilation can lead to little learning, and too much accommodation can lead to confusion. This could explain why heavy television viewing can lead to misconceptions in science. Equally children may not grasp the subject knowledge at all, but instead pick up social knowledge, such as appropriate (or inappropriate) behaviour (Forge and Phemister, 1982; Sanson and Di Muccio, 1993).

How can television aid learning? Television in the classroom has always been a resource to aid visual representation (Fisch, 2004b) and to demonstrate experiments difficult to conduct in the classroom (Sewell, 2006). Television programmes, such as *Sesame Street*[35], can help children learn non-curricular subjects, or those that they may be taught later in their education (Fisch, 2004b). But whether it is an educational programme or not, it needs to be entertaining to grab the viewer's attention since no one will learn anything if they are not interested to begin with. There needs to be motivation to learn (Parkinson, 2004) for any learning to take place. And creative teaching has been shown to motivate children to learn.

2.2. Creativity in science teaching

As mentioned in the introduction, creativity in science teaching can bring many subjects to life, enhancing the motivation for students to learn. So if broadcast media has a role in educating viewers, should it not have a place in creative science teaching?

Creativity is difficult to define, as is evident from the special edition of School

Science Review[36]. I see creativity in science education in several forms: creative science teaching, linking sciences and the arts and the nature of science (creative problem-solving). Teaching creatively is defined as 'using imaginative approaches to make learning more interesting, exciting and effective' (NACCCE, 1999, p. 89), moving from the comfort of the curriculum and using 'wacky ideas' to inspire young minds (Wardle, 2009). Many organisations[37-41] are nurturing young people's creativity in all subjects including science, addressing the call by academics (Duggan and Gott, 2002) and policymakers (NACCCE, 1999) for the need to foster creativity in education, and therefore nurturing the creative workforce of the future.

There are many creative pedagogical approaches, for example, using props to teach mitosis (Watson, 2006), drama to stimulate scientific debate[42,43] (Littledyke, 2004; Nickerson, 2009) or filmmaking to teach and learn science topics[44,45]. Kempton (2004) found that his class enjoyed scientific discussion after watching a video, listening to a guest speaker or viewing cartoons. This increased motivation from creative teaching approaches can result in students wanting to stay after a lesson (Naylor and Keogh, 1999), and gaining new learning experiences that they may not have had otherwise.

However, some students are only enthused by the situational interest, for example, the use of the media clip (novelty) rather than the individual interest (subject area or content). It is possible that sustained situational interest can result in students developing a greater individual interest (Grant, 2005), but teachers often state there is not enough time to deliver the syllabus and can resort to non-creative, didactic teaching. This often results in rote learning and regurgitation by students in the quest for better examination grades (Parkinson, 2004; Longshaw, 2009). Yet more teachers want to experiment with novel teaching techniques having watched students become more engaged in lessons[46]. Yager and Tweed (1991) suggest that through creative science teaching students ask more questions, find science more accessible and have more ideas as a result of this newfound interest. Science embedded within entertainment programming could have the same effect. Torrance mentions five creative strengths (Kim, 2007), of which two are particularly poignant in both creative science teaching and entertainment cartoons: humour and storytelling.

2.2.1. Humour and fun (entertainment) in science

Although some feel that when science was optional it could be taught without 'entertainment' (Rowcliffe, 2004), many educators believe that we can motivate students of all ages to learn science through fun. Teachers often refer to popular media and websites, because school science is found to be dull otherwise (Appelbaum, 2001; Liddell, 2006) whereas others think education should not be fun at all (Teare, 2006; Devlin, 2007), and using humour is undignified (Fisher, 1997).

I agree with Hawkey (1998), that humour is particularly useful. It not only provides motivation for learning but can provide a relaxed environment therefore reinforcing the learning process itself (Maslow, 1970). There are three theories of humour (James, 2001 quoted in Rule and Auge, 2005): superiority theory (the belittling of an individual by someone who thinks themselves superior), relief theory (making light of a negative situation) and incongruity theory (wordplay, absurdity; which requires higher cognitive processing). The mental processes involved in understanding humour (for example, recognising the punchline), are the same as those involved in problem-solving, and therefore humour can reinforce these cognitive processes, therefore aiding learning.

Individual tastes matter in the case of humour. What an adult may find funny can result in groans or embarrassment from children (Kempton, 2004), and different age groups vary in what they find amusing. Older children find puns and insults amusing, whereas younger children prefer slapstick (Fisch, 2004a). Those who write for animation are aware of this, and cleverly weave layers of humour within the same scene to appeal to as wider audience as possible (Ferris, 2007). Humour is equally important in the classroom, as it has positive effects on attention, (students need to pay attention to understand the jokes) attitude and engagement, especially when combined with cartoons for teaching difficult subjects (Rule and Auge, 2005). Humour can inspire and motivate by breaking the tension and decreasing anxiety (Guthrie, 1999 quoted in Rule and Auge, 2005) therefore resulting in meaningful learning.

Creative teaching techniques can make dull topics fun (Manning *et al*., 2009). But children will notice if subjects are 'dressed up' as fun. This can lead to negative reinforcement (Appelbaum, 2001). Students may be switched off science if they believe fun elements have been added to boring topics (known as extrinsic motivation), and this can lead to associating 'fun' with 'boring'. This could be why fun starters can successfully engage students to begin with, but then lead to boredom. Boredom can then lead to misbehaviour (Cowley, 2003) and no meaningful learning can take place. However, fun as an intrinsic motivation, can lead to attentive students who do not realise that they are learning. This can be extremely powerful, although ethically, it may feel like tricking the students (Appelbaum, 2001).

2.2.2. The importance of narrative

Storytelling may be seen as a passive learning technique, but we must not underestimate how engaging a powerful narrative can be, especially within broadcast media.

Within science communication, event organisers have used popular fiction such as *Harry Potter*[47] and *Godzilla*[48] to attract audiences. According to Bruner (1986 quoted in Avraamidou and Osborne, 2009) we order our experiences based on reason and logic (paradigmatic) or by making stories (narrative); therefore storytelling is a particularly powerful and creative technique when embedded in science education. Stories can help spark curiosity in children, help them make sense of the world around them, show them how science is integrated in their lives and motivate them to learn (Dagher and Ford, 2005; Bage and Turner, 2006; Dunne, 2006; McCullagh, 2009; Sherborne, 2009).

Storytelling may promote socio-constructivism in as much as teachers can encourage imagination and thought drawing upon the learner's background and experiences so that they will be better able to understand the science. So why are we more likely to remember, and therefore 'learn' the science embedded within a story? The answer lies in emotions and the brain (Fisch, 2004b; Rowcliffe, 2004). Emotional scenes in movies can trigger the release of noradrenaline in the amygdala (part of the limbic system in the brain) and this improves memory at that particular time. Moderate emotion-causing (even novel) events are better remembered than neutral ones (Gibb, 2007). Therefore we remember stories and films better if we have been emotionally affected by them. This can improve both our declarative (explicit: about facts and events) and procedural (implicit: applies to habits and skills) memories (Kandel, 2008). Declarative memories are made through conscious attention as in discussion and rote learning, which is why we are more likely to forget these. Procedural memories occur as a result of no conscious attention, which could explain how children pick up information from entertainment media without realising, such as becoming more aggressive following the viewing of violence on television (Feshbach, 1972; Bandura, 1986).

2.3. The use of cartoons in science education

There has been no research on children's perceptions and understanding of biological science from entertainment cartoons, or even what knowledge adults gain from cartoons. Most studies have described the use of cartoons and movies to motivate students to engage with science[49] (Haggerty, 2005), to stimulate the discussion of socio-scientific issues (Kempton, 2004) or as a didactic tool to teach physics (Perales-Palacios and Vílchez-González, 2005). Other research papers and popular books (Halpern, 2007; Meskill, 2007) have looked at cartoon families, such as *The Simpsons*, as comparative parodies to real-life and education in the USA with some references to science. Interestingly, Perales-Palacios and Vílchez-González (2005) and Blickenstaff (2009) have shown that misconceptions about physics can occur from watching entertainment cartoons, therefore supporting Baxendale's (2004) study mentioned earlier (see 1.2.).

There is limited research on understanding physical science from cartoons. Fisch *et al.* (1997) describes an educational cartoon *Cro*[50], about an 11-year-old prehistoric boy (based on Cro-Magnon man) who creatively solves scientific problems. It was a humorous adventure cartoon broadcast on a Saturday morning trying to appeal to the broadest school-aged audience (Fisch, 2004b), especially those who would not usually watch a programme about science and technology. I agree with Fisch (*ibid.*) that there is a definite relationship between appeal and comprehension, as I have experienced this running practical cell biology workshops with an entrepreneurial aspect based on *The Apprentice*[51]. The teachers expressed how students were more motivated to learn new biological information during this activity.

Since television viewing is voluntary, and cartoons are ‘cool’ media (McLuhan, 2003), that is, requiring much of the viewer’s mental effort to make meaning, we need to understand what makes someone want to watch a cartoon? Intriguingly, some of the characteristics that make one science programme more effective than another (Fisch, 2004b), I feel are the same characteristics that would make an entertainment cartoon effective as an educational programme. These are: action-based rather than static visuals (or talking-heads); age-appropriate language and humour; identifiable and appealing characters; simple narrative, linearly and temporally ordered; and topics which are inherently interesting and relevant. These points also mirror the reasons given for why certain stories work in the development of creative curricula (Sherborne, 2009). However, there is a reason why entertainment cartoons may not always result in learning. In educational programming there is a need to closely weave the educational content into the narrative, therefore it is important to consider what Fisch (2000) refers to as the ‘capacity model’.

2.4. The capacity model

Cognitive psychologists describe the working memory as how information is stored and used in the short-term. Working memory is important in problem-solving and understanding, but its capacity is limited during viewing. Viewers cannot control the pace at which information is relayed to them from the television (unlike with books; Fisch, 2004a), therefore there is a demand on the working memory, and comprehension can be impaired. As similar processes (accessing prior knowledge and drawing inferences) are used in the working memory to understand narrative and educational content, there is competition as to which should be cognitively processed. The closer the narrative and educational content are interlinked, the more likely that both will be understood by the viewer. If the educational content is tangential to the narrative (i.e. does not contribute to the progression of the story), narrative dominance occurs in the working memory and only the narrative is processed and retained. However, if the viewer is watching to learn (or to be tested), narrative dominance could be overridden, so educational content will be cognitively processed and retained in the memory.

This could explain why it may be difficult to learn science from entertainment cartoons, as the factual information is not made explicit. The narrative and characterisation is uppermost in an animator's mind instead. Humour, narrative and dialogue can distract viewers from the educational content in poorly prepared educational programmes. But educational content within entertainment programming is only an added extra, so it would not matter to the creators if the humour, narrative or dialogue grabbed the viewer's attention more. Variation in the auditory stimuli (music, tempo, lyrics and rhyme) can capture the attention and aid learning (Amitay, 2007). Again, a distraction to learning can occur when the visual images do not match the audio. Here, viewers will take away only the images due to the visual superiority hypothesis (Fisch, 2004b). This can be a problem when the visuals are more engaging than the audio commentary in the case of entertainment cartoons that embed educational content within the soundtrack. However Fisch (2004a) has found that children's reactions to television series depend less on format (style, imagery) and more on content. An exciting animated show with the characteristics described here (and in 2.3.) will hold the viewers' attention more than a dull live-action show. Equally, an exciting live-action show will be more engaging than a dull cartoon (*ibid*.). But if the style is live-action, does reality play a part in children's learning? How do children discriminate what is real from what is not real on television?

2.5. What is real?

Animators often bring wild animals into their animation studios to capture realism (Canemaker, 1996) therefore cartoons could provide a 'magic window' to the real world (Hawkins, 1977). However, *Happy Feet*[52] and *Finding Nemo* may depict accurate penguin behaviour and marine life respectively, but do penguins tap dance and fish speak? Anthropomorphism is often frowned upon in science education, such as atoms 'getting married' to describe a chemical reaction (Rowcliffe, 2004), but anthropomorphic characters in cartoons could actually help students learn salient points delivered within conversations (Haggerty, 2005).

The more fantastical the cartoons are, the more likely children are able to discriminate that the cartoon world is unreal. The need to dissociate real from non-real is a genuine concern for 6-12 year olds (Hodge and Tripp, 1986; Allen, 1992). Even then, Fisch *et al.* (1997) found that viewers were unable to distinguish between real science and pseudoscience in cartoons such as *The Flintstones*. In Hodge and Tripp's (1986) study, 6-8 year olds preferred cartoons, whereas 9-12 year olds preferred television dramas, suggesting that as children become older they choose to view more realistic programmes. Children understand what is real based on 'modality judgements' (Chandler, 1997). If a programme and real-life are very different, the programme is said to have a weak modality. Therefore often cartoons have a weak modality, but movies such as *Finding Nemo* would be stronger than say, *Shark Tale*[53], as the former is more true to life than the latter. At the age of 7-8 years old, the verisimilitude to life is an important factor, which is why some children of this age group chose *Superman* as more real than *Charlie Brown*[54] (Kelly, 1981), and children in lower socio-economic groups believed that *Sesame Street* actually exists (Nikken and Peeters, 1988).

Hawkins (1977) refers to the 'magic window' (how much a child believes they are watching real-life on television) and 'social expectations' (whether a child believes that television programmes match their understanding of real-life or not). Understanding what is real relates to a basic Piagetian framework of cognitive development, that children's understanding becomes more sophisticated with age. Children can only understand what is real on television once they understand what is real in the world. By the age of four, children realise that what is seen on television is an 'absent reality', for example a bowl of popcorn viewed on television will not move if the television set is moved (Flavell *et al*. 1990), and that what they see is a separate world which cannot be influenced by them (Jaglom and Gardner, 1981a; 1981b). Very young children begin at the high end of 'magic window' status believing everything on television to be real (Fitch, 1993), but start to discriminate better by the age of 8 (Hawkins, 1977; Dorr, 1983). By the age of 10, children are reasoning like adults (Fitch, 1993), and by 11-12 years old, they ask the researchers to specify, as adults would, what they mean by 'real' (Kelly, 1981). Older children are also more aware of performance features, for example, scripts, authors, actors, plots and fiction, as well as fiction based on fact (*ibid*.), whereas younger children are more likely to only deem television programmes as unreal based on physical features: stunts, video trickery or costumes.

Dorr (1983) has suggested more criteria by which children assess reality: physical actuality (if children know someone or something exists in the real world, then when it is seen on television, it must be real); possibility (children extrapolate their own knowledge i.e. since we cannot fly, someone flying on television is not possible) and plausibility (children assess what is seen on television as 'true to life' based on their own or their peers' prior experiences. This latter criteria supports the social learning theory as described by Vygotsky (Parkinson, 2004) and Bandura (1986) i.e. learning from the behaviours and experiences of others. Plausibility is more common with older children and adults (Kelly, 1981) to the point of neglecting the first two criteria when determining the reality status of television programmes. Some children judge programmes as real if they enjoyed it, whereas others feel that if a programme was funny, it could not be real (Howard, 1993). Often programmes were regarded as realistic if it taught children something and learning was one of their motives for watching (*ibid.*).

2.6. Justifying my research

Past research by educational programmers concentrates on what children learn from television and how to improve their programmes (Fisch, 1997). There is no research where children have been asked about biological science knowledge that they have learnt from entertainment cartoons or their preferences for the types of programmes they would like to learn from. I decided to use a survey to discover people's perceptions about learning science from the entertainment media in general, and classroom-based research to delve further into how young people learn from entertainment clips whether animated or live-action. My research builds on previous studies (described in this chapter), but is unique in that I am researching adults' perceptions as well. I wanted to know what kinds of programmes people (children and adults) like to watch in their spare time and why (for entertainment or to learn from), and whether anyone has ever gained accurate information from an entertainment cartoon before, and if so, does this compare to my categories given in 1.3.1? And when shown a live-action documentary and an entertainment cartoon both containing accurate biological science, which one would people learn the most from, and is this related to what they believe to be real?

The various methods and methodologies used will be described in Chapter 3.

Chapter 3: Methodologies

My research plan draws on the methods of Fisch *et al.* (1997), Clifford *et al.* (1997) and McCrory (2004) as well as novel techniques using multimedia as a complementary approach of ICT for data collection. There are two aspects to my study: a survey approach and an ethnographic approach. The online survey enabled me to quickly gain many responses, whereas the ethnographic approach allowed me to see the world from the children's perspective and question and observe them in their classroom environment to find out more about their preferences when learning about science.

3.1. Online survey

I decided to use Web 2.0 technologies (Placing, 2005; Tan and Koh, 2008) to elicit people's opinions on what kinds of programme they preferred to watch and whether they found any of these enjoyable and/or educational. As most people have access to broadband Internet connections, I decided to utilise freely available software to produce a weblog ('blog') and an online form in my positivist approach to this research.

A blog is often referred to as 'personal publishing' (Downes, 2004), but here I was using a blog[55] as an online area to host media clips and a questionnaire. Whilst there are studies where such technologies have been used as a research tool (Kraut *et al*., 2004; Downing and Clark, 2007), I am unaware of any science education research project using blogs with embedded media and online surveys for collecting data. Blogs also allow for visitors to comment, for a wide audience to be reached (all ages, backgrounds and geographical locations) and quicker returns (Downing and Clark, 2007) than postal surveying. Judging by the websites that young people are familiar with[56] (McCrory, 2004) they are confident about answering and commenting online. As I am not a teacher myself, I felt that this web-based research approach would be manageable within the constraints of an MA research project and working full-time.

The aim of the online questionnaire was to find out what people prefer to watch, their perceptions about learning and whether choices varied amongst age groups. I wanted to know whether people were likely to watch what they enjoy, or what they can learn from, and whether this compared with their answers for their favourite clip. This method also gave me the opportunity to ask as many adults as possible if they had ever learnt anything from an entertainment cartoon.

3.1.1. Data sources

I contacted science and educational professionals via the British Interactive Group[57] Chat e-list, PSCI-COM[58] e-list, Planet Science e-newsletters[59] as well as personal contacts, asking them to take part in an online survey. I received a strong response rate for the questionnaires (n=67) probably because I did not pick one particular group to focus on, for example, only teachers. The age range of contributors was six to 65 years old. Although the questionnaire did not ask for many personal details, the population was mixed in terms of gender (determined from names), geographical location (some mentioned their place of work, or country) and educational background (determined from age range or responses).

3.1.2. Design and pilot activities

YouTube[60] is a widely used media dissemination platform, even in educational settings (Klaebe and Bolland, 2007). Using the site I sourced six two-minute video clips, chosen to be as diverse as possible in terms of educational content and entertainment value (Table 1).

Table 1. Reasons for choosing the film clips for the online survey.

Film clip	**Genre**	**Reason this clip was chosen**
Pixar's *Finding Nemo*[61]	Entertainment animation	Explicit information - Marlin explains that as a clownfish living in anemones he is not affected by jellyfish.
BBC's *The Life of Birds*: *The Lyre Bird*[62]	Live documentary	Entertaining and educational - A bird that mimics sounds.
Warner Bros' *Happy Feet*[63]	Entertainment animation	Implicit information - The behaviour of penguins, the birth of Mumble and how his father looks after him.
Aardman Animation's *Creature Comforts*[64]	Entertainment animation	No educational benefit - Insects and animals playing sports.
National Geographic's *Bedbugs*[65]	Live documentary	Educational, not very entertaining - Facts about bedbugs.
MediaSemantics' *Photosynthesis*[66]	Educational animation	Didactic presentation – Facts on photosynthesis.

I set up an online form using *Wufoo*[67], for adults and children, designed to elicit responses representative of the wider population. As it was online I did not need to have direct access to the respondents thus saving on printing and postage costs. The questions were kept as simple as possible, with no jargon or difficult instructions of how to answer the questions. I asked friends and colleagues working in schools, science education, filmmaking, communications technology and public relations to trial the questionnaire (henceforth known as 'triallers') to see if it was pitched right, clear and appealing or boring and time-consuming, and whether it would be easy to code and analyse. One of these triallers did not agree with my reasoning stating that, as *Finding Nemo*, *Happy Feet* and *Creature Comforts* were all entertainment cartoons, only one was needed to demonstrate the genre and therefore the time taken to fill out the survey could have been reduced. I wanted to use all three, as they exemplified explicit, implicit and no educational information respectively. Most triallers stated that watching the clips and answering the questionnaire took no longer than 30 minutes.

It was also important to check for technical issues. As I was working on an Apple Mac, it was essential to ask colleagues working on PCs to check if the blog appeared exactly as I was seeing it, before announcing the link to the wider public. I made sure that the questions were embedded into the blog to the right-hand side of the video clips to make it easy for respondents, but also provided a hyperlink to the online form in case of any difficulties in viewing the form within the blog. It was important to get as many returns to the questionnaire as quickly as possible since *YouTube* is user-generated, and authors can decide to delete their videos at any time.

3.1.3. Data collection methods

I e-mailed the blog link to various networks (see 3.1.1.) with instructions and left the site live for four months (sending reminders in between) until I was ready to collate the responses. Subject recruitment here can be described as snowball sampling, since colleagues forwarded the link to others (see 3.1.4.). Whilst there was no real benefit for the respondents, many said it was an enjoyable survey linking multimedia clips and short questions (Martin, 2008; Sheikh, 2008).

The *Wufoo* system made data collection at any point in time simple: all responses could be exported straight into a Microsoft Excel spreadsheet.

3.1.4. Validity and reliability

Since the networks I approached to take part in the survey were predominantly science-based, this could be seen as a biased sample. However, some personal contacts have non-scientific backgrounds and forwarded the link to their colleagues (whose backgrounds I was unaware of).

3.1.5. Ethical considerations

All those who took part received details about the nature of my research, my background, what I required from them and a guarantee of confidentiality (Appendix 3).

There is still debate over copyright issues of *YouTube* clips, however since they are in the public domain there were no issues with regards to educational usage (Klaebe and Bolland, 2007).

3.1.6. Data analysis approaches

Self-completion questionnaires may be easier to score if the questions are closed, structured or multiple-choice, but this can lead to bias as answers would be restricted by pre-determined choices (Aikenhead *et al*., 1987 and Solomon *et al*., 1994). Answers to open questions are more difficult to code and interpret, but often result in richer responses (Cohen and Manion, 1994). My questionnaire contained a combination of closed and open response questions: some were 'tick-box' to conduct frequency counts and quickly gain quantitative data about people's clip preferences; others were open to get a better idea of respondents' reasons for their choices. Open questions were useful to find out if any of the respondents mentioned the categories as their reasons for why they liked/disliked a clip (Tables 2 and 3) or what they had learnt from a cartoon clip (see 1.3.1.). The incidence of these categories mentioned within responses were counted (or converted to a percentage).

Spearman's Rank Correlation analyses were performed to see if there was a correlation between the clips people learnt the most from and what they would watch in their spare time.

For the open-ended questions, I did not prepare anticipated responses as the answers would be based on respondents' opinions. Instead I mapped out the coding scheme after examining the responses (and checked this with triallers), to ensure that all responses could be accounted for. These categories are given in Tables 2 and 3. Categories 5-8 turned out to be almost the exact negative of categories 1-4.

Table 2. Categorising what respondents liked about the clip they chose as their favourite.

Category	**Respondent answers used for coding**
1. Informative	Factual, correct information, believable situation, learnt something new, educational
2. Entertaining	Excitement, drama, story, humour
3. Style and Tone	Dialogue, interaction, animation, filming, easy to understand, quality of presentation
4. Interesting/Inspiring	Relevant to job or background, subject matter, astonishment, fascination

Table 3. Categorising what respondents did not like about the clip they chose as their worst.

Category	**Respondent answers used for coding**
5. Not informative	Misleading information, fictional, not useful, nothing new learnt, forgettable
6. Boring	Dull, did not keep attention, slow and no story, drama or humour
7. Style and Tone	Didactic, patronising, no detail, difficult to understand, distracting elements, poor quality of presentation, too much information
8. Personal dislike	Unpleasant, disgusting, scary, silly, American, sexist, sensationalist, violent

Although there was a strong response rate to the online questionnaire (n=67), there were few responses from those who were of school-going age. Sites such as *YouTube* are blocked in schools so young people may not have had access to the questionnaire unless they were at home. Since the cartoon-watching population is composed mainly of young school-aged children, to make my study more relevant I wanted to undertake some classroom-based research. This enabled me to study further what science young people (in primary school) think they can learn from entertainment cartoons.

3.2. Classroom-based research

The aim of the classroom-based research was to build upon the online survey, but measure the learning gained from entertainment clips. I wanted to know whether young people could access accurate biological information from the clips, and whether more scientific factual information could be gained after viewing an entertainment cartoon than a live-action documentary. Would older students (10-11 year olds) be better able to recall knowledge than younger students (7-8 year olds)? And which clip would young people believe more?

My initial plan was to compare children's recall of biological knowledge from clips of cartoons that were immediately comparable to live-action documentaries, (such as *Happy Feet* to Luc Jacquet's *March of the Penguins*[68]) and determine which source gave rise to students' accumulation of scientific factual information more. Sourcing short, suitable clips proved difficult and since the clips would contain similar information but in different formats it would be difficult to know which clip students were obtaining their knowledge from. I wanted to know about preference of format and whether factual information is better recalled as a result of this preference (and therefore enjoyment). Using different test subjects could overcome this (i.e. one class could watch the live-action, another class watch the cartoon clip), but then age would have been the only constant variable. Instead I decided to use the same test subjects, and two different formats and subjects, to find out which one young people learnt the most from.

3.2.1. Data sources

I worked with a local primary school in Hertfordshire (predominantly caucasian, middle-class background), that I had visited on previous occasions. I had the opportunity to describe my research project to the teachers and students, and what I was hoping to get them involved in. I decided for a cross-age study, comparing two year groups at either end of primary education, to gain answers from students with different levels of educational and social experience but a similar potential level of development according to Piaget (Parkinson, 2004). The test subjects were two classes of children: one Year 3 group (aged 7-8) and one Year 6 (aged 10-11). The Year 3 class consisted of 27 students, but only 24 were tested as some were away on the day one of the questionnaires was administered. Ten girls and 14 boys made up the 24 students. The Year 6 class consisted of 30 students, evenly split between males and females.

Teachers were interviewed prior to testing to glean background information about each class (Appendix 7). It was also useful to ask teachers for specific details such as whether students were scared of spiders and to obtain feedback on the questionnaires. The teachers were extremely supportive and felt that my research would give them a better insight into how their students learn about science out of school and the media formats they enjoy learning from.

Literacy levels of the Year 3 students varied tremendously, from a high level 4 (average for Year 6) to high level 1 (two years below average). The literacy levels in Year 6 were extremely variable too: from Level 2 (infant school level) to a high Level 5. Lower-achieving readers had teaching assistants to help them during this study, however the teachers felt it would be difficult for some of those with special education needs to take part. There were no students with English as an additional language, so the teachers felt that students would have no difficulties in understanding the dialogue in the video clips.

Nationally, as a school the students were well above average for science, with 76% of students achieving level 5, the top bracket for science. The Year 3 teacher said that they make sure there is a high quality of science teaching throughout the school, including the provision of enrichment activities throughout National Science and Engineering Week[69]. The students in Year 6 had already studied about the rainforest during lesson time such as adaptation, environment, oxygen from plants, carbon dioxide and some information about oceans.

The teachers said that video clips and other media (such as radio broadcasts) were used in class once a fortnight to add variety to lessons. Programmes around 20-30 minutes long helped bring historical subjects to life, such as World War II, or gave students a sense of space and size, such as panoramic views of the rainforest, as described earlier (see 1.1.). Year 6 students were often asked to make notes so that they had a purpose to viewing and listening. Both teachers said that their classes had a good attention span, so clips of 15-20 minutes would be ideal. Interactive whiteboards, laptops and DVD players were used frequently in the classroom, so children were familiar with new technologies. This meant that my use of such technologies would not be novel to the students and affect their learning, but instead aid engagement (Beauchamp and Parkinson, 2005). The Year 6 teacher noted that her students would talk about *I'm a Celebrity*[70], *Doctor Who*[71] and *Friends* during class and break times. Overall, all but three of the 54 Year 3 and Year 6 students tested had a television set in their room, suggesting heavy television viewing.

3.2.2. Design and pilot activities

Preparation for this project (sourcing relevant clips from DVDs, devising the questionnaires and trialling and liaising with colleagues and teachers) took two months.

It was important to use a live-action clip which was not didactic or interview-style (as this would be too obviously 'educational'), and to use two clips which had significantly different information so that I would know which clip gave rise to the most learning. I had decided on Pixar's *Finding Nemo* as the entertainment cartoon, and then sourced a clip from BBC Worldwide's *Deep Jungle*[72] about the Brazil nut tree and associated wildlife (Table 4). *Finding Nemo* may be well-known amongst the school-going population, but it was the only cartoon I found with a 20-minute clip containing sufficient factual information to base questions on.

Table 4. Description of the two clips chosen for the classroom-based research.

Film	**Genre and other information**	**Content in the chosen 20-minute clip**
***Finding Nemo* (2003)**	Computer-generated animation (USA), fictional story with celebrity voices given to characters. Not explicitly educational, but accurate marine biology is referred to.	Clownfish, sea turtles, anemones, sharks, memory-loss, predator-prey relationships, different marine species.
***Deep Jungle* (2005)**	Live-action documentary (UK), narrated by Scottish actor, John Hannah. Educational but not directed at schools (educational resources were developed as a consequence of the programme[73]).	Amazon rainforest, Brazil nut tree, seed pod dispersal, germination, spiders, legend of the chicken-eating spider, scientific research, historical references and re-enactments.

Both programmes could be watched in the comfort of one's own home as entertainment. The clips were not explicitly educational and contained significantly entertaining and emotion-inducing scenes in integral to the narrative, not as an extrinsic motivation for viewing (Appelbaum, 2001) and triallers agreed with me. I hoped this would result in remembering factual information for recall later (see 2.2.2.). Not only was one clip an animation and the other live-action, the former contained believable material (where clownfish live) and the latter contained non-believable material (reconstruction of a chicken-eating spider). As mentioned earlier, I wanted to find out if the children would believe the accurate parts, and whether live-action made a clip more believable. Would children use their own plausible experiences to explain their understanding (see 2.5.)?

It was important to find out prior viewing information in case students' information recall was because of having seen the clip previously. For example, if students got more sea-life questions correct on pre-viewing, perhaps it was because they had seen *Finding Nemo* before. Anecdotal evidence from one of the trialler's parents suggests this was possible:

> *He said he knew all the answers from* Finding Nemo*.*

Several questions were formulated (Appendices 8 and 9) based on the content of each clip, for example, 'where do clownfish live and why?' I had an idea about the kinds of answers to expect, (Appendix 10) and verified the questions and answers with colleagues working in the fields covered by both clips and by using various websites[74,75]. I made a note of the answers based on the clips, but only developed my hierarchical marking scheme to determine learning after collecting in the responses, and authenticating the answers in my discussions with the teachers. The questions had to enable me to discover how much factual knowledge children could recall immediately (rather than comprehend and retain over time), either from the visuals or audio in the film clips. I also wanted to gauge what they believed to be true, which would help demonstrate the potential for entertainment media in developing individuals' scientific literacy. I made sure the questions were as mixed as possible: open-ended, closed and multiple-choice (see 3.1.6). Multiple-choice questions can also indicate guesswork if answers are different in the pre- and post-viewing questionnaires. Two questions were pictorial multiple-choice questions. The choices given in these questions represented species which appeared in each clip, but asked for one specific organism to be named. This helped me find out whether students had paid attention to the clip, or just ticked the creature they remembered seeing (Appendix 8), therefore cognitively processing the visuals more actively than the scientific facts from the narration (see 2.4.).

It was important to trial the questionnaire as it was difficult to know what students might misinterpret because of issues with language and level. I contacted science networks (see 3.1.1.) asking for those who had children in Year 3 or Year 6. Several parents responded, and eight children took part and gave me constructive feedback. These young triallers were asked to fill in the questionnaire as best as they could as all I needed to know was whether they understood the questions and instructions. In the end, only a few words needed changing so that the questions were comprehensible.

3.2.3. Data collection methods: Questionnaires and observations

I gave out the pre-viewing questionnaire for both year groups to test prior knowledge of marine and rainforest ecosystems. It took longer for the younger group to complete, and help was at hand for any individuals with reading difficulties. It was the last Friday before spring half-term and non-uniform day.

The week after half-term, I returned to the school and showed each year group the two clips. Whilst the students were watching the clips, I made a few salient observations of their non-verbal behaviour.

Previous studies have shown that video clips are not always useful in the classroom (McCrory, 2004), as students need to view clips several times to pick up relevant information. As my research was attempting to mimic how young people watch cartoons in their spare time, I did not stop and start the DVD with time for questioning, as teachers would do when using educational videos (Fisch *et al.*, 1997). Children are unlikely to rewind and watch a segment again when viewing at home, unless they felt they had missed something integral to the plotline (as opposed to overlooking some inherent educational information).

I immediately administered the post-viewing questionnaire. I was concerned that eager students may have found out more about the topics in the period between the pre- and post-viewing questionnaires being administered. The teachers assured me that students did not ask anything between my visits and perhaps because it was half-term they had forgotten about the project. However, students were eager to know their results, so I returned to the school to give feedback which I will discuss in Chapter 5.

3.2.4. Data collection methods: Interviews

As it is difficult to know whether young respondents truly understand the questions in questionnaires, interviews can help clarify the answers given (McCrory, 2004). So I decided to interview some students. The day after the students had viewed the clip and answered the post-viewing questionnaire, I conducted two semi-structured small group interviews (a maximum duration of 25 minutes each). Four students from each year group were interviewed to find out what they thought about each clip and their general viewing habits and preferences. I asked the teachers to choose these students to ensure a mixed group (two boys and two girls; as McCrory (2004)), who were neither too nervous nor too overpowering when voicing their opinions.

The interview schedule (Appendix 11) asked for children's ages, names, what they liked/disliked and why, which clip they had learnt the most from, questions based on content, what they may have learnt from a cartoon and what kind of science programme they would produce if they could. Each child was asked to rate each clip on its appeal using a Likert scale as modified from Fisch *et al.* (1997). I asked several contacts with young children whether their own children would understand how to rate clips on a scale of 1 to 5. Most suggested a pictorial representation, as it would be difficult for Year 3 students to understand '2' and '4' on a scale. So I used a 'smiley face' and 'thumbs up/down' system.

The interviews were conducted in the school's quiet reading area, away from normal lessons and recorded using an iPod and voice memo adapter so that audio files could be saved onto the computer. I asked for advice from colleagues and the teachers about the questions, but in retrospect I feel that I should have trialled the interview questions to gain a better technique. I had already established a good rapport with the students, so when I wanted them to expand upon their answers it was difficult to keep them focused and prevent it becoming a non-directive interview (Cohen and Manion, 1994). For this reason I have not transcribed and coded the interviews; instead I have picked up on some of the important quotes and issues which arose, as agreed with colleagues. The informality of the interview was still useful as it became a natural conversation; less about what I was hoping the students would say (as described in Cohen and Manion, 1994) and more about exploring what the students thought of the clips, what they felt they may have learnt and which formats they preferred.

3.2.5. Validity and reliability

Ideally I would have liked to commission my own cartoon as others have done (Lloyd, 2008), to have greater control over the content and educational and/or entertainment value, and so that students would have had no prior exposure to the clip. This would have been difficult within the constraints of an MA research project.

Before giving out the pre-viewing questionnaire, I reassured students that this was not a test; it was to find out how much they already knew and it did not matter if they got the answers right or wrong. This was important, as fear of failure is a disparaging consequence of testing in class and in research (McCrory, 2004). Even then, children asked me afterwards how many they got right, as seen in other studies (Himmelweit *et al.*, 1958), where children are concerned with what the teacher or researcher may think. Because of this anxiety, in some cases it was difficult to prevent students copying each other's answers.

There was some rumour bias (*ibid*.), since the teacher had alerted them prior to my arrival that they would be shown video clips and asked questions on them. I made sure students knew what I was researching, and those who were interviewed knew that they were being recorded. However there was no rumour bias in terms of being primed by predecessors for the interviews, as I interviewed one group from each year straight after the other, leaving no time for them to share information.

As suggested by Himmelweit *et al.* (1958) I added an extra question about oceans, not related to the two clips, to find out if the students were answering at random, or had done some extra research between my visits. It was also important to keep the questions in both questionnaires exactly the same. I could not ask in the post-viewing questionnaire, 'what did you learn about where clownfish live from the *Finding Nemo* clip?' as this would be different to the pre-viewing questionnaire question (see 3.2.2.). The way in which questions were interpreted was left to the students and was not for me to influence this. To make sure that I was not biased when choosing quotes to discuss in the results chapter, I consulted the triallers.

3.2.6. Ethical considerations

There were a number of ethical issues to take into consideration during my research. As I am not a teacher I needed to engage the trust of all those involved. I gained the school's approval in order to work within the school timetable and on the premises, in the form of replies to a permission letter to the Head teacher and all teachers involved (Appendix 5). As I was collating primary evidence of students' answers, opinions and ideas (written and recorded) I needed parental consent. A letter was produced (Appendix 6) and the two teachers whose classes I was working with printed enough copies to be sent home with each child. I was advised to use an 'opt out' return letter, as I would not get the returns on time if I chose 'opt in.' I assumed that all parents read the letter (as one parent refused for their child to take part) but it is impossible to be certain. Anonymity and confidentiality was guaranteed and that no personal details or any individual's answers would be known publicly. However, in retrospect, I could have used assigned codes to each student to guarantee this further (Himmelweit *et al.*, 1958).

As a STEM Ambassador[76], I am legally-covered in terms of insurance and an enhanced Criminal Records Bureau disclosure for any work undertaken in schools with children whether supervised or not. Although the interviews were unsupervised, there was another teacher at the far end of the room working with a student. At all times the students were aware of what my research was about and why they were involved. This helped them relax and openly discuss their ideas about programmes and science. To find out what they thought and understood from the programmes without disclosing my reasons for the study would have been deceptive and unethical. It would also have been unethical to test children within their homes after watching a clip in familiar settings and in their own time. However, being in a school situation may have influenced their answers, as students can equate what is done in schools with learning and being assessed. When filling out the questionnaires it was possible that the students may have found it difficult to express what they had learnt as the teachers were present in the room.

It was vital to check copyright issues for screening films within classrooms. In almost all European countries there are no copyright problems when using DVDs (Oberhummer, 2008) and the fair dealing clause in the 'Copyright Designs and Patents Act 1988' allows the use of films for teaching (Nightingale, 2008).

3.2.7. Data analysis approaches

In the questionnaires, one ('1') mark was given for each part of the answer that was correct and related to the film clip (Appendix 10). Nineteen points were available for *Finding Nemo* and 18 for *Deep Jungle* questions. 'C' indicated a correct answer but not what I was expecting (i.e. either general knowledge or not related to the clip). For example, for the first question: 'where do clownfish live?' I was looking for:

> 1 - anemones (any spelling of this was accepted, but 'coral' was marked as incorrect)
>
> 1 - for safety/protection

1 - from predators

1 - brushing against the anemone prevents stings

C - in the sea/water (correct, but this is a general answer)

Expert contacts (see 3.2.2.) provided further information which allowed me to return to the school at a later date to confirm answers, address any misconceptions and present some preliminary results (see Chapter 5 and Appendix 12).

To reduce and process the data, I took an inductive approach and developed my own coding categories using the responses to the questionnaire as a basis. Once again, the triallers checked and used my coding system and categories. The process of editing was important in eliminating errors when analysing the data from questionnaires. Unfortunately young people often write 'don't know' or leave answers blank in the worry that they might be wrong if they tried or guessed, so it was impossible to gain answers for every question. These were marked as incorrect answers.

To gauge the knowledge gained from both clips, the pre-viewing and post-viewing questionnaire scores were recorded for each student, making a note of which scores were for which film (Appendix 10). The average score for each year group for each film was calculated and converted to percentages. The average percentage pre-viewing score was subtracted from the average percentage post-viewing score. This gave the average percentage gain score. Although I collected frequency data and the sample numbers were small, a Kruskal-Wallis non-parametric test was performed on the median of scores (as the data were not normally distributed). All results and further details about analysis will be described in Chapter 4.

Chapter 4: Results and Analysis

In this chapter I will summarise the data gained in my research using the methodologies described in the previous chapter. I will begin with the online survey data followed by the classroom-based research. Frequency data and percentage incidence of responses are reported here in all graphs and tables. Raw data can be found in Appendices 13 and 14.

4.1. Online survey

Firstly, looking at the results from the blog questionnaire, I was able to find out whether any of the respondents (aged six to 65 years old; n=67) had learnt from cartoons in the past, what kinds of programmes they liked and did not like and why, and what they learnt from the clips shown (see Table 1).

4.1.1. Learning from cartoons

Just under half of respondents stated that they had learnt from cartoons in the past (Fig. 6.).

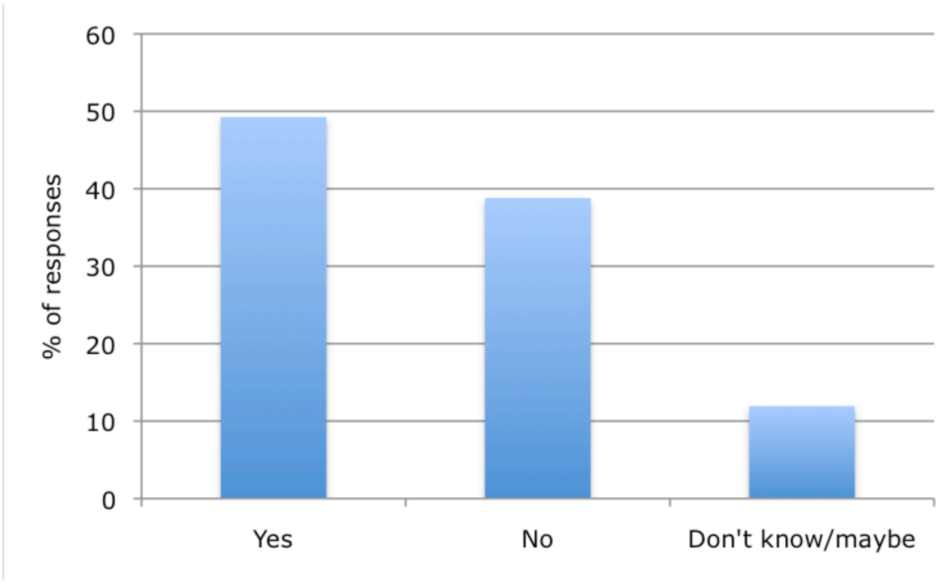


Fig. 6. Percentage responses to the question, 'Have you ever learnt anything from a cartoon?'

Looking closely at respondents' answers for what they have learnt from cartoons, it would seem that these fit within the categories mentioned earlier (see 1.3.1.):

Character-building:

> *I am sure I have learnt loads from cartoons! Struggling to think of something though! How about 'with great power comes great responsibility!' from Spiderman.*

> *The Lion King - how wonderful it is when parents love and protect their kids, don't hesitate to help them find out all the aspects of life (who we should trust or not, by being evil you can achieve ...nothing, our limit is*

the sky, love is a great thing...) Finally they would even sacrifice their lives for their kids.

Accurate factual information (explicit):

Um I have but it was a long time ago. There use to be a cartoon on Sunday mornings on Channel 4 (I think) about the body. I think it was dubbed into English. It showed each of the organs as factories, with the red blood cells going off to visit each one that needed them in turn. It also showed the white blood cells as an army fighting off infections and intruders. I found it really interesting anit [sic] *watching it made more sense to me then trying to read in a book what the body did and how it worked.*

Whenever the golden mean and its relationship to music and geometry comes up, my main point of reference is a Disney cartoon I watched when I was 11. I think this may be it: http://en.wikipedia.org/wiki/Donald_in_Mathmagic_Land. Tons of things I know about history and geography are also based on educational filmstrips I saw as a kid, which I guess are a really slo-mo [sic] *type of animation.*

Accurate information not spoken/written (implicit):

When I watched Happy Feet*, I learned that female penguins bring food for their family.*

The Lion King - the female lions do the hunting.

Adding to the imagination:

Only that animations can bend the rules of the natural world!

Understanding about literature/culture/traditions/folk stories/legend and myth:

Spirited Away is a great animation and I didn't learn so much about the facts and figures of the subject matter rather the culture and fascinations of the Japanese people.

I learned Mozart's The Magic Flute *and Wagner's* Rhinegold *from beautifully illustrated cartoons.*

Inaccuracies/unbelievable situations for entertainment:

Wallace and Gromit - The moon is made of cheese.

Promoting stereotypes:

On the whole I think there is a really sexist female horrible sexist side to cartoons.

It was encouraging to find that respondents learnt from the cartoon clips given:

OK, here's something I didn't know: that penguin eggs hatch at the same time.

I learnt about clownfish being able to cope with jellyfish stings.

4.1.2. Which clips were liked/disliked and why?

Respondents were asked to state which clip they liked, and which one they did not like.

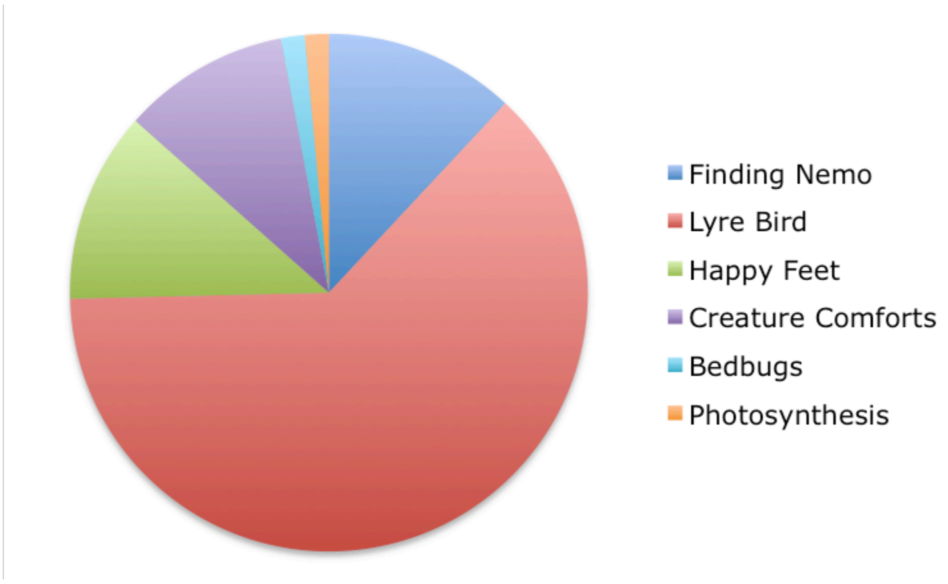


Fig. 7. Percentage responses to the question, 'which clip did you like best?'

Over half the respondents (63%, n=67) said they liked the *Lyre Bird* clip best (Fig. 7.), indicating that real-life factual programmes with entertaining content can be more popular than pure entertainment programmes (*Finding Nemo*, *Happy Feet* and *Creature Comforts*).

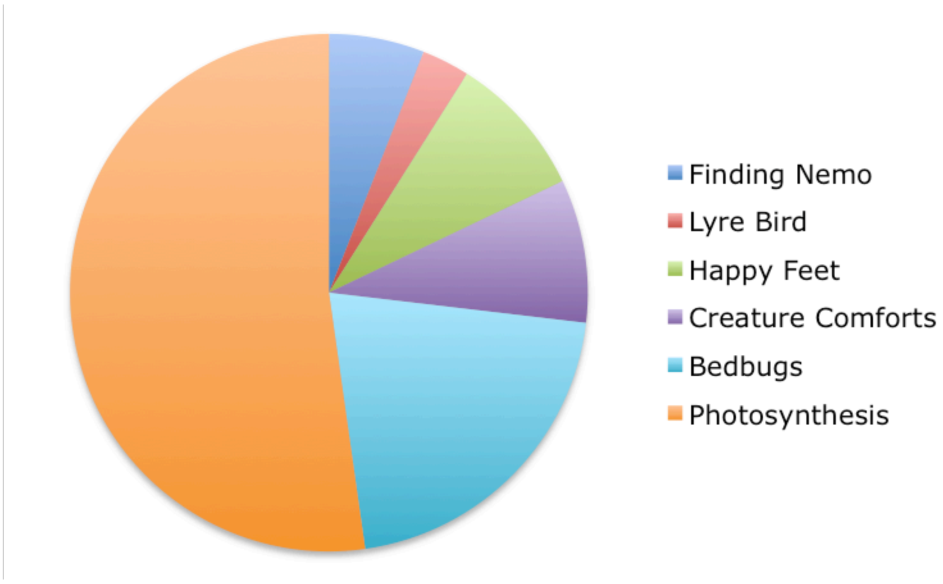


Fig. 8. Percentage responses to the question, 'which clip did you not like at all?'

Just over half of respondents (52%, n=67) said they did not like the *Photosynthesis* clip (Fig. 8.). Whilst this was an informative animation, the style was didactic.

Using the category system (Tables 2 and 3) the number of incidences a reason was given for liking or disliking a clip were counted and assigned to each category. The results are given in Fig. 9. Respondents liked a clip more when the subject matter was interesting or inspiring. Words such as 'fascinating' and 'amazing' were often used to describe these clips. Secondly, respondents preferred those that were informative and believable. Entertainment, style and tone were less important.

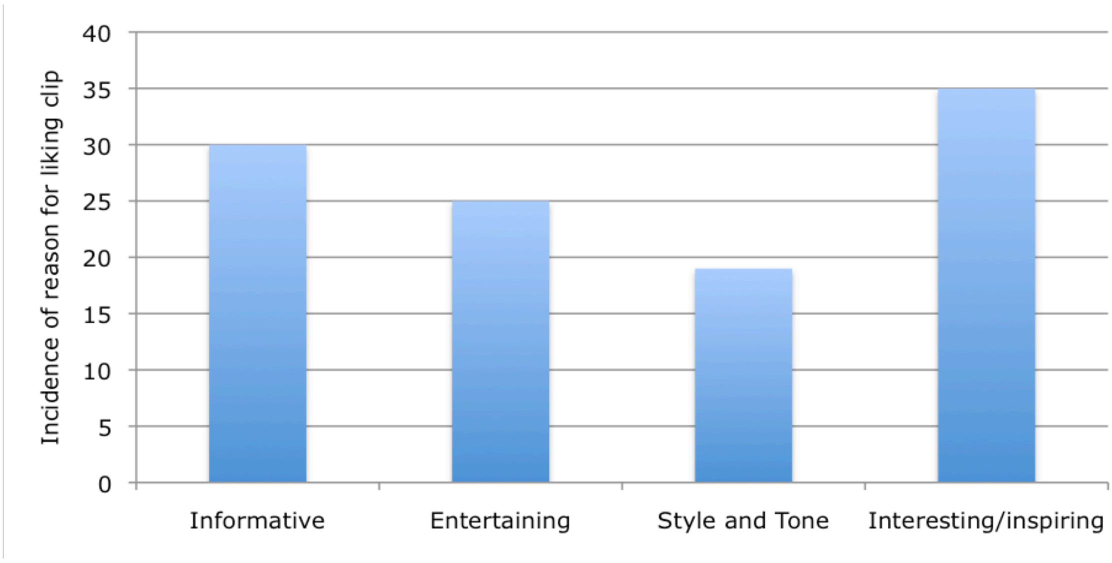


Fig. 9. Categorising what respondents said they liked about their favourite clip.

Examples of responses for each category are given here:

> *It gave the opportunity of seeing an organism not natural to the UK without having to leave the country.*
>
> *(Category: Informative).*

> *It made me laugh.*
>
> *(Category: Entertaining).*

> *The dialogue and interaction between the characters.*
>
> *(Category: Style and Tone).*

> *I thought it was amazing that a bird can make those noises.*
>
> *(Category: Interesting/Inspiring).*

People often gave responses that fell into more than one category, particularly when choosing why they liked a clip. For example:

> *It was amazing and I wasn't sure if it was real - I might not have believed it if David Attenborough wasn't saying it.*
>
> *(Categories: Style and Tone; Interesting/Inspiring).*

This comment refers to trust in the presenter. Respondents often alternated between mentioning 'the *Lyre Bird* one' or 'the David Attenborough one' indicating how important familiarity with the presenter can be, even though respondents were less likely to mention 'style and tone' as their reason for liking a clip.

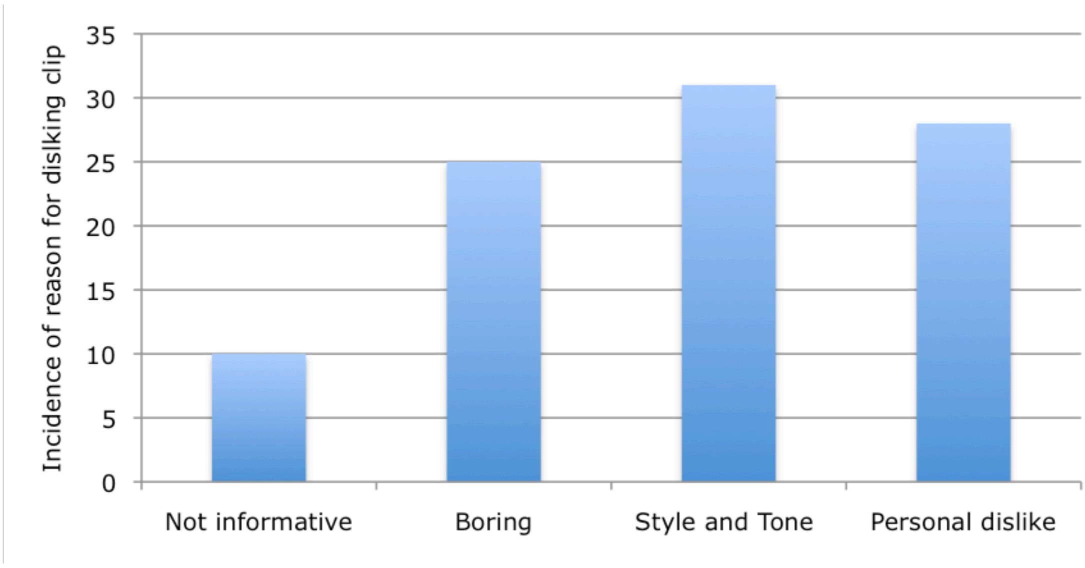


Fig. 10. Categorising what respondents said they disliked about their least favourite clip.

'Style and tone' seems a more important reason for not engaging with a clip (Fig. 10.). Unfortunately, if viewers do not engage with a clip, they will turn it off or ignore the content, therefore no learning can take place. Since the majority of respondents disliked the *Photosynthesis* clip, the reasons are mainly because of this particular clip as opposed to the genre (didactic animation). The *Photosynthesis* clip was the least popular because it was dull, not uninformative.

Examples of comments for each category are given here:

> *It didn't really tell me anything interesting.*
>
> *(Category: Not informative).*

Respondents were asked to choose one clip they disliked, but some gave reasons for why they disliked more than one clip. In these cases their answers were categorised based on why they disliked the main clip they chose (Appendix 2):

> *Was torn between Clip 5 and 6 - Bedbugs made me squirm but Photosynthesis was boring - reminded me of something you would watch in school.*
>
> *(Category: Boring).*

> *Too much like a lecture, the animation was poor, and it started skipping, but I wasn't bothered that I couldn't watch it all to the end.*
>
> *(Category: Style and Tone).*

> *Because bedbugs was disgusting…*
>
> *(Category: Personal dislike).*

Once again, some responses fell into more than one category (especially those about the *Photosynthesis* clip):

> *It was incredibly boring with a monotone voice and phrases like 'this is where it gets really interesting' and 'hope to see you again soon'. It also gives continuous facts with not enough time to take it all in.*
>
> *(Categories: Boring; Style and Tone; Personal dislike).*

I found one comment, from an educational resource producer particularly fascinating:

> *I didn't hate it, but I thought the visual presentation of the material was a bit dry, and didn't really take advantage of the potential of the accompanying visuals to add to what the speaker was saying. The narrator character seemed a bit lifeless, and the diagrams were not as illustrative as I would have liked. As a disclaimer, I make a lot of educational animation, so I have all kinds of unusual and weirdly specific prejudices about how it should be done. I can also tell that most of the dryness of the piece was because it was made in a simple, standardised way, probably to work to a budget and make lots of material affordably. I can totally appreciate and emphasise* [sic] *with the need for that!*

4.1.3. Learning from clips and spare time viewing

Respondents were asked to choose the clip they learnt the most from, and which one they would watch in their spare time. I wanted to see if these were related.

Is it possible that people can learn science from a programme they would watch for enjoyment?

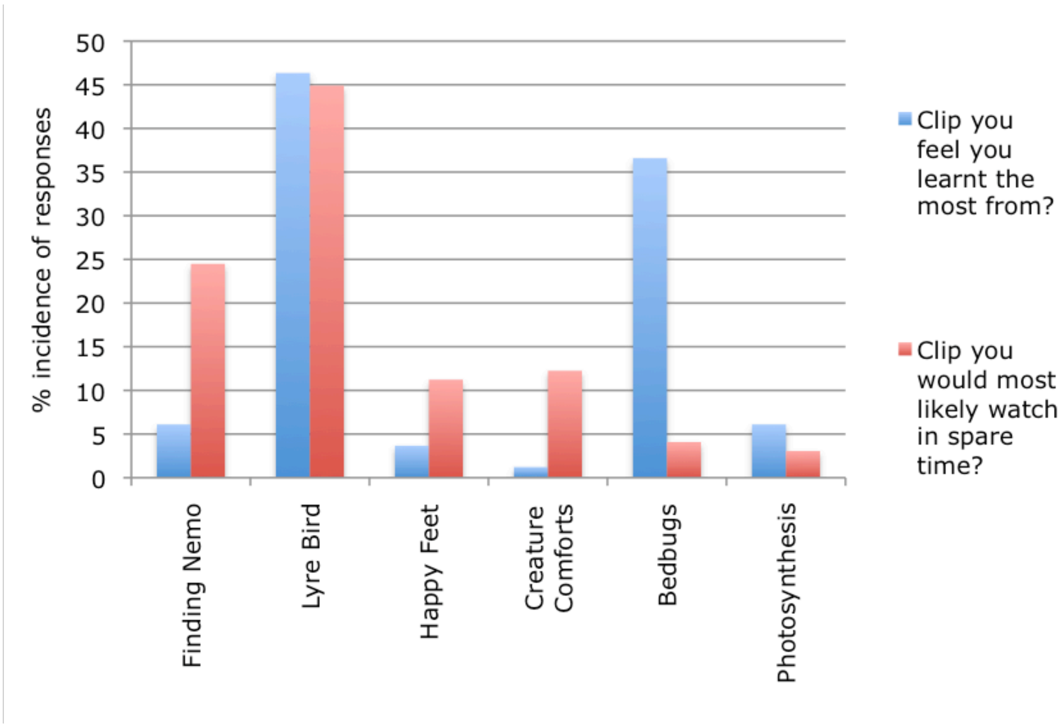


Fig. 11. Percentage incidence of responses to which clip respondents learnt the most from, and which clip came close to what they would watch in their spare time.

I performed a Spearman's Rank Correlation Analysis to see if there was a statistically significant correlation between the clip people learnt the most from, and which ones they would watch in their spare time. The correlation coefficient was 0.21, a low correlation ($p<0.05$). Only the *Lyre Bird* clip scored the same rank in both cases. The *Lyre Bird* clip was not only the most popular, but also seemed to be the one respondents learnt the most from and would watch in their spare time. However, it was interesting that although the *Bedbugs* clip was the second least liked, it was the second most popular clip that respondents 'learnt something new from':

> *I learnt most from the bedbugs as it was interesting whilst also giving facts. I learnt about how they track (they sense carbon dioxide emissions and heat), what they do (suck plasma) and how they infest (in great numbers). I also felt a personal connection as it could happen to me.*

4.1.4. Does film clip preference and dislike vary between different age groups?

I wanted to see if different age groups preferred different clips. The following graphs illustrate which age groups liked (Fig. 12.) and disliked (Fig. 13.) which clips.

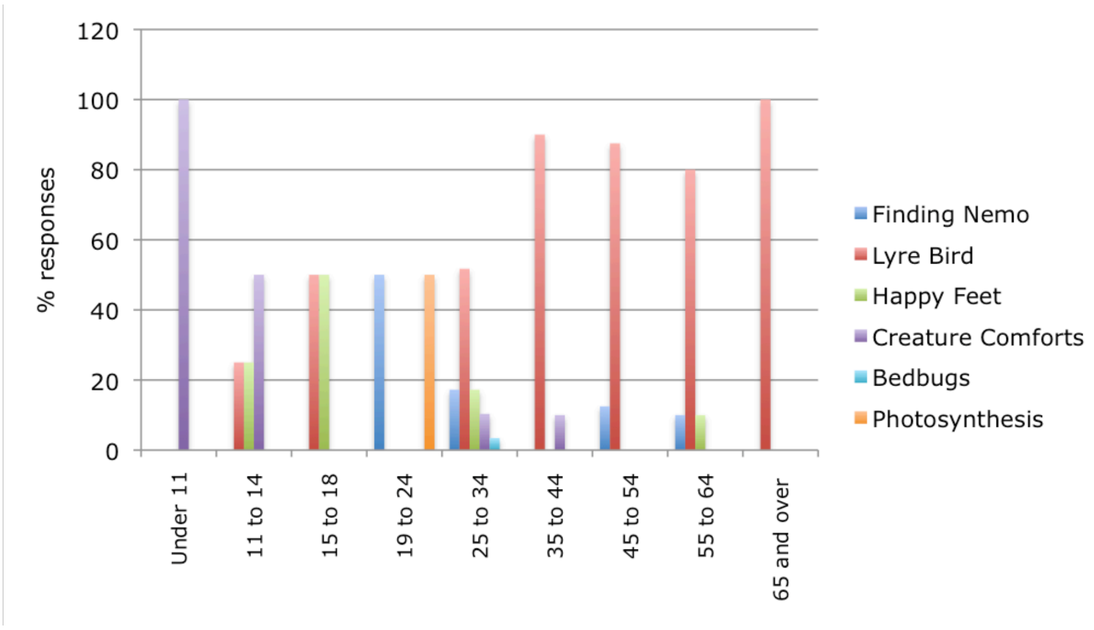


Fig. 12. Percentage responses to the question, 'which clip did you like best?', separating responses into age-ranges. Note that n=1 for 'Under 11', and for '65 and over.' (Table in Appendix 13).

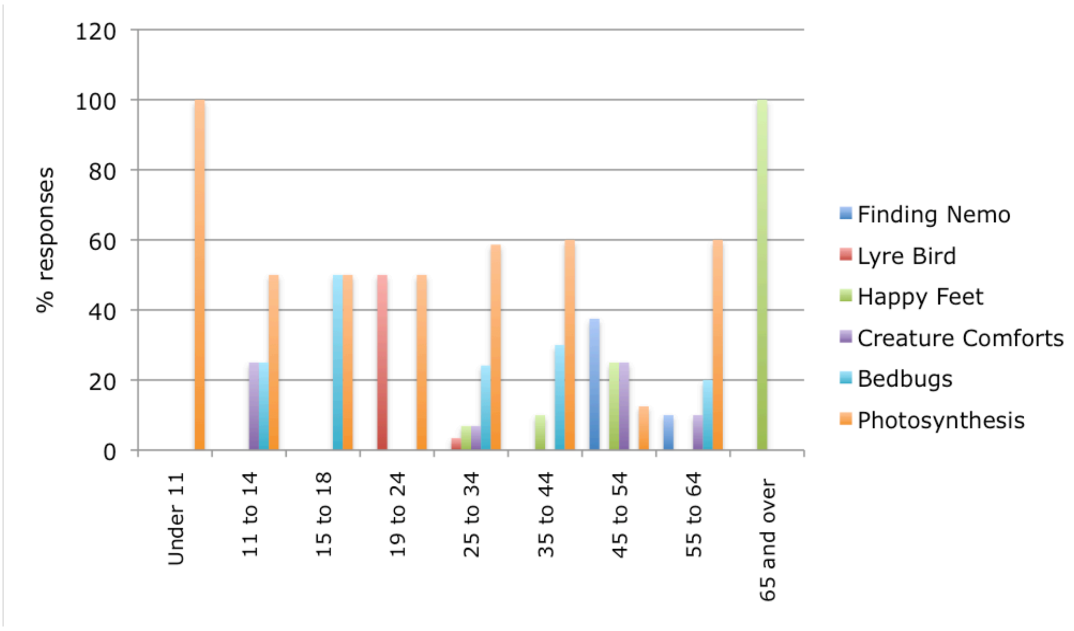


Fig. 13. Percentage responses to the question, 'which clip did you not like at all?', separating responses into age-ranges. Note that n=1 for 'Under 11', and for '65 and over.' (Table in Appendix 13).

Ignoring the extreme age ranges ('Under 11' and '65 and over', because n=1 in both cases), we can see that the more entertaining clips (*Finding Nemo*, *Creature Comforts*) are disliked by older respondents, whilst the *Photosynthesis* clip is universally disliked.

Since the survey returns were mainly from adults, I extracted the data from 6-18 year old respondents (school-going age; n=7) to look at trends amongst this age group (Table 5).

Table 5. Answers from 6-18 year olds, where FN=Finding Nemo, LB=Lyre Bird, HF=Happy Feet, CC=Creature Comforts, BB=Bedbugs and P=Photosynthesis.

	Age	**Which clip did you like best?**	**Did you learn anything new from any of the clips? Which clip(s)?**	**Which clip would you watch in your spare time?**
	Under 11 years old (6 years old)	CC	BB	CC
	11-14 years old	CC	BB	CC and comedy
	11-14 years old	LB	LB	LB
	11-14 years old	CC	BB, P	CC
Greek student	11-14 years old	HF	No	Cartoons
Greek student	15-18 years old	HF	LB	P
	15-18 years old	LB	BB	FN, LB

The ‘favourite clip’ answers matched better in young people with what they would most likely watch in their spare time. Whilst most adults liked the *Lyre Bird* clip, some were likely to watch *Finding Nemo* in their spare time.

To further investigate this, and measure the learning gained from watching entertainment programmes, as mentioned in Chapter 3, I conducted some classroom-based research.

4.2. Classroom-based research

Year 3 (n=24) and Year 6 (n=30) students were tested before and after viewing clips from *Finding Nemo* and *Deep Jungle*. The results below show the gain in science-based factual learning for both year groups, preferences and what they believed to be real. Other results are included here as gleaned from interviews and observations.

4.2.1. Learning about science

By calculating the average gain scores (as mentioned in 3.2.7.), I was able to see whether students obtained more scientific knowledge after watching an entertainment cartoon or a live-action documentary (Table 6).

*Table 6. Average percentage pre-viewing, post-viewing, and gain scores for Year 3 and Year 6 students based on questions asked about Finding Nemo and Deep Jungle clips. (*p<0.001, **p<0.05; Degrees of Freedom: 1).*

Year group	**n**	**Film clip viewed**	**Pre-viewing score (% correct)**	**Post-viewing score (% correct)**	**Gain (%)**
Year 3	**24**	***Finding Nemo***	29.17	34.87	5.70
Year 6	**30**		38.07	42.28	4.21
Year 3	**24**	***Deep Jungle***	11.56	22.92	11.34**
Year 6	**30**		16.67	44.07	27.41*

Whilst it seems that Year 3 gained more scientific knowledge from *Finding Nemo* than Year 6, the Kruskal-Wallis analysis showed the significant gain in knowledge for Year 3 students ($p<0.05$) and Year 6 students ($p<0.001$) after viewing *Deep Jungle* only. This could be because of the difficulty young people have with accessing implicit facts from entertainment media, or the novelty of *Deep Jungle*, hence the need to find out if students had seen either clip before (Fig. 14.).

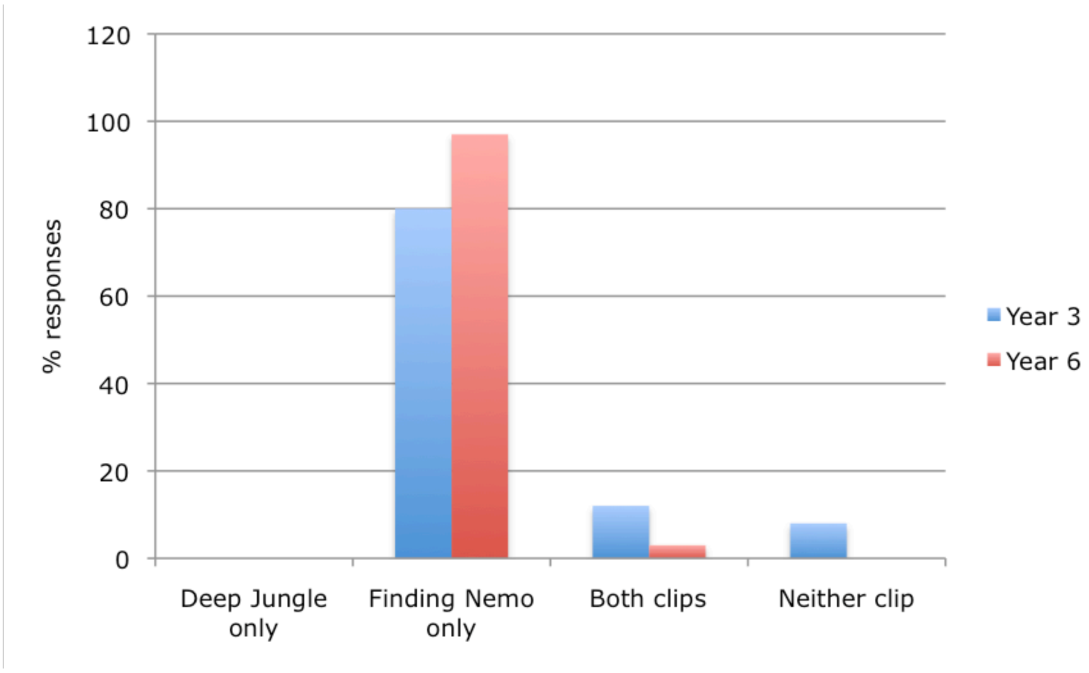


Fig. 14. Percentage responses to the question, 'which clip had you seen before today?'

Some students had seen both clips. I am not sure if this is true, or whether they remember watching a similar programme to *Deep Jungle*, as it has only been televised in the USA on the PBS channel[77]. The pre-exposure to *Finding Nemo* could also explain why some answers given for the sea-life questions were based on information outside of the clip (i.e. from the rest of the film; Appendix 10).

It was useful to count the correct ('C') answers given, but not add them to the overall score, as these answers were those not extracted from the clips (Appendix 10). Most students got the extra question ('which is the largest ocean in the world?'), which was not given in either clip (Appendix 14), wrong in both pre- and post-viewing questionnaires, suggesting guesswork. This indicates that it was unlikely that students did any background work between testing.

4.2.2. Learning and believing

Students were asked which clip they had learnt new information from, and what it was they had learnt. *Deep Jungle* was mentioned the most in both year groups. As this compares with the above results (that the most learning took place after viewing this clip), this indicates that students were aware of their learning.

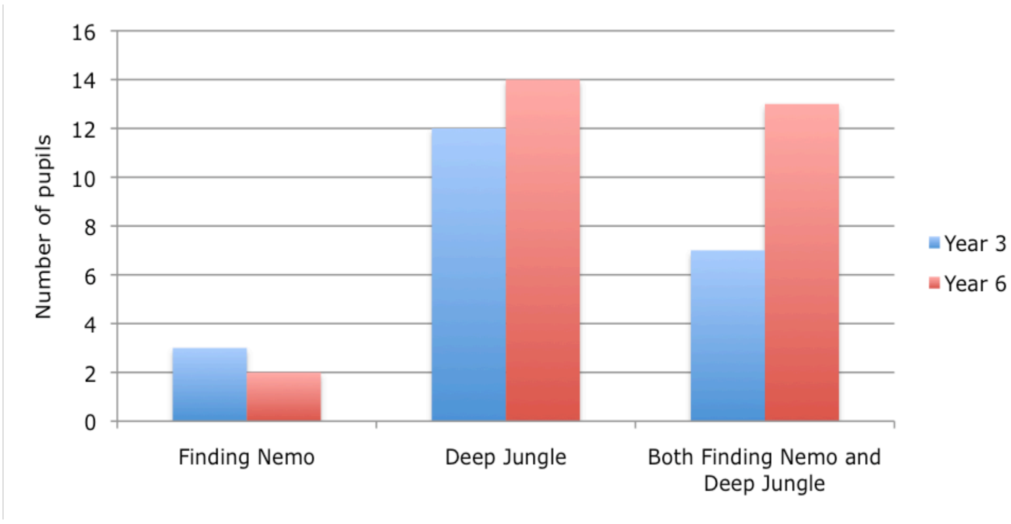


Fig. 15. Responses to the question, 'which clip did you learn new information from?'

Although I asked students what they had learnt from both clips, they often chose one clip to write about. But out of the 13 Year 6 students who mentioned learning from both clips, four of them gave an overall statement such as 'the world's *[sic]* not safe.'

When asked what exactly they had learnt, answers varied tremendously, from scientific facts to social learning, to the unusual:

> *85% of the Amazon has not been explored. Sea turtles can live to about 100 years.*
>
> *Do what your mum or dad tells you.*
>
> *Fish are not allowed to touch bout's* [sic - boats]*.*

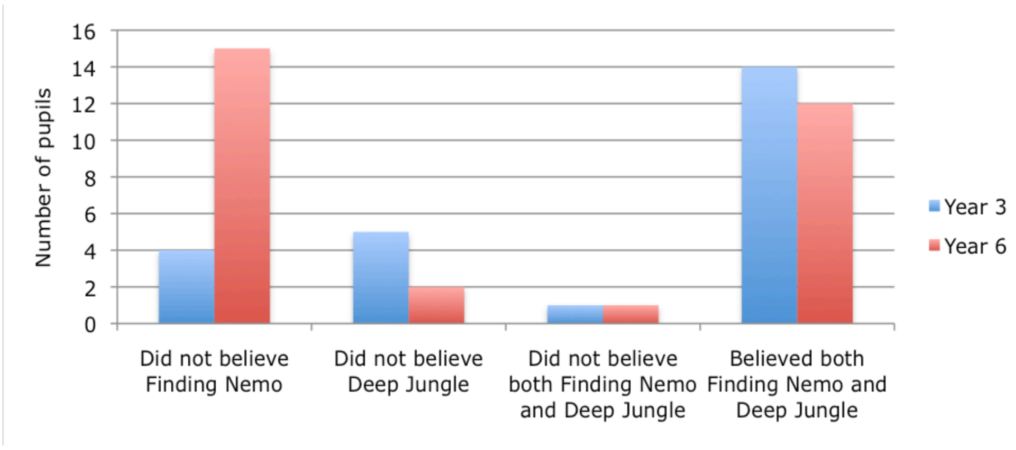


Fig. 16. How many students believed the content in one film clip over another?

Almost half of both year groups believed everything shown in both clips (Fig. 16.). Seventeen percent of Year 3 students and 27% of Year 6 students gave their reasons for not believing *Finding Nemo* as 'fish cannot talk' (or 'stingrays cannot sing'). Year 6 students gave more examples of what they did not believe, such as: sharks do not eat fish (or are vegetarians) - 13%; there are water mines - 3%; fish go to school - 10%; fish cross the road - 3%; short-term memory loss is real - 3%. In both year groups, some students did not believe the chicken-eating spider existed in *Deep Jungle* (Year 3 - 17%; Year 6 - 10%).

Those that had learnt about (i.e. believed) the existence of the chicken-eating spider, either said there was nothing that they did not believe in either clip, or that they did not believe anything in *Finding Nemo*, such as:

> *Agoutes* [sic] *were rodents theres* [sic] *a spider that eat's* [sic] *chickens.*
>
> *(Year 3 student A; believed* Deep Jungle*)*
>
> *Fish don't talk.*
>
> *(Year 3 student A; did not believe* Finding Nemo*)*

Alternatively, those that had learnt facts from *Finding Nemo* did not believe the *Deep Jungle* clip (or believed everything in both clips), for example:

> *How sharks became enimys* [sic] *to fish*
>
> *(Year 3 student B; believed* Finding Nemo*)*
>
> *The spider to kill something as big as a chicken.*
>
> *(Year 3 student B; did not believe* Deep Jungle*)*

When interviewing the students, Year 3 and Year 6 students differed in their opinions about whether a squid could release ink:

A: *She squirted ink.*

Interviewer: *Does that happen in real-life?*

B: *I don't think so.*

C: *I have seen a squid, but I haven't seen it do anything.*

(Year 3 students)

I believe that. It's true, I've seen it.

(Year 6 student)

In the real-life *Deep Jungle* clip, they believed that a man was suffering from Leishmaniasis (his diseased leg was shown):

Yeah. I believe that, because we saw it. And you'd hardly put on a fake leg just for a film.

(Year 3 student)

But there was some debate over the chicken-eating spider:

A: *I didn't think a spider that big could kill a chicken.*

B: *They can 'cause there's a bird-eating spider that big.*

(Year 6 students)

4.2.3. Learning from cartoons

The interview enabled me to ask the students what they thought about learning science. When asked whether it is possible to learn from cartoons:

> A: *Yeah, if it's like someone, a man, cartoon man actually saying about science or something like that.*
>
> B: The Secret Show *has something about it.*
>
> *(Year 3 students)*

Student A's comment compares with my definition of a didactic, educational cartoon (see 1.2.).

Year 6 students did not think it appropriate to watch Disney cartoons in class:

> *You can sometimes, but cartoons are mainly for humour.*
>
> *(Year 6 student; others nodded in agreement)*

Year 6 students better understood the need for untruths to enhance the narrative, even if they did not believe it (supporting Howard's (1993) findings), for example:

> A: *I didn't believe the part, when the sharks are being nice.*
>
> B: *Yeah, sharks don't do that, but that was just part of the movie…*
>
> *(Year 6 students; about* Finding Nemo*)*

And when their own knowledge did not match up with what they had seen:

> *Sharks are predators…and if you get something heavy and you whack them on the nose they don't like it. So it didn't make sense that he* [the shark] *was whacking into that wall to try and get it open…it would've hurt his nose.*
>
> *(Year 6 student)*

During the Year 6 interview, two students explained the benefits of *The Simpsons*:

> A: *Actually, when I was watching The Simpsons once, we had a test and one of the questions in The Simpsons, was…to learn some of the times tables and it made me learn them. It was helpful.*
>
> B: *Cartoons do actually help. And I rub it in my mum's face when she says cartoons are a waste of time.*
>
> *(Year 6 students)*

4.2.4. Preferences for clips

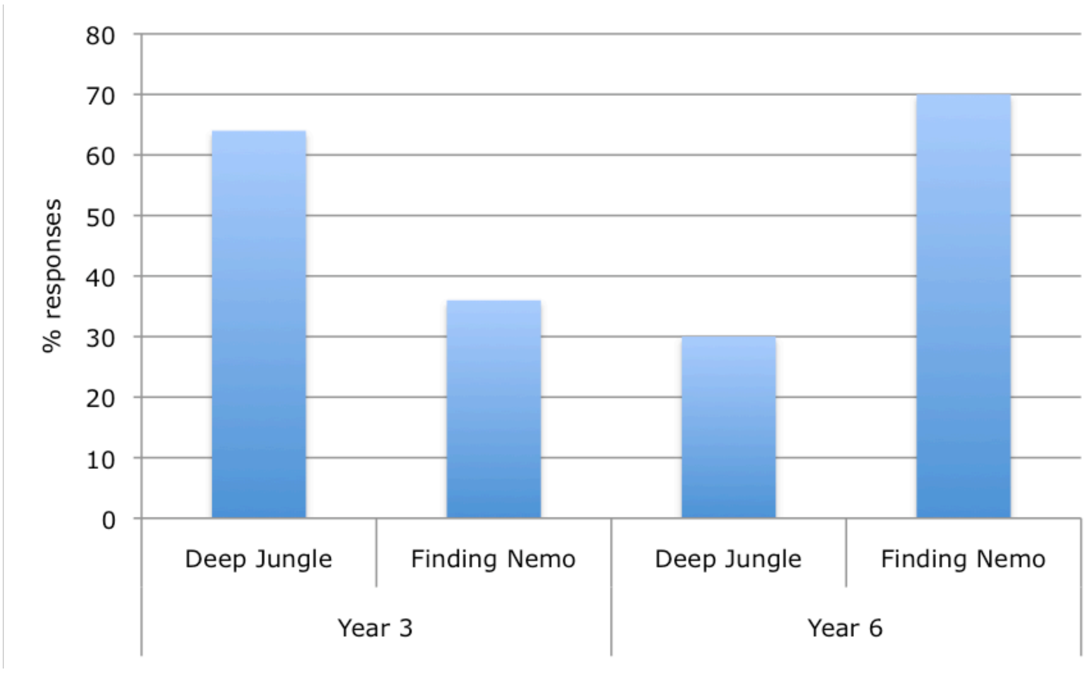


Fig. 17. Percentage responses to the question, 'what was your favourite clip?'

It is evident from Fig. 17. that more Year 3 students preferred *Deep Jungle* than *Finding Nemo*, whereas the opposite was true for Year 6 students. This corresponds well with Likert scale ratings given by the students (Year 3, n=4; Year 6, n=4) who were interviewed (Appendix 14). Whilst both clips were highly rated by both age groups, i.e. above 3.5 (1=Terrible; 5=Great) on the scale, *Deep Jungle* was rated as the 'better' clip in both year groups (Year 3, average rating=5; Year 6, average rating=4.25). When asked to explain why:

> *Well, I learned more about the animals I knew…and about things like the Amazon was the biggest rainforest in the world, and about the Brazil nut tree… and I found it quite interesting about thinking that a tarantula could eat chickens.*
>
> *Year 3 student (liked* Deep Jungle*)*

I learnt a bit in the Finding Nemo*, but I found out more about the* Deep Jungle *one.*

Year 3 student (liked both clips equally)

Well, I thought that since I've seen Finding Nemo *a few times before, and I know sort of what happens….I liked the* Deep Jungle *because I hadn't seen it before. But it would've been great apart from I don't like spiders that much.*

Year 6 student (liked both clips equally)

I don't like spiders. Finding Nemo *was funny and I like funny things. And* Deep Jungle *was a bit boring for me.*

Year 6 student (liked Finding Nemo*)*

From the above quotations, it would seem that novelty, fascination and gaining information are common reasons for liking a clip. To confirm this I categorised students' responses in the same way as the blog responses (see 3.1.6.).

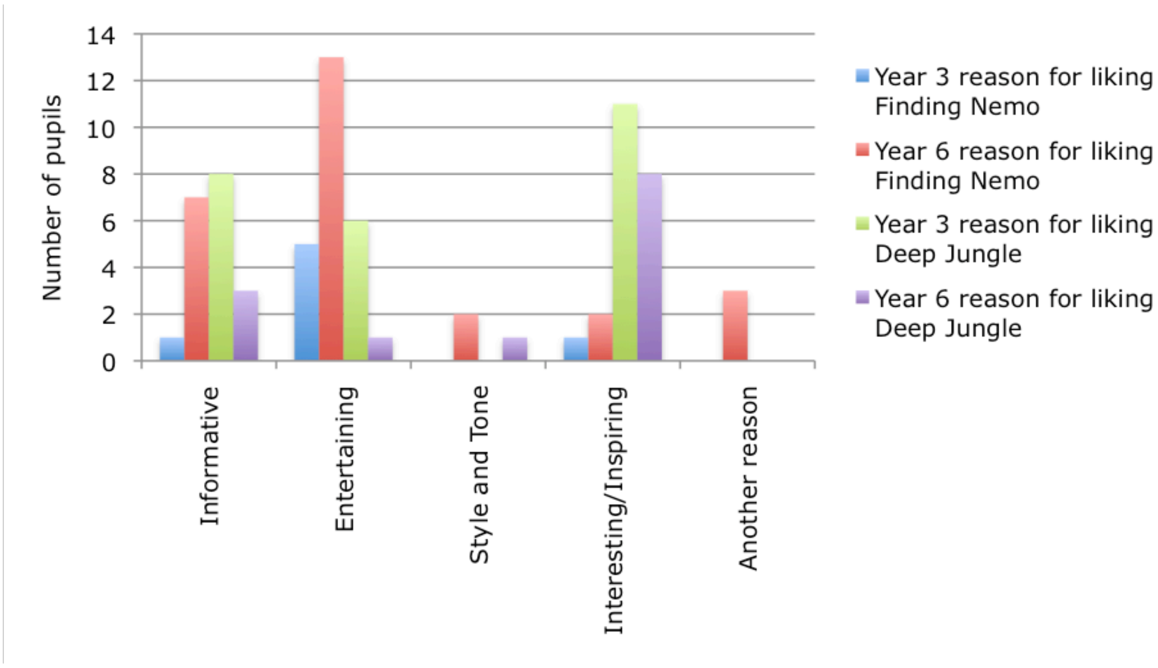


Fig. 18. Reasons given for why students liked Finding Nemo *or* Deep Jungle *better than the other?*

Both year groups liked *Finding Nemo* for entertainment, and as predicted earlier, they liked *Deep Jungle* for being informative and inspiring.

I studied the students' answers as well. Reasons given for liking *Finding Nemo* included:

> *Because it was funny but you learnt some things at the same time. Because finding nemo* [sic] *was funny and you got to find out things in a fun way.*
>
> *(Categories: Informative; Entertaining)*

'Another reason' is given in Fig. 18. because some of the answers were coded using negative categories (Table 3) such as when students said they liked *Finding Nemo* because they did not like *Deep Jungle*:

> *Because I am afrad* [sic] *of spiders and jungel* [sic] *deep had them in and nemo dident* [sic] *nemo was child frenly* [sic].
>
> *(Categories: Style and Tone; Personal dislike)*

> *It was not Factual.*
>
> *(Category: Not informative;*
> *the student liked* Finding Nemo *because it was not factual)*

Reasons for preferring *Deep Jungle* included:

> *Because it was real and it had more facts.*
>
> *(Category: Informative)*

> *The infomation* [sic] *was easier to pick out.*
>
> *(Categories: Informative; Style and Tone)*

4.2.5. Classroom observations

An advantage of being on site and conducting research (unlike the online survey) is the ability to observe the students. The following observations were made as the students were watching the clips.

Table 7. Observations made during students' viewing of both film clips in both year groups.

YEAR 3	**YEAR 6**
Laughed at 'butt' (rude words), slapstick jokes	Laughed at 'butt' and 'escape-ay', wordplay jokes
More attentive during *Deep Jungle*	More attentive during *Finding Nemo*
Shocked at shark appearance	Shocked at shark appearance
Not scared of spiders	Scared of spiders in *Deep Jungle* (fright put them off watching further)
Larger groan when *Deep Jungle* stopped	Larger groan when *Finding Nemo* stopped
Looking at the clock more during *Finding Nemo*	Looking at the clock more during *Deep Jungle*
No disgust during *Deep Jungle*	A lot of disgust during *Deep Jungle*

I noticed many differences between the year groups as to which clips and sections were found to be more humorous, fear-inducing or boring. Each year group laughed in different places, supporting previous literature on humour variation at different ages (see 2.2.1.), with younger students preferring ‘superiority’ humour (ridicule) and older students preferring ‘incongruity’ humour (wordplay). More disgust was expressed by females in Year 6 during the fighting scenes and when diseased limbs and spiders were shown in *Deep Jungle*.

The results described in this chapter helped me gain a better understanding of people’s preferences for programmes and the ones they learn from. Based on what I have discovered here and previous studies, I will discuss my findings further in Chapter 5.

Chapter 5: Discussion

This dissertation research aims to explore people's preferences and their learning of science from entertainment media. I will discuss the results of the online survey to find out adults' perceptions about what they had learnt from various clips and entertainment cartoons, as well as scientific factual knowledge gained by young students following the viewing of an entertainment cartoon (*Finding Nemo*) and a live-action documentary (*Deep Jungle*).

5.1. Discussion of the results

Results from my limited sample size are in agreement with those of Fisch *et al.* (1997) and Fitch (1993). That is, young people do not label programmes and films; they can be both entertaining and educational, and content is more important than format.

5.1.1. Online survey

The purpose of the blog was to find out what kinds of programmes people liked and preferred to watch in their spare time and whether they found these educational, entertaining or both. I wanted to find out which clips they learnt the most from, and whether they had they ever learnt from cartoons.

The most favoured clip was the *Lyre Bird*, a real-life factual clip, with entertaining content and an engaging presenter. I even received e-mail comments about this clip:

> *Man, the Lyre bird is the best thing in the whole world! I showed [partner's name] and he was so impressed he went a posted it on Facebook!*

Whilst this supports previous research with young people (Fisch, 2004a), my research indicates that adults are equally attracted to media with engaging content and less bothered about format (graphics or smart camera tricks). The *Photosynthesis* clip, even though animated, was not favoured as it was didactic, monotonous talking-head (see 2.5.), not an appropriate style and often referred to as 'something you would watch at school.' These clips strongly influenced the reasons given for why respondents liked or disliked a clip.

'Style and tone' (whether didactic, difficult to understand, poor quality; Fig. 10.) was an important reason for not engaging with a clip. Unfortunately, if viewers felt the content of a clip was dull or disgusting (personal opinion), they switched it off or ignored the information and therefore no learning could take place. Although the *Photosynthesis* clip was least popular, it was because it was dull, not uninformative. The delivery of scientific information is important if you want to engage an audience. The comment from an educational resource producer (see 4.1.2.) was particularly enlightening, as he was disappointed with the *Photosynthesis* clip, but understands the lack of funding available for such materials.

It was interesting that the *Bedbugs* clip was the second least liked, but the second most popular clip that people learnt the most from, as is evident from respondents' quotes (see 4.1.3.). This could be because of their belief that it could happen to them (Dorr, 1983), or due to their disgust, there was no cognitive processing of the narrative or visuals, so their working memory focused solely on processing factual content and retaining this information, such as:

> *I have acquired some information from the fifth clip…Someone might get bitten 500 times in a single night!*

The 'favourite clip' answers matched well with what people would be most likely to watch in their spare time, but matched better for young people. Adults liked the live-action (*Photosynthesis*, *Bedbugs*) clips, but some were more likely to watch an entertainment cartoon in their spare time. Young people also felt they learnt more from live-action clips (Table 5).

It was interesting to find out what people think they have learnt. One young person said he learnt from the *Bedbugs* and *Photosynthesis* clips, however it was actually an opinion:

> *Bedbugs are gross, plants are really boring.*
>
> *(11-14 year old)*

Researchers such as Fisch *et al.* (1997) have found that educational programmes are not necessarily deemed unappealing by young people, however this is not what I found. Although *Photosynthesis* and *Bedbugs* were disliked, science knowledge was gained (Fig. 11.). However the *Lyre Bird* clip does support Fisch's (*ibid*.) statement that educational clips can be appealing. A parent whose child trialled the questionnaire also commented:

> *It was interesting how David scored the highest even though his narration was straightforward and the bedbugs one was narrated from a 'scarey* [sic] *movie' type perspective.*

Some had made inferences from the cartoon clips given; from the implicitly educational *Happy Feet* where penguins' eggs hatch at the same time and the females bring food, to explicit knowledge in *Finding Nemo* where a clownfish copes with jellyfish stings. Some even gave examples of having learnt from cartoons in the past and their examples fitted within my categories mentioned earlier (see 1.3.1.). Interestingly, there seemed to be a bias towards mentioning science topics learnt from cartoons when describing explicit information delivered in cartoons, perhaps because they were aware of my background (as an MA Science Education student), even though I was careful not to mention that this research was only about learning science.

5.1.2. Classroom-based research

The purpose of the classroom-based research was to find out if young people could gain more accurate science knowledge from an entertainment cartoon than from a live-action documentary, whether they preferred one genre over another, and which one they believed.

There were significant (Year 3, $p<0.05$; Year 6, $p<0.001$) differences in science knowledge gained after viewing in both year groups for the *Deep Jungle* clip, but not for *Finding Nemo* (Table 6). So, contrary to my thinking, recall of scientific factual content was better after viewing the *Deep Jungle* (live-action documentary) clip, and by Year 6 students, which is in agreement with Clifford (1997) that age is a significant factor in recall. Accurate scientific information from *Finding Nemo* had been taken in by young people, but probably not during the course of my research. Pre-viewing scores for *Finding Nemo* were high (Table 6), which is why gain scores were lower than for *Deep Jungle*. Gain scores for *Finding Nemo* may have been higher had students not seen the film before. Looking closely at the answers for the pictorial multiple-choice question (to correctly identify the clownfish), because 23 out of 24 Year 3 students and 30 out of 30 Year 6 students had seen *Finding Nemo* before, all Year 6 students got this question correct in the pre-viewing questionnaire (Appendix 14). In general, the picture multiple-choice questions had a better recall result, but for *Deep Jungle* (identifying the agouti) it was still not 100%. This was probably because students had seen *Finding Nemo* many times before (some even told me they have the film on DVD).

My research supports Fisch's study (2004b), stating that it is easier to remember and recall facts, rather than making inferences, remember visuals rather than audio, and a student's interest in a programme to learn from may have less to do with format and more to do with content. For example, one student I interviewed said she had never seen *Deep Jungle* before, so it was new and interesting. Therefore the novelty factor can result in students engaging with a clip, assimilating and recalling more content. Since *Deep Jungle* was not originally aimed at a primary audience, all students would have been cognitively functioning in their ZPD (see 2.1.).

In the *Finding Nemo* clip, viewers must make more inferences from what is spoken rather than seen. This is easier for older viewers (Fisch, 2004b), and is supported by my results (see 4.1.1.). There is a significant gain in *Deep Jungle* knowledge by Year 6 students, after viewing the clip. Straightforward factual information, analogies in documentaries, and information explicitly delivered by cartoon characters are easier to recall. For example, most students in both year groups for the post-viewing question about short-term memory loss, stated word-for-word what Dory had said: 'forgets things almost instantly.' This relates to past research (Fisch, 2004b) on the whether educational content is integral or tangential to the narrative. As Dory's short-term memory loss is integral to the plotline, young people processed and retained this educational information. However, descriptive details of a shark were tangential to the plotline, and therefore less likely to be processed. In the *Deep Jungle* clip, the presenter explains that most spiders cannot harm us because it is similar to us humans trying to bite through a beach ball; some spiders' 'jaws are not big enough to penetrate the skin.' This analogy was poignant enough to be recalled (almost word-for-word) on 18 occasions.

Images in both clips had a profound effect, therefore supporting the visual superiority hypothesis (see 2.4.). Students made inferences from what had been seen in *Finding Nemo*, such as when a small fish was seen being eaten by a shark the resulting comments were: 'sharks eat little fish.' The *Deep Jungle* clip, although not marketed as an educational film (see Table 4), was more explicitly scientific and the nature of science and how scientists research could be gleaned from this clip. However it also contained a fictional reconstruction of a legendary chicken-eating spider and the 20-minute *Deep Jungle* clip finished before students saw any real evidence. This is why students' beliefs varied as to whether the spider actually existed or not.

Nevertheless, *Deep Jungle* was considered real, perhaps because as described earlier (Hawkins, 1977; Howard, 1983) this was a 'magic window' into the real world, the information was easier to access and it taught the students new information and this was their motivation for engaging with the clip. Students under ten years old can find it difficult to distinguish between live-action and animations (Chandler, 1997), and in my study more Year 3 than Year 6 students did not believe the chicken-eating spider. However, this could be because the Year 3 teacher said he did not believe it, or that Year 6 students would also have not believed it had they paid more attention (see Table 7). Year 6 students were more likely to believe in the squid releasing ink in *Finding Nemo*, because of increased general knowledge, prior learning (Driver, 1997; Bennett, 2003) more television viewing and life experiences (a couple of Year 6 students in the interview stated that they had travelled to many countries already). This also follows a basic Piagetian framework of cognitive development: children's understanding of what is real improves with age (Parkinson, 2004). Whilst I did not find out the general viewing habits of the students tested, I was able to gauge from the interviews (with students and teachers) how much television students were watching. This is in agreement with the cultivation theory (Chandler, 1995), that watching television can contribute to our knowledge of the world around us.

As mentioned in 5.1.1., no learning could take place if students were repulsed by the content. However moderately inducing emotions, such as fear in the case of *Deep Jungle*, or humour in the case of *Finding Nemo* (and therefore the possible concomitant release of noradrenaline in the brain) could have resulted in a positive effect on engagement, attention and memory consolidation (see 2.2.2.). As Fisch (2008) has stated, an exciting live-action show will be more engaging than a dull cartoon. Whilst most would agree (as shown by blog survey responses), that *Finding Nemo* is not a dull cartoon, it is one that many have seen before and therefore not as awe-inspiring as a novel show. Most students recalled facts from *Deep Jungle* suggesting they learnt the most from this clip.

However almost half of Year 6 students stated they learnt from both, suggesting that the older students recognised educational elements in *Finding Nemo*. Interestingly the learning from *Finding Nemo* included social learning, such as listening to your parents.

I would have expected more Year 3 students to mention the inaccuracies in *Finding Nemo*, such as fish cannot speak, but perhaps they felt that no one believes that anyway so it was not worth mentioning. What the students felt they had learnt was related to what they believed in. In the interviews I found that the students believed information based on what they had seen before, for example a squid releasing ink (see 4.2.2.), or the real-life situation such as the patient with Leishmaniasis, therefore supporting Dorr's (1983) criteria (see 2.5.) that students believe a real-life depiction, or information relating to their current knowledge of the real world.

During the interviews, both Year 3 and Year 6 students felt that they could learn from cartoons. Although a couple of the Year 3 students described a didactic format with a cartoon character presenter, the Year 6 group felt it was not appropriate to show Disney animations in class (see 4.2.3.). The Year 6 students also understood the need for anthropomorphism and unbelievable situations to add to the humour. If information differed from what the students already knew, such as sharks' behaviour (see 4.2.3.), they did not believe it. This supports the research of Kelly (1981) and Nikken and Peeters (1988), that cartoons have a weak modality, and therefore not a 'magic window' to real-life. However, if individuals do not have a real-life example to compare to the content viewed perhaps they may believe cartoons, therefore resulting in the situations that Baxendale (2004) has encountered (see 1.2.). Equally, students who believed the reconstruction of the chicken-eating spider could be compared to the individuals who believed *Superman* over *Charlie Brown* (see 2.5.). Stating that cartoons are only for humour suggests that some students differentiate between entertainment and education, whilst others feel that cartoons (such as *The Simpsons*) can be educational (see 4.2.3.).

5.1.3. Other observations

Some students wanted to write detailed answers for questions such as ‘what else can you tell me about sharks?’ in the pre-viewing questionnaire. For example:

> *Sharks eat people theres a tipe of shark called a graet white wich is a man eter not evry shark eats meat. Sharks are dangros. If your not still they atak. There is a nuver tip of shark wich is called a tiger shark. Sharks have for sets of teeth. Sharks are a variety of coulers like gray blue brown. Sharks live in see sott water. Sharks way over 30 stone.*
>
> *(Year 3 student; original spelling retained)*

For the post-viewing questionnaire, these same students, rather than using the information from the clip, felt they had to write exactly as they did before, and did not want to. This compares with previous studies (Amos and Reiss, 2006). In general the pre-viewing questionnaire resulted in students wanting to show off how much they knew, as Himmelweit *et al.* (1958) found. They were bored answering the post-viewing questionnaire to the point that answers which were correct in the pre-viewing questionnaire, were wrong (or less detailed, therefore less marks were awarded) in the post-viewing questionnaire. This could be related to John Keller’s ARCS (attention, relevance, confidence and satisfaction) model for learner motivation (Kruse, n.d.). Engaging students with relevant information in the pre-viewing questionnaire is novel, but since they do not see their answers immediately acknowledged (lack of satisfaction), they can lack the confidence to contribute a similar quality of answer in their post-viewing questionnaire. Other students were more aware of the actual content from the clip and tailored their answers accordingly in the post-viewing questionnaire, leaving out extraneous information.

The younger age group in general were succinct with their answers to open questions, maybe because they did not want to write much, and probably why some decided to draw their answers (shark's teeth). Some Year 6 students were more descriptive in the pre-viewing questionnaire. Another reason why the answers to open questions in the post-viewing questionnaire were shorter, could be because I administered the pre-viewing questionnaire on a Friday before half-term on non-uniform day. The excitement of the day, a visitor and no schoolwork may have relaxed them into just writing as much as they knew. The post-viewing questionnaire, however, was administered on an ordinary school day afternoon just before home time, when energy levels were low.

The Year 3 teacher noticed that some students said they believed everything, so he asked them about *Finding Nemo* and whether fish went to school, spoke or played? One Year 3 student said that she did not believe *Finding Nemo*, as fish could not talk, but that younger children might believe the film. The teacher asked why the rest of the class did not think to write that down if they too did not believe that. He proceeded to ask whether the students thought they could learn from cartoons, and which clip they learnt the most from? Another Year 3 student said that *Finding Nemo* was 'just a story about someone looking for Nemo…you don't learn anything.' Only a couple of students said that they had learnt from *Finding Nemo* by show of hands, the rest either did not learn from it, or seemed to not want to say, as they would be disagreeing with their teacher. It was useful to have this teacher-conducted class conversation after the post-viewing questionnaires had been collected in as this meant that the students did not know their teacher's views beforehand.

5.2. Addressing misconceptions

I did not address any misconceptions with the blog survey, and having not asked for participants' contact details there has been no opportunity to give direct feedback on my research findings. I could however add feedback to the blog and alert respondents via the networks mentioned in 3.1.1.

For the classroom-based research, the teachers were keen that I return to school with feedback. Having read through the questionnaire responses I felt it necessary to address some misconceptions (Appendix 12). These included why squids release ink (to distract their predators as they escape; in the film the squid releases ink by accident and remains stationary), what short-term memory loss means, and that the chicken-eating spider was a reconstruction. It was useful to show students the rest of the *Deep Jungle* episode and answer questions. Symbiosis is not covered in the Key Stage 2 curriculum, but the students wanted to know about the mutual relationship between clownfish and anemones. Even though it is not made explicit in the film, some students had understood this relationship, therefore supporting Bruner's (1977) theory that complex topics can be taught to young children, whatever their age.

I will now summarise my findings, reflect and recommend further studies in Chapter 6.

Chapter 6: Conclusions, Reflections and Recommendations

I began this research because I wanted to understand how the entertainment media could play an important role in science education and provide an intrinsic motivation for learning science informally. Educators could harness these resources rather than using purpose-made didactic educational programmes. This piece of research provides a small insight into how young people (and the wider community) view educational and entertainment programmes with regards to preferences and learning science.

6.1. Summary of main findings

I have found that people can learn science from entertainment cartoons. However, whether young or old, they were more engaged by novel content and real, believable situations shown in live-action documentary clips, therefore more learning took place, whether this was perceived (as seen with the online survey results) or measured (in the classroom-based research) learning.

It was difficult for younger viewers to make inferences from cartoons; when scientific facts were made explicit they were recalled better. People also learnt more than scientific facts from cartoons, such as personal development, culture and stereotypes.

6.2. Reflections on methods and methodology

There are some aspects of my research I would now do differently. Regarding the blog, it would have been useful to try and gauge the opinions of more young people (via parents) and ask respondents to rate each clip to determine a scale of preference. This could have helped inform the classroom-based research more.

6.2.1. Online survey

It would have been interesting to gain a better international perspective. Some respondents were Greek students and liked the *Photosynthesis* clip. This could be because they saw a clip with taught information as more important. This compares to anecdotal evidence from India, where educational material is deemed more important than spare time entertainment.

Only three out of the 67 blog respondents said none of the clips were close to what they would watch in their spare time, even then offering an 'other' option could have been useful. These individuals may prefer to watch soap operas and dramas. I could have added a suitable clip from a prime-time show such as *EastEnders*[78], which is popular amongst young people (McCrory, 2004), with say, a medical storyline to ensure there was some science in the clip.

6.2.2. Classroom-based research

Trialling the questionnaire was useful, however it would have been beneficial to re-trial the questionnaire having incorporated the changes had there been more time. Originally question 5 in the pre-viewing questionnaire (Appendix 8), was 'what does a squid do when it feels threatened?' A couple of parents suggested changing the word 'threatened' or adding 'startled or scared' afterwards. Having discussed this with a marine biologist, we agreed to add the latter. However many Year 3 students thought that they had to circle either the word 'startled' or 'scared'.

Piloting the questionnaires helped me find out what questions may have needed extra support (for example what 'percent' (describing it as a 'hundreth' worked) meant, or how to read 'tarantula'), however I was studying the recall of information from the clips not comprehension. Whether students understood what 'percent' meant or not could have been addressed later. But reading ability did pose a problem. Although reading assistants were available, one student read 'planet' instead of 'plant', and proceeded to write about the solar system. Had I read these questionnaires before leaving the classroom, I could have addressed these issues and asked for clarification or conducted the questionnaires as interviews for those who had reading difficulties.

Conducting the interviews after going through the questionnaires in detail and perhaps picking particular students to have a more in depth conversation with, could have offered a better insight into why participants answered in the way that they did. This would have been difficult within the time available, however it may also have caused concern for the students as to why they were chosen. Even here, the students I interviewed wanted to know if they had been chosen because they answered their questionnaires well.

6.3. Limitations of this study

6.3.1. Generalising from this research

For the blog survey, as mentioned in section 3.1.4., the networks contacted were predominantly science-based, and although many recruited other respondents on behalf of me, this could still be seen as a biased sample. To confirm this bias, I could have asked respondents what their background was. I could have also found out what clips they had seen before. Some mentioned not having seen some of the cartoon clips, or the *Lyre Bird* one. Novelty would have played a huge part in attracting viewers to a particular clip. It was also difficult to generalise from this data, as there were only seven respondents of the school going age (two of which were Greek students; Table 5), and a sample of one for the youngest age and oldest age categories.

Categorising the reasons as to why respondents liked or disliked a clip was subjective, as this was based on my own interpretation. I used an inductive approach based on the answers already collected. To minimise any bias I asked other colleagues (science education professionals, filmmakers, teachers) to comment on my categories, or make up their own based on the respondents' answers. Whilst there were differences of opinion, it was easy to come to a compromise. For example, differentiating between codes 6 (boring) and 7 ('style and tone'; Table 3). We agreed that 'boring' covered everything the opposite of category 2 (entertaining), therefore dull, no story or humour; whereas 'style and tone' covered all elements relating to the presentation itself: didactic, lack of detail and distracting.

Regarding the classroom-based research, the school has an above average achievement in science, so it would be difficult to generalise from my study and suggest that this school was typical of the general population. It would be useful to replicate this research with Year 3 and Year 6 students from different schools, making sure that other factors are taken into consideration, such as varying abilities, ethnicity and socio-economic status. This would give a better representation of the general student population for each age group.

The Year 6 group had already learnt about the Amazon rainforest within class, giving them an unfair advantage over the Year 3 class. Had I interviewed the teachers earlier into my research, I could have sourced a different live-action documentary clip.

Another reason that I cannot generalise from this research is teacher bias.

6.3.2. Teacher bias

In my study, the teachers involved were engaged with their students, but may have been unwittingly biased against entertainment cartoons, as both seemed more interested in their students viewing the *Deep Jungle* clip. Teachers will understand the need to present neutral viewpoints (Oulton *et al*., 2004), however their personal opinions may subconsciously influence their students, for example, the Year 3 teacher does not own a television set and did have opinions about young people watching entertainment programmes, especially before school. His students may have been aware of his opinions. This could be why Year 3 students said they preferred *Deep Jungle*, and when interviewed they felt that they had learnt more from the *Deep Jungle* clip. Or perhaps they thought, like their teacher, that I wanted to hear that?

The Year 6 teacher was surprised at the scientific accuracy of *Finding Nemo*, and how much her students already knew. She wanted more words to flash up on the screen during *Deep Jungle* to help the students with the vocabulary, and mentioned how the students usually jot down notes when viewing videos in class. Which could be why there was disagreement: the students stated that they hardly ever watched videos in class (perhaps they do not associate it as viewing when writing tasks are included), whereas the teacher said videos are shown often in class. This could also be why Year 6 students preferred *Finding Nemo*: the entertainment value, a break from academic videos and they had already covered the Amazon in class.

As mentioned earlier (see 3.2.5.) I am unsure how much rumour bias (Himmelweit *et al.*, 1958) there was because of the Year 3 teacher's explanation of my research ahead of time. Students from his class said, 'you got to find out things in a fun way' about *Finding Nemo* in the post-viewing questionnaire suggesting that they were watching to learn from it. Here, the students would have paid less attention to the narrative, as they knew they would be tested (see 2.4.). As an outside researcher, it was difficult to control such variables.

6.3.3. Researcher bias

In the interviews, even though I reassured the students that their answers would not be marked and no teachers were present, they gave me educated answers. For example, when asked what they watch in their spare time, they mentioned *Discovery Channel*[79] programmes, which was difficult to believe based on what the teachers have heard them discuss with their friends. This was an example of my viewpoint influencing the research. Instead I asked, 'Is there a programme, that if you missed it, you would be upset?' Their answers included *Harry Hill's TV Burp*[80] and *Primeval*[81]. Others may have been honest about watching educational programmes in their spare time, but with a sample of four for each year group it was impossible to generalise from these interviews.

6.4. Further research opportunities

The advantage of collating questionnaire answers via a blog is the opportunity for respondents to give general comments within the blog itself. This powerful feature for gauging opinion could be exploited further, especially to gain data from young people that I would be unable to interview. However, unless they choose to be anonymous (or the blog is made private), all data would be public during the course of the research. Preliminary data via this method in my research showed adults commenting on what a child may wish to watch:

> *If I were a child however I'd want to watch* Nemo *and* Happy Feet *because I do actually love new animations.*

If I continued with this research, I would like to work with the young people in a more informal setting. There is little anxiety in the home i.e. not worrying about physiological (food, drink), emotional (bullying) and safety (shelter) needs (Maslow, 1970) which is why watching at home could result in better learning. I realise testing students in their own homes would be impossible, but perhaps by conducting the research in neutral settings, such as a museum, town hall or youth club I could negate the inferences to academia and assessment.

The viewing of video clips may be seen as transmissive learning (Bennett, 2003), so it would be interesting to study the retention of facts over a period of time, and see if young people can apply the knowledge gained from viewing, in other areas. Memory is known to improve after a night's sleep (Huber, 2004), so recall of information could be improved with time. Clips such as those from *Robots*[82] or *Meet The Robinsons*[83] could be used where creativity and problem-solving in scientific experiments are shown (therefore testing procedural memory rather than declarative memory retention), and participants could then be asked to carry out a similar problem a few weeks after having watched the film clips.

6.5. The role of entertainment media in increasing viewers' scientific literacy

With the advances in Web 2.0 technology, numerous television channels, and fast-paced advertising, society is moving towards entertainment to engage interest in all subjects, including science. New programmes such as *Bang Goes The Theory*[84] have been produced specifically to attract audiences to the wonders of science, as well as increase viewers' scientific literacy.

> *I watch Brainiac Science Abuse and on that they say, 'Don't do this at home; we do it so you don't have to…'*
>
> *(Year 4 student; Sewell, 2006)*

I feel the media has a role in addressing the demands of science education organisations for developing students' questioning and practical skills and scientific literacy (Biosciences Federation, 2005; NESTA, 2005; Royal Society of Chemistry, 2005; Rocard *et al*., 2007). If science (especially natural science) was not inherently interesting to society, such programmes would not get made, or would they? It is not just about delivering scientific facts. Scientific literacy includes understanding scientific enquiry, science as a social enterprise and debating scientific issues.

6.6. Recommendations and implications

I feel that studies such as mine can be useful for programme-makers here in the UK to find out what young people like and how they learn; in the USA they think about 'edutainment' more than in Britain. It is also valuable for educators to know that students can pick up accurate science from many sources of popular culture. And should their learning result in misconceptions, these can be discussed in class and discriminatory skills may be nurtured. With the plethora of media information bombarding children, it is not the difficulty in accessing information, it is the need for young minds to determine what is accurate (Nolan and Darby, 2005). This is one of the reasons adults resist science, there so many scientific claims in the media but not enough time to accumulate, assess and evaluate (Weisberg and Bloom, 2007).

Perhaps cartoon makers should ensure that their science content is accurate, even though they are in the entertainment business. Do young people believe everything they see? I do not think so. I would be concerned if children gathered all their knowledge from cartoons; children are not going to dive off cliffs because they see *Wile E. Coyote*[85] do it. So, instead of using popular media clips within the classroom as a 'fun' starter or to stimulate discussion, as educators we could use the knowledge gained from entertainment media viewed by students in their own time, to encourage them to think about the wider implications of science within their lives. Some (Himmelweit *et al.*, 1958) argue that viewing reduces knowledge, as it takes up time that could be spent on other more 'profitable' activities, such as reading. I disagree, as I feel that, like Chandler (1995), the entertainment media has significant, cumulative effects on young people leading to many cultural benefits. Informal science learning from entertainment media should not only prepare future scientists but help future citizens gain a wider understanding about science and its impacts upon society.

Bibliography

Aikenhead, G., Fleming, R. W. and Ryan, A. G. (1987) High school graduates' beliefs about science-technology-society. 1: Methods and issues on monitoring student views. *Science Education,* 71 (2) pp. 145-161.

Allen, R. C. (1992) *Channels of discourse, reassembled: Television and contemporary criticism*. London: Routledge.

Amitay, S. (2007) *What can we learn about auditory learning?* Presentation given at the Institute of Education. London.

Amos, R. and Reiss, M. (2006) What contribution can residential field courses make to the education of 11–14 year-olds? *School Science Review*, September, 88 (322) pp. 37-44.

Appelbaum, P. and Clark, S. (2001) Science! Fun? A critical analysis of design/content/evaluation. *Journal of Curriculum Studies*, 33 (5) pp. 583-600.

Armstrong, S. (n.d.) *What is a scientist?*
[Details available online at:
http://www.biosciences.bham.ac.uk/external/PrimarySchools/what_is_a_scientist.htm, last accessed 25.07.09].

Avraamidou, L. and Osborne, J. (2009) The role of narrative in communicating science. *International Journal of Science Education*, Research report, 31 (12) pp. 1683 – 1707.

Bage, G. and Turner, J. (2006) Real stories, real science*. Primary Science Review*, 92, pp. 4-6.

Balkwill, F. (2006) *A silent killer*. Talk given at the Royal Society: The Michael Faraday Prize Lecture. London.
[Details available online at:
http://www.royalsoc.ac.uk/page.asp?tip=1&id=4120, last accessed 24.04.07].

Bandura, A. (1986) *Social foundations of thought and action: a social cognitive theory*. USA: Prentice Hall.

Baxendale, S. (2004) Memories aren't made of this: amnesia at the movies. *British Medical Journal*, 329, pp. 1480-1483.

Beauchamp, G. and Parkinson, J. (2005) Beyond the 'wow' factor: developing interactivity with interactive whiteboards. *School Science Review*, March, 86 (316) p. 97.

Bennett, J. (2003) *Teaching and learning science: a guide to recent research and its application.* London: Continuum.

Biosciences Federation (2005) *Enthusing the next generation*. *A report on the bioscience curriculum by a working group established by the Biosciences Federation.* London: Portland Press Ltd.

Blickenstaff, J. C. (2009) Pixar is *Up* to something good. *NSTA Reports – Blick on Flicks*. National Science Teachers Association, USA.

[Details available online at:
http://www.nsta.org/publications/news/story.aspx?id=56127, last accessed 14.08.09].

Bodmer, W.F. (1985) *The public understanding of science*. London: The Royal Society.
[Details available online at:
http://royalsociety.org/displaypagedoc.asp?id=26406, last accessed 01.08.09].

Bone, R. (2004) Not quite real-life. *Science and Public Affairs*, December, pp. 16-17. London: British Science Association.

British Science Association (2008) *Science on TV – livening up or dumbing down?* Presentation by The British Science Association Physics and Astronomy Section. Liverpool.
[Details available online at:
http://www.britishscienceassociation.org/NR/rdonlyres/1EF12FB0-6F92-41E7-9B0C-DE60D910C9DB/0/SUPPLEMENTARYPROGRAMMEwithMAPtoprint.pdf, p. 32, last accessed 13.08.09]

Brown, J. (2008) Joys and perils of television. *Sesame Family Newsletter*.
[Details available online at:
http://www.kintera.org/cms.asp?id=559638&campaign_id=100329&enString=hhTGSDXzKlIQI7NGIhIRI0NDJaKyFHQqMSRKPaPGKlKWL4NJLsG, last accessed 28.06.09].

Bruner, J. S. (1977) *The process of education*. Second edition. Cambridge: Harvard University Press.

Bruner, J. S. (1986). *Actual minds possible worlds*. Cambridge: Harvard University Press.

Byron, T. (2008) *Safer children in a digital world – The report of the Byron Review*. Nottingham: DCSF Publications.
[Details available online at: http://www.dcsf.gov.uk/byronreview, last accessed 01.08.09].

Canemaker, J. (1996) *Before the animation begins: the art and lives of Disney inspirational sketch artists.* New York: Hyperion.

Cartwright, L. and Goldfarb, B. (1994) Cultural contagion: On Disney's health education films for Latin America. *In*: Smoodin, E. (ed.) *Disney discourse: producing the magic kingdom*. London: Routledge.

Chandler, D. (1997) Children's understanding of what is 'real' on television: a review of the literature. *Journal of Educational Media*, 23 (1) pp. 65-80.

Chandler, D. (1995) *Cultivation theory*.
[Details available online at:
http://www.aber.ac.uk/media/Documents/short/cultiv.html, last accessed 15.08.09].

Choat, E. and Griffin, H. (1989) *Using television in the primary school*. London: Routledge.

Clifford, B. R., Gunter, B. and McAleer, J. L. (1997) Children's memory and comprehension of two science programmes. *Journal of Educational Media*, 23 (1) pp. 25-50.

Coffield, F. (2009) It's learning but not as we know it. *Vision*, January-June pp. 9-12. Bristol: Futurelab.

Cohen, L. and Manion, L. (1994) *Research methods in education*. Fourth edition. Great Britain: Routledge.

Cowley, S. (2003) *Getting the buggers to behave 2*. London: Continuum Books.

Dagher, Z. R. and Ford, D. J. (2005) How are scientists portrayed in children's science biographies? *Science and Education*, 14, pp. 377-393.

de Jong, S. (2007) Personal communication with colleague.

Devlin, K. (2007) We will finally get mathematics education right. *In*: Brockman, J. (ed.) *What are you optimistic about? Today's leading thinkers on why things are good and getting better*. New York: Harper Perennial, pp. 216-218.

Donnelly, J. (2002) Instrumentality, hermeneutics and the place of science in the school curriculum, *Science and Education*, 11 (2) pp. 135-153.

Dorr, A. (1983) No shortcuts to judging reality. *In*: Bryant, J. and Anderson, D. R. (eds.) *Children's understanding of television: Research on attention and comprehension*. New York: Academic Press, pp. 199-220.

Downes, S. (2004) Educational blogging. *EDUCAUSE Review* 39 (5) pp. 14–26. [Details available online at: http://www.educause.edu/pub/er/erm04/erm0450.asp?bhcp=1, last accessed 20.07.07].

Downing, J. R. and Clark, R. S. (2007) Using electronic surveys in organisational/employee communication research: A study at GE's Global Research Centre. *Professional Communication, IEEE Transactions*, 50 (3) pp. 249-262.

Driver, R., Squires, A., Rushworth, P. and Wood-Robinson, V. (1994) *Making sense of secondary science: research into children's ideas*. London: Routledge.

Driver, R. (1997) *The pupil as scientist?* Milton Keynes: Open University Press.

Duggan, S. and Gott, R. (2002) What sort of science education do we really need? *International Journal of Science Education*, Research report, 24 (7) pp. 661-679.

Dunne, I. B. (2006) Bringing the story alive. *Primary Science Review*, 92, pp. 22-24.

Ferris, S. (2007) How to be a writer – secrets from the inside. West Sussex: Summersdale Publishers Ltd. p. 107.

Feshbach, S. (1972) Reality and fantasy in filmed violence. *In*: Murray, J. P., Rubinstein, E. A. and Comstock, G. A. (eds.) *Television and social behavior* 2: *Television and social learning*. Rockville: National Institute of Mental Health, pp. 318-45.

Fisch, S. M., Yotive, W., McCann Brown, S. K., Garner, M. S. and Chen, L. (1997) Science on a Saturday morning: children's perceptions of science in educational and non-educational cartoons. *Journal of Educational Media*, 23 (2-3) pp. 157-167.

Fisch, S. M. (2000) A capacity model of children's comprehension of educational content on television. *Media Psychology*, 2, pp. 63-91.

Fisch, S. M. (2004a) Characteristics of effective materials for informal education: A cross-media comparison of television, magazines and interactive media. *In*: Rabinowitz, M., Blumberg, F. C. and Everson, H. T. (eds.) *The design of instruction and evaluation: Affordances of using media and technology*. New Jersey: Lawrence Erlbaum Associates, pp. 3-18.

Fisch, S. M. (2004b) *Children's learning from educational television Sesame Street and Beyond*. New Jersey: Lawrence Erlbaum Associates.

Fisch, S. M. (2008) Personal communication with President of MediaKidz Research and Consulting.

Fisher, M. (1997) The effect of humor on learning in a planetarium. *Science Education*, 81, pp. 703-713.

Fitch, M., Huston, A. C. and Wright, J. C. (1993) From television forms to genre schemata: Children's perceptions of television reality. *In*: Berry, G. L. and Asamen, J. K. (eds.) *Children and television: Images in a changing sociocultural world*. California: Sage, pp. 38-52.

Flavell, J. H., Flavell, E. R., Green, F. L. and Korfmacher, J. E. (1990) Do young children think of television images as pictures or real objects? *Journal of Broadcasting and Electronic Media,* 34 (4) pp. 399-419.

Forge, K. L. S. and Phemister, S. (1987) Effect of prosocial cartoons on preschool children. *Child Study Journal*, 17 (2) pp. 83-88.

Frailich, M., Kesner M. and Hofstein A. (2007) The influence of web-based chemistry learning on students' perceptions, attitudes, and achievements. *Research in Science and Technological Education*, 25 (2) pp. 179–197.

Frayling, C. (2006) *Mad, bad and dangerous: how are scientists represented today and does it matter?* Talk given at the Cheltenham Science Festival. Cheltenham, Gloucestershire.
[Details available online at: http://www.press.uchicago.edu/cgi-bin/hfs.cgi/00/167721.ctl, last accessed 24.04.07].

Freeth, M. (2008) *Films of fact*. Presentation at the Dana Centre. London.
[Details available online at:
http://www.danacentre.org.uk/events/2008/11/12/454, last accessed 01.08.09].

Gibb, B. J. (2007) *The rough guide to the brain.* Chapter 5: Memory. p. 76. London: Penguin books Ltd.

Golia, P. (2008) Personal communication with Senior Vice-President, Oneida Nation.

Grant, L. (2005) *Comparative evaluation of science communication activities and their impacts*. PhD Thesis, Science Communication Unit, University of Liverpool.
[Details available online at

http://www.lauragrantassociates.co.uk/ReportsAndResources.aspx, last accessed 19.08.09].

Guthrie, P. (1999) *Knowledge through humor: an original approach for teaching developmental readers*. Presentation at the International Conference on Teaching and Leadership Excellence, Austin, Texas.

Haggerty, D. L. (2005) Creating an interest in learning science. *Childhood Education*, 81.

Halpern, P. (2007) *What's science ever done for us? What The Simpsons can teach us about physics, robots, life, and the universe*. New Jersey: John Wiley and Sons.

Hawkey, R. (1998) Have you heard the one about...science? *School Science Review*, September, 80 (290) pp. 29-36.

Hawkins, R. P. (1977) The dimensional structure of children's perceptions of television reality. *Communication Research,* 4 (3) July, pp. 299-320.

Himmelweit, H.T., Oppenheim, A.N., and Vince, P. (1958). *Television and the child: an empirical study of the effect of television on the young*. London: Oxford University Press.

Hodge, B. and Tripp, D. (1986) *Children and television: A semiotic approach*. Cambridge: Polity Press.

Hofstein, A., Rosenfeld, S. (1996) Bridging the gap between formal and informal science learning. *Studies in Science Education*, 28, pp. 87-112.

Howard, S. M. (1993) How real is television? Modality judgements of children. *Media Information Australia*, 70, November, pp. 43- 52.

Huber, R., Ghilardi, M. F., Massimini, M., Tonomi, G. (2004) Local sleep and learning. *Nature* 430, pp. 78-81.

Hughes, M. (2009) *'Stories out of school': what children and young people tell us about their learning outside school*. Presentation by University of Bristol, supported by Futurelab. London.
[Details available online at:
http://www.esrc.ac.uk/ESRCInfoCentre/about/CI/events/StoriesOutOfSchool.aspx, last accessed 01.08.09].

Iddon, B. (2006) Making Science Cool. *In*: T. Gilland (ed.) *What is science education for?* London: Academy of Ideas, pp. 67-68.

Jaglom, L. M. and Gardner, H. (1981a) Decoding the worlds of television. *Studies in Visual Communication*, 7 (1) pp. 33-47.

Jaglom, L. M. and Gardner, H. (1981b) The preschool television viewer as anthropologist. *In*: Kelly, H. and Gardner, H. (eds.) *Viewing children through television* (*New directions for child development*). San Francisco: Jossey-Bass, pp. 9-30.

James, D. (2001) *Split a gut and learn: Theory and research*. (Unpublished manuscript, quoted in Rule and Auge, 2005).

Kaiser Family Foundation. (2004) *Entertainment education and health in the United States*. Issue Brief.
[Details available online at: http://www.kff.org/entmedia/7047.cfm, last accessed 01.08.09]

Kandel, E. (2008) *We are what we remember*. Talk given at the Royal Society, London. [Details available online at: http://royalsociety.org/author.asp?id=6405, last accessed 14.08.09].

Kelly, H. (1981) Reasoning about realities: Children's evaluations of television and books. *In*: Kelly, H. and Gardner, H. (eds.) *Viewing children through television* (*New directions for child development*). San Francisco: Jossey-Bass, pp. 59-71.

Kempton, T. (2004) Using paintings and cartoons to teach ethics in science. *School Science Review*, December, 86 (315) pp. 75-82.

Kim, K-H. (2007) The two Torrance creativity tests: The Torrance tests of creative thinking and thinking creatively in action and movement. *In*: Tan, A-G. (ed.) *Creativity - A handbook for teachers*. USA: World Scientific Publishing Co. Ltd. pp. 117-141.

Klaebe, H. and Bolland, C. (2007) Text meets technology: Creatively writing for digital media. *Writing in Education*, Autumn, 43, pp. 41-46.

Kraut, R., Olson, J., Banaji, M., Bruckman, A., Cohen, J., and Couper, M. (2004) Psychological Research Online: Report of board of scientific affairs' advisory group on the conduct of research on the Internet. *American Psychologist*, February/March, 59 (2) pp. 105-117.

[Details available online at: http://www-2.cs.cmu.edu/~kraut/RKraut.site.files/articles/kraut04-PsychologicalResearchOnline.pdf, last accessed 14.08.09].

Kruse, K (n.d.) *The magic of learner motivation: The ARCS model*. [Details available online at: http://www.e-learningguru.com/articles/art3_5.htm, last accessed 20.07.07].

Liddell, A. (2006) *Now do this – teaching suggestions.* Presentation given at *Enhancing scientific literacy - using the media to motivate students*, The Guardian Newsroom, 20 October 2006. London.

Littledyke, M. (2004) Drama and science. *Primary Science Review*, 84, pp. 14-16.

Lloyd, H. (2008) Personal communication with Science Communicator, Science Made Simple.

Longshaw, S. (2009) Creativity in science teaching. *School Science Review*, March, 90 (332) pp. 91-94.

Lynch, D., and McKenna, M. (1990). Teaching controversial material: new issues for teachers. *Social Education*, 54, pp. 317–319.

Mallory, M. (1999) *Hanna-Barbera cartoons*. London: Virgin Publishing Ltd.

Maltin, L. (1987) *Of mice and magic: a history of American animated cartoons*. New York: Plume.

Manning, A., Glackin, M. and Dillon, J. (2009) Creative science lessons? Prospective teachers reflect on good practice. *School Science Review*, March, 90 (332) pp. 53-58.

Martin, N. (2008) Personal communication with colleague.

Maslow, A.H. (1970) *Motivation and personality.* New York: Harper and Rowe.

McCrory, A. (2004) *Investigating Year 2 students' understanding and knowledge of topical socio-scientific issues in light of global media. Do we underestimate young children's knowledge and understanding of these issues and their levels of moral reasoning?* MA in Science Education Dissertation, Institute of Education, London.

McCullagh, J. (2009) Books and stories in children's science (BASICS Project). *In*: Feasey, R. (ed.) *Supporting primary science the AZSTT way 2003-2007: Ten more projects*. University of Bath: AstraZeneca Science Teaching Trust, p. 3.

McLuhan, M. (2003) Understanding media - the extensions of man: Critical edition. Gordon, W. T. (ed.). USA: Gingko Press.

Meskill, C. (2007) Through the screen, into the school: Education, subversion, ourselves in 'The Simpsons'. *Discourse*, March, 28 (1) p. 37-48.

Mochan, A. (2008) Europeans split on science in the media. *Science and Public Affairs*, March p. 23. London: British Science Association.

NACCCE (National Advisory Committee on Creative and Cultural Education) (1999). *All our futures: Creativity, culture and education*. London: DfEE.

Naylor, S. and Keogh, B. (1999) Constructivism in classroom: Theory into practice. *Journal of Science Teacher Education*, May, 10 (2) p. 93-106.

NESTA (2005) *Real Science – encouraging experimentation and investigation in school science learning*. London: NESTA Research and Policy.

Nickerson, L. (2009) Science drama. *School Science Review*, March, 90 (332) pp. 83-89.

Nightingale, J. (ed.) (2008) *Guardian Media Supplement: Focus on Film*. London: UK Film Council.

Nikken, P. and Peeters, A. L. (1988) Children's perceptions of television reality. *Journal of Broadcasting and Electronic Media*, 32 (4) pp. 441-452.

Nolan, V. C. and Darby, G. (eds.) (2005) *Reinventing education – A thought experiment by 21 authors*. Synectics Education Initiative.

Oberhummer, H. (2008) Personal communication with Director of CISCI – Cinema in Science.

Oulton, C., Dillon, J. and Grace, M. (2004) Reconceptualising the teaching of controversial issues. *International Journal of Science Education*, Research report, 26 (4) pp. 411-423.

Papageorgiou, G., Johnson, P. and Fotiades, F. (2008) Explaining melting and evaporation below boiling point. Can software help with particle ideas? *Research in Science and Technological Education*, 26 (2) pp. 165–183.

Parkinson, J. (2004) *Improving secondary science teaching*. London: Routledge Falmer.

Perales-Palacios, F. J. and Vílchez-González, J. M. (2005) The teaching of physics and cartoons: Can they be interrelated in secondary education? *International Journal of Science Education*, Research report, 27 (14) pp. 1647-1670.

Placing, K., Ward, M., Peat, M. and Teixeira, P. T. (2005) *Blogging in science and science education*. UniServe Science Blended Learning Symposium Proceedings: Poster presentation. Sydney.

Radford, T. (2006) *Creationism and intelligent design – do they have a place in the school curriculum?* Presentation at Guardian newsroom seminar. London.
[Details available online at:
http://www.guardian.co.uk/newsroom/story/0,,1929365,00.html, last accessed 10.03.07].

Reilly, C. (2007) *Dear God: Children's letters to God from around the world*. Leicester: Silverdale Books.

Rocard, M., Csermely, P., Jorde, D., Lenzen, D., Walberg-Henriksson, H. and Hemmo, V. (2007) *Science Education NOW: A renewed pedagogy for the future of Europe*. Brussels: European Commission.
[Details available online at: http://ec.europa.eu/research/science-society/index.cfm?fuseaction=public.topic&id=1100, last accessed 08.08.09].

Rowcliffe, S. (2004) Storytelling in science. *School Science Review*, 86 (314) pp. 121-126.

Royal Society of Chemistry (2005) *Surely that's banned? Report for the Royal Society of Chemistry on the understanding of schools and education authorities of chemicals and procedures thought to be banned from use in schools*. London: Royal Society of Chemistry.
[Details available online at:
http://www.rsc.org/ScienceAndTechnology/Policy/EducationPolicy/SurelyThatsBanned.asp, last accessed 08.08.09].

Rule, A. C. and Auge, J. (2005) Using humorous cartoons to teach mineral and rock concepts in sixth grade science class. Journal of Geoscience Education, 53 (5) November, pp. 548-558.

Sanderson, J. (2008) Personal communication with Series Producer, How2 and Media Consultant.

Sanderson, J. (2009) Personal communication with Series Producer, How2 and Media Consultant.

Sandford, R. Ulicsak, M., Facer, K. and Rudd T. (2006) *Teaching with games - using commercial off-the-shelf computer games in formal education*. Bristol: Futurelab.

Sanson, A. and Di Muccio, C. (1993) The influence of aggressive and neutral cartoons and toys on the behaviour of preschool children. *Australian Psychologist*, 28, (2) July, pp. 93-99.

Sewell, K. (2006) Why science? *Primary Science Review*, 95, pp. 20-21.

Sheikh, E. (2008) Personal communication with colleague.

Sherborne, T. (2009) Cracking science: How to build an inspirational curriculum. *School Science Review*, March 90 (332) pp. 65-71.

Solomon, J., Duveen, J. and Scott, L. (1994) Pupils' images of scientific epistemology. *International Journal of Science Education*, 16 (3) pp. 361-373.

Swallow, N. (1966) Factual television. London: Focal Press Limited.

Swanson, R. (2008) Personal communication with Science Director, DragonflyTV.

Tan, K. C. D. and Koh, T. S. (2008) The use of Web 2.0 technologies in school science. *School Science Review*, (90) 330.

Teare, H. (2006). Education shouldn't be fun. *In*: T. Gilland (ed.) *What is science education for?* pp. 73-76. London: Academy of Ideas.

Turkle, S. (2007) The immeasurables. *In*: Brockman, J. (ed.) *What are you optimistic about? Today's leading thinkers on why things are good and getting better*. New York: Harper Perennial, pp. 233-238.

Wardle, J. (ed.) (2009) Creativity in science. *School Science Review*, March 90 (332) pp. 29-30.

Watson, J. (2006) Handstands and ties: A career in teaching. *Science in School*, Issue 3 Winter, pp. 81-83.

Weisberg, D. S. and Bloom, P. (2007) Why do some people resist science? *Science and Public Affairs*, December, p. 22. London: British Science Association.

Whitelegg, E., Holliman, R., Scanlon, E. and Hodgson, B. (2008) *The (In)visible Witnesses Project: Investigating gendered representations of scientists, technologists, engineers and mathematicians on UK television*.
[Details available online at: http://www.open.ac.uk/invisible-witnesses, last accessed 13.08.09].

Yager, R. E. and Tweed, P. (1991) Planning more appropriate biology education for schools. *The American Biology Teacher*, 53 (8), pp. 479-483.

Yang, E., Andre, T. and Greenbowe, T. J. (2003) Spatial ability and the impact of visualization/animation on learning electrochemistry. *International Journal of Science Education*, Research report, 25 (3) pp. 329-349.

Notes

1. *What Is Web 2.0?* by Tim O'Reilly: http://oreilly.com/web2/archive/what-is-web-20.html [last accessed 09.08.09]. Web 2.0 refers to the web's second generation i.e. where the end user creates as well as 'consumes' content.
2. *Tomorrow's World*: http://en.wikipedia.org/wiki/Tomorrow's_World [last accessed 08.08.09].
3. *Horizon*: http://www.bbc.co.uk/sn/tvradio/programmes/horizon/broadband/index.shtml [last accessed 08.08.09].
4. *Brainiac*: http://sky1.sky.com/show/brainiac [last accessed 08.08.09].
5. *Blast Lab*: http://www.bbc.co.uk/programmes/b00gqcn3 [last accessed 08.08.09].
6. *Grow Your Own Drugs*: http://www.bbc.co.uk/programmes/b00j4j41 [last accessed 08.08.09].
7. *All Creatures Great and Small*: http://www.bbcprograms.com/pbs/catalog/allcreatures/acgsmain.htm [last accessed 08.08.09].
8. *ER*: http://www.nbc.com/ER [last accessed 08.08.09].
9. *CSI* (Crime Scene Investigation): http://www.cbs.com/primetime/csi [last accessed 08.08.09].
10. *Friends*: http://www2.warnerbros.com/friendstv/container.html [last accessed 08.08.09].
11. *The Big Bang Theory*: http://www.cbs.com/primetime/big_bang_theory [last accessed 08.08.09].

12. *Nit-Witty Kitty* (1951) cartoon: http://video.google.com/videoplay?docid=997399908372068689 [last accessed 08.08.09].
13. Pixar's *Finding Nemo*: http://www.pixar.com/featurefilms/nemo [last accessed 08.08.09].
14. *Randomise* games on the *Planet Science* website: http://www.planet-science.com/randomise [last accessed 16.08.09].
15. *DragonflyTV*: http://pbskids.org/dragonflytv [last accessed 08.08.09].
16. *Newton's Apple*: http://www.newtonsapple.tv [last accessed 08.08.09].
17. *How2*: http://www.citv.co.uk/page.asp?partid=144 [last accessed 08.08.09].
18. *Save Kids' TV*: http://www.savekidstv.org.uk [last accessed 25.06.07].
19. British Science Association's *Meet the Robinsons* competition: http://www.britishscienceassociation.org/web/NSEW/NSEW_archive/NSEW2007/MTR [last accessed 08.08.09].
20. The Institute for Civil Engineers' *Flushed Away* game: http://www.icg-uk.org/iqs/cpti.2/dbitemid.269/sfa.view/news.html [last accessed 01.08.09].
21. *Asterix*: http://gb.asterix.com [last accessed 08.08.09].
22. *What's Opera Doc?* (1957) cartoon: http://www.metacafe.com/watch/430148/whats_opera_doc [last accessed 08.08.09].
23. Disney's *Fantasia*: http://disney.go.com/vault/archives/movies/fantasia/fantasia.html [last accessed 08.08.09].
24. *Bugs Bunny's Christmas Carol*: http://www.imdb.com/title/tt0078914 [last accessed 08.08.09].

25. *Histeria!*:

    http://www.timewarner.com/corp/newsroom/pr/0,20812,667535,00.html [last accessed 08.08.09].

26. *Pinky and the Brain*: http://www.warnervideo.com/pinkyandthebrain [last accessed 08.08.09].

27. *Futurama*: http://www.comedycentral.com/shows/futurama/index.jhtml [last accessed 08.08.09].

28. *Alpine Climbers* (1936) cartoon:

    http://www.youtube.com/watch?v=x2eX3xXV_a8 [last accessed 16.08.09].

29. The myth of St. Bernard's dogs carrying brandy, mentioned in the programme, *QI*: http://en.wikipedia.org/wiki/QI_(B_series) and in *Mythbusters*:

    http://www.discoverychannel.co.uk/web/mythbusters/episodes/season-6 [last accessed 16.08.09].

30. Ratatouille's *Remy: Your Friend the Rat*:

    http://www.pixar.com/shorts/yftr/index.html [last accessed 08.08.09].

31. *Exploring the Reef*: http://www.imdb.com/title/tt0375744 [last accessed 09.08.09].

32. Lynda La Plante on *BBC's One Show*:

    http://www.bbc.co.uk/iplayer/episode/b00hjzp5/b00hjznz/The_One_Show_09_02_2009/ [last accessed 16.08.09, was not able to view].

33. *The Simpsons*: http://www.thesimpsons.com [last accessed 09.08.09].

34. *Predator*: http://www.imdb.com/title/tt0093773 [last accessed 16.08.09].

35. *Sesame Street*: http://www.sesamestreet.org [last accessed 16.08.09].

36. Special edition of *School Science Review* on *Creativity*:

    http://www.ase.org.uk/htm/journals/ssr/ssr_mar_2009.php [last accessed 16.08.09].

37. *Wellcome Trust*: http://www.wellcome.ac.uk [last accessed 09.08.09].
38. *Ignite!*: http://www.ignitefutures.org.uk [last accessed 09.08.09].
39. *NESTA* (National Endowment for Science, Technology and the Arts): http://www.nesta.org.uk [last accessed 09.08.09].
40. *Arts Council*: http://www.artscouncil.org.uk [last accessed 09.08.09].
41. *Creative Partnerships*: http://www.creative-partnerships.com [last accessed 09.08.09].
42. *The Icarus Project* by Dragon Breath Theatre: http://www.ntu.ac.uk/cels/about/news/48921gp.html [last accessed 09.08.09].
43. *Every Breath* by Y-touring: http://www.ytouring.org.uk/productions/breathe/index.html [last accessed 09.08.09].
44. *Planet SciCast*: http://www.planet-scicast.com [last accessed 09.08.09].
45. *Films for Learning*: http://www.filmsforlearning.org [last accessed 09.08.09].
46. Feedback from teachers who attended first *STEM Fluency Lab*, as part of the *Ignition** programme (November 2008): http://www.ignitefutures.org.uk/ignition/stem-fluency-labs [last accessed 16.08.09].
47. *The Science of Harry Potter*, Cambridge Science Festival 2006, Roger Highfield: http://www.admin.cam.ac.uk/news/press/dpp/2006012501 [last accessed 16.08.09].
48. *Godzilla on the Big Screen* (Cryptozoology), Presentation at the Darwin Lecture Theatre, 25 June 2008, University College London. Organised by *The Grant Museum of Zoology*: http://www.ucl.ac.uk/museums/zoology [last accessed 19.08.09].
49. *CISCI* (Cinema and Science): http://www.cisci.net [last accessed 09.08.09].

50. *Cro*: http://www.youtube.com/watch?v=gq95Blz5nxI [last accessed 09.08.09].
51. *The Apprentice*: http://www.bbc.co.uk/apprentice [last accessed 09.08.09].
52. *Happy Feet*: http://www2.warnerbros.com/happyfeet [last accessed 09.08.09].
53. *Shark Tale*: http://www.sharktale.com [last accessed 09.08.09].
54. *Charlie Brown*: http://en.wikipedia.org/wiki/Charlie_Brown [last accessed 16.08.09].
55. *Edublogs*: http://edublogs.org [last accessed 09.08.09].
56. *CBBC Newsround*: http://news.bbc.co.uk/cbbcnews/default.stm [last accessed 09.08.09].
57. *British Interactive Group*: http://www.big.uk.com [last accessed 09.08.09].
58. *PSCI-COM*: http://www.intute.ac.uk/pscicom [last accessed 09.08.09].
59. *Planet Science* e-newsletters: http://www.planet-science.com/about_sy/listFS.html [last accessed 09.08.09].
60. *YouTube*: http://www.youtube.com [last accessed 09.08.09].
61. *Finding Nemo*: http://www.youtube.com/watch?v=S3998wh4vdc [last accessed 04.07.09].
62. *Lyre Bird*: http://www.youtube.com/watch?v=XkEU-ZAHasc [last accessed 04.07.09].
63. *Happy Feet*: http://www.youtube.com/watch?v=6cDyEpOFPYM [last accessed 04.07.09].
64. *Creature Comforts*: http://www.youtube.com/watch?v=9nJiETbEjvY [last accessed 04.07.09].
65. *Bedbugs*: http://www.youtube.com/watch?v=lpkTC3bs4Cg [last accessed 04.07.09].

66. *Photosynthesis*: http://www.youtube.com/watch?v=mpPwmvtDjWw [last accessed 04.07.09].
67. *Wufoo*: http://wufoo.com [last accessed 08.08.09].
68. *March of the Penguins*: http://www.nationalgeographic.com/marchofthepenguins [last accessed 08.08.09].
69. *National Science and Engineering Week*: http://www.britishscienceassociation.org/web/nsew [last accessed 08.08.09].
70. *I'm a Celebrity…Get Me Out of Here!*: http://celebrity.itv.com [last accessed 08.08.09].
71. *Doctor Who*: http://www.bbc.co.uk/doctorwho [last accessed 08.08.09].
72. *Deep Jungle*: http://www.pbs.org/wnet/nature/episodes/deep-jungle-new-frontiers/introduction/1369 [last accessed 08.08.09].
73. *Deep Jungle* teacher guides: http://www.pbs.org/wnet/nature/category/for-educators/teachers-guides [last accessed 16.08.09].
74. *Dove Marine Laboratory*, Newcastle University: http://www.ncl.ac.uk/marine/about/facilities/dove [last accessed 08.08.09].
75. *National Aquarium*, Baltimore: http://www.aqua.org/news/index_pr_findingnemo.html [last accessed 16.08.09].
76. *Science and Engineering/STEM Ambassadors*: http://www.stemnet.org.uk/ambassadors.cfm [last accessed 16.08.09].
77. *PBS* (Public Broadcasting Service) channel: http://www.pbs.org [last accessed 16.08.09].
78. *EastEnders*: http://www.bbc.co.uk/eastenders [last accessed 09.08.09].
79. *Discovery Channel*: http://dsc.discovery.com [last accessed 16.08.09].

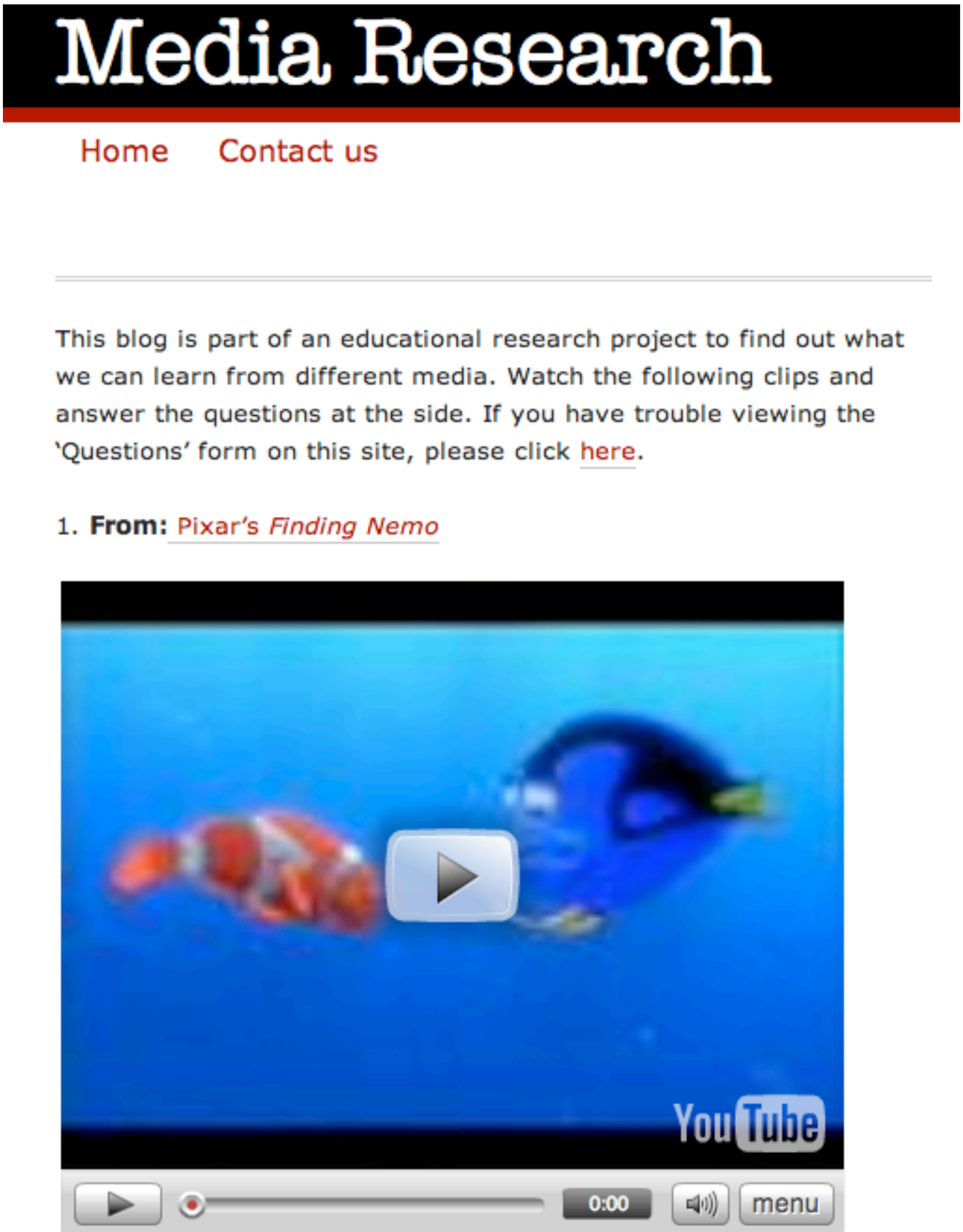
80. *Harry Hill's TV Burp*: http://www.itv.com/Entertainment/comedy/HarryHillsTVBurp/default.html [last accessed 16.08.09].
81. *Primeval*: http://www.itv.com/Drama/cult/Primeval/default.html [last accessed 16.08.09].
82. *Robots*: http://www.blueskystudios.com/content/features-robots.php [last accessed 08.08.09].
83. *Meet the Robinsons*: http://disney.go.com/disneyvideos/animatedfilms/meettherobinsons [last accessed 08.08.09].
84. *Bang Goes the Theory*: http://www.bbc.co.uk/bang [last accessed 08.08.09].
85. *Wile E. Coyote*: http://en.wikipedia.org/wiki/Wile_E._Coyote_and_Road_Runner [last accessed 16.08.09].

Appendices

Appendix 1:

Screenshot of weblog page

The other video clips (*Lyre Bird*, *Happy Feet*, *Creature Comforts*, *Bedbugs* and *Photosynthesis*) appeared below the *Finding Nemo* clip on the blog. See references for *YouTube* links.



Appendix 2:

Screenshot of webpage with blog survey questions

Questions

After watching the clips, please answer the following questions:

Name

Age *

- Under 11 years old
- 11–14 years old
- 15–18 years old
- 19–24 years old
- 25–34 years old
- 35–44 years old
- 45–54 years old
- 55–64 years old
- 65–74 years old
- 75 years and over

Which clip did you like best? *

- Clip 1: Finding Nemo
- Clip 2: Lyre Bird
- Clip 3: Happy Feet
- Clip 4: Creature Comforts
- Clip 5: Bedbugs
- Clip 6: Photosynthesis

Why did you enjoy that clip? *

Which clip did you not like at all? *

- Clip 1: Finding Nemo
- Clip 2: Lyre Bird
- Clip 3: Happy Feet
- Clip 4: Creature Comforts

http://myresearchproject.wufoo.com/forms/questions/ Page 1 of 2

- ○ Clip 5: Bedbugs
- ○ Clip 6: Photosynthesis

Why did you not like that clip? *

Did you learn anything new from any of the clips? Which clip(s) and what did you learn? *

Have you ever learnt anything from a cartoon (animation)? What cartoon was it and what did you learn? *

Out of all these clips (if any), which one comes closest to the type of programme you would watch in your spare time? *

Appendix 3:

Correspondence with those who took part in blog survey

Dear All,

I am an MA in Science Education student at the Institute of Education, London, whilst working at the same time on science communication projects, and my final year dissertation is on media and science. I am researching how much we can learn from different types of media - and whether young people are more likely to learn science from entertainment cartoons (because they enjoy them more and so may subconsciously take in accurate science).

I have put together a multimedia blog: [blog address] with some video clips and questions and if you (and/or your children/students) have 30 minutes spare (maximum) to take part, I would be so grateful. You can remain anonymous, and all answers will be confidential.

Kindest regards and thank you for taking the time to read this,

Sai

[Contact details]

More informal to those who I know well. I had already discussed the research in person, with most of them:

Hi [Contact Name],

If you have a spare moment (30min max, there are a few video clips and questions) - could you fill in an online survey for me, to find out what we can learn from different types of media? It's at: [blog address] as part of my MA dissertation. If you can twist anyone else's arms to give it a go too, it would be much appreciated. You can remain anonymous!

Thanks,
Sai

[Contact details]

Appendix 4:

Postings and e-mails to those on e-lists

Dear All,

If there is anyone on this list who has a child who is in Year 3 (7-8 years old), or Year 6 (10-11 years old), or you teach these year groups, and would be willing to ask them to help with a piece of educational research by trialling a questionnaire for me, could you get in touch? Thank you. Contact details are below.

Kindest regards,

Sai

[Contact details]

Responding to those who got in touch:

Dear [Name],

Thanks ever so much for getting in touch about the questionnaire trial.

Just to give you a bit of background: I am currently a freelance science communication and education consultant and have worked for [short description of my work background]. The reason I am looking for parents of primary aged children, primary school teachers and science coordinators is because I am also studying for a Masters in Science Education at the Institute of Education, London, and my final year dissertation is on media and science.

I will be starting some classroom research in a local primary school to find out how much science Year 3s (7-8 year olds) and Year 6s (10-11 year olds can learn from two different video clips. All I need is for some young volunteers (of both age groups) to have a look at the questionnaire (attached as a .pdf as well as Word document, as there are pictures) and to let me know if the questions make sense.

I am not looking for the right answers, I just want to see whether the questions are phrased well enough for students to understand, and will result in the answers I am expecting. I will not be marking the questionnaires or using them in my dissertation, this is just the trial for feedback purposes. All responses will remain confidential, and will be shredded at the end of my course.

The questionnaire consists of 16 questions (some are multiple-choice, others open-ended) based on ocean and rainforest wildlife and ecology. They can either type out their answers on the Word document and you can e-mail it to me, or please feel free to print it out, let them answer by hand, and I can send you an SAE to return it to me. If you need to go through it with [child/student] and you can send me feedback as to what could be better phrased/edited/deleted that would be extremely useful.

Would this be something your [son/daughter/students] might be able to trial for me? If yes, would you be able to get back to me by [date]? If you are also able to offer feedback on some interview questions for both/either age group too, I would be grateful, and can send that on to you too.

Thanks ever so much,
Kindest regards,
Sai

[Contact details]

Link to short advert posted on the noticeboard of the Planet Science Newsletter dated 24th April 2008 (Last accessed 19.07.09):

http://www.planet-science.com/about_sy/news/ps_251-275/274.html#6

Appendix 5:

Teacher consent letter

Dear [Teacher name],

As a past student of [school name], I would like to conduct my final dissertation research as part of my MA in Science Education (Institute of Education, London) at the school.

The research project will involve showing all students in your class a couple of science-based video clips and ask them questions based on the videos. I would also like to interview you before the research takes place and afterwards to find out about topics taught in class, students' preferences, backgrounds and about the school. For this I require your permission. Your name (unless you do not mind being acknowledged), the school's name, all students' names, results and comments will remain confidential, used only for the purposes of this study and will not be mentioned in the dissertation. I hope this study will benefit my profession as a freelance science consultant and educational resource producer. I would be more than happy to pass on the results of this study for you to share with the class, other staff and parents should you wish to do so.

Please could you sign the bottom of this letter to let me know you consent to taking part in this piece of research. Many thanks for your co-operation and support.

Yours sincerely,

[Sign]

____

Sai Pathmanathan

...✂...

MA in Science Education Research Proposal – Teacher consent

I, ______________________ consent to you interviewing me and to work with my class for the purposes of your research only.

Signed:

Appendix 6:

Parent/Guardian Consent Letter

Dear Parent/Guardian,

I am currently studying for a Masters Degree in Science Education at the Institute of Education, London. As a past student of [school name] and Science and Engineering Ambassador for Hertfordshire, I would like to conduct my final dissertation research at the school.

The research project involves showing all students in your child's class a couple of science-based video clips and ask them questions based on the videos. I may also like to interview your child (in a group) and record their conversations. For this I require your permission. All students' names, results and comments will remain confidential and will only be used for the purposes of this study and will not be mentioned in the dissertation. I hope this study will benefit my profession as a freelance science consultant and educational resource producer.

Please could you return the bottom section of this form to [teacher name] by **8th February 2008** if you **would not** like your child to take part. Should you wish to know more, feel free to contact me via e-mail on [my e-mail address] or speak with [teacher name] should you have any concerns. Many thanks for your co-operation and support.

Yours sincerely,

[Sign]

____

Sai Pathmanathan

____

[Teacher signature and name]

...✂..

MA in Science Education Research Proposal – Parent/Guardian permission

Child's name:

No, thank you. I would like my child to be withdrawn from your research.

Signed:

Appendix 7:

Questions to ask the teacher

Before the research begins:

1. How many children in the class? Year 3/6?
2. Number of boys/number of girls?
3. Age range?
4. Students' abilities:
    a. Any students with English as second/third language? (Information in clips relies on understanding dialogue/narration as well as what's going on.)
    b. Literacy/numeracy levels?
    c. Key Stage scores?
    d. Any behavioural issues?
    e. Attention span?
    f. Science knowledge/level of students? What topics?
5. What individual students enjoy in class?
6. Do you use video clips in class? How often? Why? (To aid understanding, subject difficult to demonstrate in class, or as a starter?)*
7. If you use videos in the classroom regularly, approximately how long are the clips/programmes you show?*
8. Viewing habits of children in class (do they pay attention)?
9. Viewing habits of children at home – what do they talk about at school?
10. Use of whiteboard for videos? Students' use of technology/new media tools in class? At home?**
11. Have you taught the students about ocean and jungle ecosystems already?
12. What are your expectations of this research?

* Would be interesting – the whole *Finding Nemo* film lasts 1 hour 40 minutes.
** i.e. will my methods be novel to the students and therefore influence the results?

After the research:

1. Have any of the students asked about the project whilst I was not there? Asking for the answers?
2. Do you know if any of them have done any research on themselves after the pre-viewing questionnaire? Any feedback from parents?
3. What have the students been learning about between the pre-viewing questionnaire and viewing clips/post-viewing questionnaire?
4. Has this research had any impact on the students in general?
5. Any other comments?

Appendix 8:

Pre-viewing questionnaire

Name:____**Age:**________

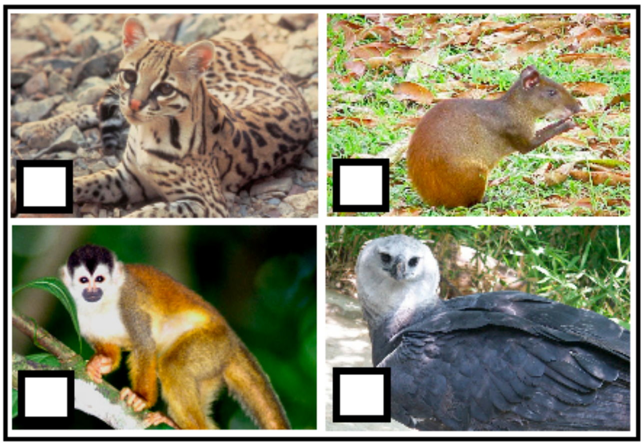
Please answer all the following questions as best as you can.

Tick the ONE that you think is…

1. …a type of **Clownfish**:

Images from Wikipedia.org

2. …an **Agouti**:



Images from Google Images

3. Where do clownfish live and why is this a good place for them to live?

4. It is thought that sea turtles can live to be over ______ years old. *(Fill in the blank).*

5. What does a squid do when it feels threatened (startled or scared)?

6. What does it mean if someone has “short-term memory loss”?

7. What do sharks’ teeth look like?

8. What else can you tell me about sharks?

9. Which is the biggest rainforest on Earth?

10. How much of the world’s oxygen comes from this rainforest? *Tick the ONE answer you think is correct.*

☐ One quarter
☐ One fifth
☐ One tenth
☐ One percent

11. What does the Agouti do?

12. Can all spiders bite and hurt you? *Explain why you think that.*

13. What is the biggest tree in this rainforest? Do you know roughly how tall it is, and how old it is?

14. How many known species of tarantula are there? *Tick the ONE answer you think is correct.*

☐ 10
☐ 80
☐ 800

☐ 8000

15. Which is the largest ocean in the world? *Tick the ONE answer you think is correct.*

☐ Atlantic
☐ Indian
☐ Arctic
☐ Pacific

16. Why is it hard for new plants to grow near their parent plant?

Appendix 9:

Post-viewing questionnaire

Name:____Age:________

Please answer all the following questions as best as you can.

1. Which clip was your favourite… *(Tick ONE)*

☐ *Deep Jungle* clip

☐ *Finding Nemo* clip

….and why did you like this clip the most?

2. What new things did you learn from both clips?

3. Is there anything in either of the clips that you did not believe?

4. Tick ONE of the following:

☐ I had seen the *Deep Jungle* clip before today

☐ I had seen the *Finding Nemo* clip before today

☐ I had seen both the *Deep Jungle* and *Finding Nemo* clips before today

☐ I had not seen either the *Deep Jungle* or *Finding Nemo* clips before today

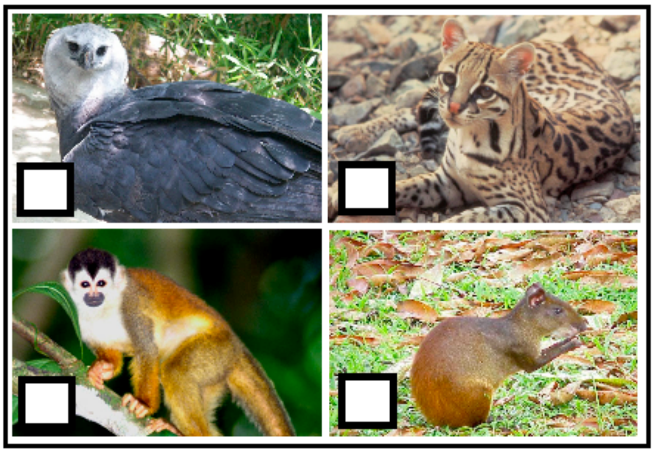
5. What does it mean if someone has "short-term memory loss"?

6. Can all spiders bite and hurt you? *Explain why you think that.*

7. How many known species of tarantula are there? *Tick the ONE answer you think is correct.*

☐ 10
☐ 80
☐ 800
☐ 8000

8. Tick the ONE that you think is an **Agouti**:



Images from Google Images

9. What does the Agouti do?

10. Which is the biggest rainforest on Earth?

11. What is the biggest tree in this rainforest? Do you know roughly how tall it is, and how old it is?

12. How much of the world's oxygen comes from this rainforest? *Tick the ONE answer you think is correct.*

☐ One quarter
☐ One fifth
☐ One tenth
☐ One percent

13. Why is it hard for new plants to grow near their parent plant?

14. Which is the largest ocean in the world? *Tick the ONE answer you think is correct.*

☐ Atlantic
☐ Indian
☐ Arctic
☐ Pacific

15. Tick the ONE that you think is a type of **Clownfish**:

Images from Wikipedia.org

16. Where do clownfish live and why is this a good place for them to live?

17. What does a squid do when it feels threatened (startled or scared)?

18. What do sharks’ teeth look like?

19. What else can you tell me about sharks?

20. It is thought that sea turtles can live to be over ______ years old. *(Fill in the blank).*

Appendix 10:

Expected questionnaire answers

[Number of marks possible per question are given below dependent on how much information the respondent gave; C = correct but not counted as this information could not be gleaned from the clips]

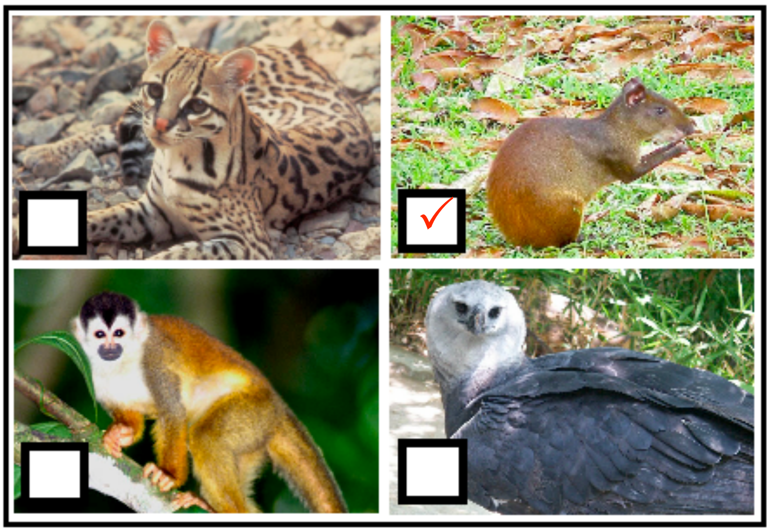
FN – Question relating to *Finding Nemo*
DJ – Question relating to *Deep Jungle*

Tick the ONE that you think is…

FN - 1. …a type of **Clownfish**: Either right or wrong

Images from Wikipedia.org

DJ - 2. …an **Agouti**: Either right or wrong



Images from Google Images

FN - 3. Where do clownfish live? Why?
1 - anemones [any spelling of this is accepted. 'Coral' is wrong.]
1 - for safety/protection [camouflage is wrong]
1 - from predators

1 - brushing against the anemone prevents stings [Marlin says: 'Do you want this anemone to sting you?']
C - 'in the sea/in water'

FN - 4. It is thought that sea turtles can live to be over ___100___ years old. *(Fill in the blank).*
1 - 100
C - 150 [not wrong – but it is mentioned at the end of the film, not in the clip]

FN - 5. What does a squid do when it feels threatened (startled or scared)?
1 - releases [or any similar word accepted, e.g. let out, spray, squirt]
1 - ink

Or:
2 - inks [Pearl the squid uses it as a verb: 'You made me ink!']

C - swim away [this is correct in real-life, but doesn't happen in film]
C - releases something black [correct, but not accurate enough]

FN - 6. What does it mean if someone has "short-term memory loss"?
1 - forget things/information
1 - almost instantly/quickly [did not accept 'easily']

Or:
1 - remember new things
1 - for short time [even if they state minutes instead of 'short']

FN - 7. What do sharks' teeth look like?
1 - sharp/pointy/triangular teeth [anything looking square/like human teeth – wrong] - Or: 1 – descriptive word e.g. like knives/daggers
1 - in multiple rows
1 - white
1 - other description based on what has been seen in film – stained teeth/fish bones/big/jagged
[If picture drawn - could cover first three marks in one go]

FN - 8. What else can you tell me about sharks?
1 - different species
1 - sensing blood
1 - number of gills
1 - predator
1 - any other information about sharks – swimming behaviour, fins, eating fish
Wrong - sharks wanting to be vegetarians, being friends with fish

DJ - 9. Which is the biggest rainforest on Earth?
1 - Amazon/Brazilian

DJ - 10. How much of the world's oxygen comes from this rainforest? *Tick the ONE answer you think is correct.*

☐ One quarter
1 - ☑ One fifth
☐ One tenth
☐ One percent

DJ - 11. What does the Agouti do?
1 - opens the brazil nut pod

1 - eats nuts
1 - buries the brazil nut (with shell) in ground
1 - forgets where it has buried it
1 - so plant can grow
1 - anything specific about the agouti itself gleaned from clip (rat-like, behaviour – not general information like 'eats, sleeps')

DJ - 12. Can all spiders bite and hurt you? *Explain why you think that.*
1 - no
1 - few spiders have large enough jaws
1 - to open wide and pierce the skin
1 - and of those very few are venomous
C - personal experience as their reason for why most spiders do not harm us

DJ - 13. What is the biggest tree in this rainforest? Do you know roughly how tall it is, and how old it is?
1 - Brazil nut tree ['Brazil tree' accepted]
1 - Roughly 50m tall
1 - 500 years old

DJ - 14. How many known species of tarantula are there? *Tick the ONE answer you think is correct.*

☐ 10
☐ 80
1 - ☑ 800
☐ 8000

DJ - 15. Why is it hard for new plants to grow near their parent plant?
1 - competition for strong direct sunlight
C - food/nutrients
C - water
C - any other correct answer not mentioned in the film - lack of space
Wrong - strangling by parent's roots

16. Which is the largest ocean in the world? *Tick the ONE answer you think is correct.*

☐ Atlantic
☐ Indian
☐ Arctic
1 - ☑ Pacific

[An extra question not related to either of the clips at all – do they get the same answer pre- and post- viewing (or have some of them done some extra homework? Or is this guesswork?)].

From the post-viewing questionnaire:

17. Which clip was your favourite… *(Tick ONE)*

☐ *Deep Jungle* clip

☐ *Finding Nemo* clip

….and why did you like this clip the most?
[Find out their reason – entertainment/educational?]

18. What new things did you learn from both clips?
[They may choose one as their favourite but learnt something from both/one/neither. Were the 'new things learnt' accurate, or have they taken away inaccurate information?]

19. Is there anything in either of the clips that you did not believe?
[Do they believe everything they see? Or do they know when something is made up? How much information do they believe/not believe?]

20. Tick one of the following:

☐ I had seen the *Deep Jungle* clip before today

☐ I had seen the *Finding Nemo* clip before today

☐ I had seen both the *Deep Jungle* and *Finding Nemo* clips before today

☐ I had not seen either the *Deep Jungle* or *Finding Nemo* clips before today

[Are their answers to questions a result of having seen the films before – e.g. do they remember information 'outside' of the clip?]

Appendix 11:

Semi-structured interview questions

Names/Ages of children in group:

FN	DJ

1. ______________________________Age:__________
2. ______________________________Age:__________
3. ______________________________Age:__________
4. ______________________________Age:__________

Questions

1. How would you describe what you thought of the clips using the scale below?

1 ☹ 👎	2 ☹	3 😐	4 ☺	5 👍 ☺
Terrible	**Not so good**	**OK**	**Good**	**Great**

2. Did you like one clip better than the other? If so, why?

3. Is there anything wrong with taking wild animals away from their natural homes?

4. You answered questions based on the clips - was there anything else you learnt from both clips that you weren't asked about, but you'd like to tell me?

5. Is there anything in either clip that you did not believe?

6. Tell me about what you like to watch in your spare time?

7. Do you watch anything in your spare time that helps you learn new things?

8. Did you enjoy watching these clips in class or do you think you should only watch both these programmes, (or only one of them), in your spare time and why?

9. Do you think you can learn things, like science, from cartoons better than from documentary (live-action) programmes?

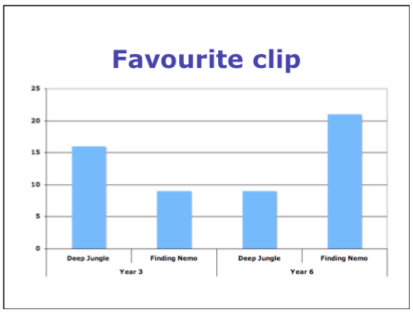
10. If you could invent your own science programme for kids, what would it be like?

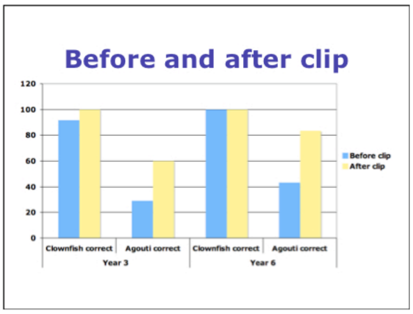
Appendix 12:

Feedback presentation given at school

My project

- To find out how much science you can learn from a cartoon (like Finding Nemo)
- Is it more fun to learn from cartoons or from a real action documentary film (like Deep Jungle)?
- What do we believe more?





Other answers

- Clownfish live in anemones - by brushing against them, clownfish are covered by a mucus layer, so they are protected from stings. Anemone protects fish, fish feed anemone.
- Sea turtles live to be very old - can be around 100 years.
- Short term memory loss: what you have just learnt you forget.
- Squids release ink when they are attacked. The ink distracts the predator and they can escape.
- Agouti - rat-like creature, opens brazil nut pods and buries the nut.

Comments

- Some pupils didn't like spiders (harder to learn about something when you don't like the subject)
- Didn't believe that fish could speak or go to school (Finding Nemo) or that there was a chicken-eating spider (Deep Jungle)
- Can learn from both films - but one seems more fun and other seems more educational

Appendix 13:

Raw data: Blog survey

Which clip did you like/dislike?

	Which clip did you like best?	Which clip did you not like at all?
Finding Nemo	8	4
Lyre Bird	42	2
Happy Feet	8	6
Creature Comforts	7	6
Bedbugs	1	14
Photosynthesis	1	35

Have you ever learnt anything from a cartoon?

Yes	33
No	26
Don't know/maybe	8

Why did you like the clip (chosen as favourite)?

	Category	Incidence
1	Informative	30
2	Entertaining	25
3	Style and Tone	19
4	Interesting/Inspiring	35

Why did you not like the clip (chosen as least liked)?

	Category	Incidence
5	Not informative	10
6	Boring	25
7	Style and Tone	31
8	Personal dislike	28

Which clips did blog respondents learn new information from, and which clip came closest to what they would watch in their spare time?

	Which clip did you learn something new from?	Which clip comes closest to what you would watch in your spare time?
Finding Nemo	5	24
Lyre Bird	38	44
Happy Feet	3	11
Creature Comforts	1	12
Bedbugs	30	4
Photosynthesis	5	3

Which age range liked/disliked which clip?

Age range - like/dislike	Finding Nemo	Lyre Bird	Happy Feet	Creature Comforts	Bedbugs	Photosynthesis
Under 11 - liked clip	0	0	0	1	0	0
Under 11 - disliked clip	0	0	0	0	0	1
11-14 - liked clip	0	1	1	2	0	0
11-14 - disliked clip	0	0	0	1	1	2
15-18 - liked clip	0	1	1	0	0	0
15-18 - disliked clip	0	0	0	0	1	1
19-24 - liked clip	1	0	0	0	0	1
19-24 - disliked clip	0	1	0	0	0	1
25-34 - liked clip	5	15	5	3	1	0
25-34 - disliked clip	0	1	2	2	7	17
35-44 - liked clip	0	9	0	1	0	0
35-44 - disliked clip	0	0	1	0	3	6
45-54 - liked clip	1	7	0	0	0	0
45-54 - disliked clip	3	0	2	2	0	1
55-64 - liked clip	1	8	1	0	0	0
55-64 - disliked clip	1	0	0	1	2	6
Over 65 - liked clip	0	1	0	0	0	0
Over 65 - disliked clip	0	0	1	0	0	0

Appendix 14:

Raw data: Classroom-based research

Which clip was your favourite?

Year 3	**Deep Jungle**	16
	Finding Nemo	9
Year 6	**Deep Jungle**	9
	Finding Nemo	21

Which clip had you seen before today?

Year 3	**Deep Jungle only**	0
	Finding Nemo only	20
	Both clips	3
	Neither clip	2
Year 6	**Deep Jungle only**	0
	Finding Nemo only	29
	Both clips	1
	Neither clip	0

Number of students who got the multiple-choice 'Clownfish/Agouti' identification question correct:

		Number of students answered correctly (pre-viewing questionnaire)	**Number of students answered correctly (post-viewing questionnaire)**
Year 3	Clownfish correct	22	25
	Agouti correct	7	15
Year 6	Clownfish correct	30	30
	Agouti correct	13	25

Why did you like this clip (the clip chosen as favourite) the most?

		Year 3 reason for liking Finding Nemo	**Year 6 reason for liking Finding Nemo**	**Year 3 reason for liking Deep Jungle**	**Year 6 reason for liking Deep Jungle**
1	Informative	1	7	8	3
2	Entertaining	5	13	6	1
3	Style and Tone	0	2	0	1
4	Interesting/Inspiring	1	2	11	8
	Another reason	0	3	0	0

Which film clip did students mention that they did not believe in:

	Year 3	Year 6
Did not believe Finding Nemo	4	15
Did not believe Deep Jungle	5	2
Did not believe both Finding Nemo and Deep Jungle	1	1
Believed both Finding Nemo and Deep Jungle	14	12

Which film clip did students mention that they learnt the most from:

	Year 3	Year 6
Finding Nemo	3	2
Deep Jungle	12	14
Both Finding Nemo and Deep Jungle	7	13

How many students got the extra question correct: Which is the largest ocean in the world?

	Year 3	Year 6
Correct pre-viewing	3	4
Correct post-viewing	1	2
Correct pre- and post-viewing	4	7
Wrong pre- and post-viewing	16	17

Number of students who drew a picture for: What do sharks' teeth look like?

	Pre-viewing	Post-viewing
Year 3	15	13
Year 6	3	4

The number of correct marks that could not be taken into consideration when assigning scores as it was knowledge not derived from the clips:

	Year 3 (pre-viewing)	Year 3 (post-viewing)	Year 6 (pre-viewing)	Year 6 (post-viewing)
Finding Nemo	32	11	42	33
Deep Jungle	16	17	21	12

Pre-viewing and post-viewing questionnaire scores. Raw data to calculate gain scores from:

Year 3					Year 6			
Finding Nemo		Deep Jungle			Finding Nemo		Deep Jungle	
Pre-viewing score	Post-viewing score	Pre-viewing score	Post-viewing score		Pre-viewing score	Post-viewing score	Pre-viewing score	Post-viewing score
8	11	3	9		4	4	1	7
3	1	0	2		7	7	1	11
4	8	2	3		8	7	2	4
10	6	3	8		4	4	2	5
4	5	1	4		8	9	4	9
3	6	1	0		5	9	4	7
4	4	1	0		6	8	3	6
4	2	2	1		7	7	2	2
5	8	2	9		7	10	3	7
8	7	1	3		14	11	6	16
7	6	1	3		8	6	5	3
5	7	1	4		5	7	3	3
9	10	5	9		10	9	3	12
9	11	6	11		7	9	4	9
9	8	6	9		9	8	2	8
6	6	2	1		5	5	3	12
5	6	2	5		4	5	1	3
4	2	0	2		11	11	2	9
7	11	2	2		9	10	6	13
2	5	1	3		5	5	3	4
4	11	3	4		8	9	2	9
5	8	1	3		7	7	5	8
3	3	2	0		4	8	3	12
5	7	2	4		8	5	3	3
					9	9	2	9
					8	10	3	9
					7	9	2	9
					8	14	3	11
					8	9	4	5
					7	10	3	13

Ratings based on the Likert scale shown during the interview (Year 3, n=4; Year 6, n=4). Where 1=Terrible, 2=Not so good, 3=OK, 4=Good and 5=Great.

		Finding Nemo	**Deep Jungle**	**Age**
Year 3	**Student 1**	3	5	8
	Student 2	3	5	7
	Student 3	5	5	8
	Student 4	3	5	7
	Average	**3.5**	**5**	**7.5**
		Finding Nemo	**Deep Jungle**	**Age**
Year 6	**Student 5**	3	5	10
	Student 6	4	5	10
	Student 7	4	4	10
	Student 8	5	3	10
	Average	**4**	**4.25**	**10**