Master Thesis

The Relationship between Learning Style, Learning Behaviour and Recall of Important and Seductive Details:

A Correlational Study using an Educational Video

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Enschede, 28th March, 2019

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Acknowledgements

I never thought going back to studying after working for ten years would be easy, but my journey through the Educational Science and Technology Masters Programme has been challenging in the most exciting of ways. My thesis has taken me through so many twists and turns and has taught me so much about academic research that now, when I have come to complete it, I have a feeling not only of satisfaction, but also of having learned and grown.

I would like to thank my first supervisor, Dr. Bas Kollöffel, for his unending patience over the last seven months, for listening to my often far-fetched ideas of what I wanted to study, for guiding me gently and firmly in the right direction, and for always being there to offer his advice, guidance and support. I would also like to thank my second supervisor, Dr. Hans van der Meij, for his feedback and guidance that resulted in significant improvements to this thesis.

My family has supported me through the entire journey, but my mom has truly been something special. Even though she was far away, it felt like she was close by my side, as she kept in constant touch with me to act as my sounding board every single time I needed one. And last, but certainly not the least, I am grateful to Andre, who was there for me through the best of times and the worst of times, and who always pushed me forward to achieve more and achieve it well.

Abstract

There has been an increase in the volume of educational videos being made and the volume of learning, both formal and recreational, that occurs through such videos. Therefore, it is necessary to ensure the benefits of such videos for students with different learning styles. However, there is insufficient research regarding the relationship between learning styles and the recall of details from educational videos. This study aimed to find the association between learning style, learning behaviour, recall of important details and recall of seductive details from an educational video, among university students in The Netherlands. The study was conducted at the University of Twente and used a correlational design, with learning style, learning behaviour, recall of important details and recall of seductive details as the variables. An online environment was used to collect data for each of the variables. Since analysis of the data showed that the learning behaviour instruments were not reliable, learning behaviour was not considered for the statistical tests. The results of the study showed no significant correlations between learning style and recall of important details or recall of seductive details, but showed a significant positive correlation between recall of important details and recall of seductive details.

Keywords: learning style, learning behaviour, learning outcomes, recall of important details, recall of seductive details, verbaliser-visualiser hypothesis, seductive details hypothesis

1. Introduction

Educational videos offer the opportunity to present important information through audio and accompanying visuals simultaneously, thus making optimal use of both the auditory and the visual sensory channels and maximising the learning potential as per the multimedia, modality and redundancy principles (Mayer, 2014b). These videos also offer the opportunity to include seductive details (interesting but irrelevant elements) through the audio and the accompanying visuals, in order to improve the appeal of the videos and increase the students' motivation to learn from them (Korbach, Brünken, & Park, 2016). In recent times, a number of universities are moving towards blended learning, in which the students take online lessons before the lecture and then engage in hands-on activities during the lecture (Zainuddin & Halili, 2016). These online lessons are often in the form of educational videos that the teachers themselves create or that are available through organisations that make such videos (van der Meij & van der Meij, 2015). Also, students are taking the initiative to look for and watch educational videos on YouTube to increase their knowledge about a variety of topics in fields including politics, history and science. The move towards formal blended learning by universities and the move towards recreational self-education by students has led to an increase in the demand for educational videos. The production of these videos has been facilitated by the development and availability of easy-to-use video-creation software and the ability to easily publish and distribute videos through the Internet (van der Meij & van der Meij, 2013). ten Hove and van der Meij (2015) estimate that new educational videos are uploaded on YouTube at the rate of 1,680 per week, or 87,360 per year. Thus, there has been an increase in the volume of such educational videos being made and the volume of learning, both formal and recreational, that occurs through such videos. Since organisations spend a significant amount of money making these videos, and since students spend a significant amount of their time watching these videos, it is necessary to not only maximise the effectiveness of the learning from these videos, but also ensure the benefits of these videos for students with different learning styles. However, there is a lack of sufficient research regarding the association between learning styles and the recall of details from educational videos, in terms of both the important details and the seductive details.

If we take a step back from educational videos as the specific type of learning material and look at the association between learning styles and the recall of details from any kind of learning materials, there is still a lack of sufficient, conclusive research. Opinions on whether learning styles

can be used to influence learning outcomes from learning materials are divided, with some researchers and educators finding that they can be used to improve learning outcomes (Baukal & Ausburn, 2014; Cassidy, 2004; Dunn, Beaudry, & Klavas, 2002; Eom, Wen, & Ashill, 2006; Felder & Silverman, 1988; Gilakjani, 2012; Hawk & Shah, 2007; Lujan & DiCarlo, 2006; Othman & Amiruddin, 2010), and others finding that they have no influence on learning outcomes (Bhagat, Vyas, & Singh, 2015; Husmann & O'Loughlin, 2018; Kirschner, 2017; Kollöffel, 2012). Even though there has been a significant amount of controversy regarding the concept, existence and usefulness of learning styles, many students and teachers still try to use their knowledge of them to adapt learning and teaching strategies in an effort to improve the learning outcomes from learning materials, while some others claim that students use their learning style as a "crutch" for their inability to learn from the available learning materials (Husmann & O'Loughlin, 2018).

The present study aims to contribute to the field of research on learning styles by providing data that can be beneficial to the understanding of the association between learning styles and learning outcomes from learning materials. While there have already been a number of studies in this field, this study endeavours to add to the field in three significant ways: 1) Using an educational video as the learning material, as opposed to using text and image-based material as done in most previous studies 2) Considering the learning behaviour, in addition to the learning styles 3) Considering the recall of seductive details, in addition to the recall of important details. Thus, the objective of the present study is to find the association between learning style, learning behaviour, recall of important details and recall of seductive details from an educational video, among university students in The Netherlands.

2. Theoretical Framework

2.1. Educational Videos

Educational videos, like other online learning tools, allow learners to learn whenever and wherever they want and at their own pace. However, they eliminate the teacher-student interaction available with classroom learning (Kelly, Lyng, McGrath, & Cannon, 2008). In the absence of support from a teacher, measures need to be taken to ensure that educational videos facilitate effective learning for all learners. Leutner and Plass (1998) emphasise how new educational technologies require educators to give special attention to the differences between learners, and how for new visualisation technologies, such as videos, this special attention should be given to the differences between learners in the verbal/visual dimension, since educational videos present information through audio and accompanying visuals and thus make use of the verbal and visual sensory channels. Therefore, in order to examine learning style, learning behaviour and recall of important and seductive details from an educational video, the present study distinguishes them as 'verbal' or 'visual'.

It is beneficial to point out how this study defined 'verbal' and 'visual'. Spoken words and sounds are easily classified as auditory information, while pictures, illustrated diagrams, charts, graphs, maps and animations are easily classified as visual information. However, printed text is not classified as easily. It is not aural, so it cannot be classified as auditory, while it is not pictorial, so it cannot be classified as visual either. Research has shown that people convert printed words into their spoken equivalent and process them the same way they would process them if they had heard them being spoken aloud (Preface to Felder & Silverman, 1988). Therefore, this study included printed text and spoken words in the same category, that is, verbal, and considered the learning styles as 'verbal' and 'visual', rather than as 'auditory' and 'visual'.

2.2. Learning Styles

2.2.1. Definition. According to Felder and Silverman (1988), in formal education, learning occurs as a two-step process, with the first step being reception of information and the second step being processing of information. During the reception of information, the student first receives external information, which the student perceives through their senses, and internal information, which the student generates on their own through introspection, and then selects which information to ignore and which information to pass on for processing. During the processing of information, the student either simply memorises the information or performs a more complex "inductive or

deductive reasoning, reflection or action, and introspection or interaction with others" (Felder & Silverman, 1988, p. 674). A learning style refers to the way in which a student undergoes the two steps of reception and processing of information. More specifically, a learning style is the manner in which, during the reception step, a student perceives and gathers information in the learning environment, and during the processing step, a student thinks about, organises, interprets, interacts with and responds to the information (Bhagat et al., 2015; Gilakjani, 2012; Husmann & O'Loughlin, 2018; Marcy, 2001). A student's learning style may be determined by his or her cognitive, affective, sociological, physiological and psychological characteristics (Bhagat et al., 2015; Gilakjani, 2012; Othman & Amiruddin, 2010).

2.2.2. Lack of a consistent definition, model and measure. Although the term 'learning style' was first used more than sixty years ago (Leite, Svinicki, & Shi, 2010) and was popularised as long ago as the 1970s (Husmann & O'Loughlin, 2018), and although the explanation of a learning style provided here seems simple enough, there are many varied definitions of learning style in the literature (Klement, 2014) and theorists and researchers have not been able to agree on a definition of learning style (Leite et al., 2010). In fact, Cassidy (2004) points out that it has been said that the number of definitions of learning style is almost equal to the number of theorists and researchers in the field of learning styles. Curry (1990) has called this a "confusion in definitions" (p. 50). Eom et al. (2006) suggest that this lack of a consistent definition has led to a continuing interest in, and research on, learning styles. On the other hand, Cassidy (2004) suggests that the large number of research studies has led to the variety and inconsistency of definitions, explanations, models and measures of learning styles. While this variety and inconsistency can be considered not only natural in a field that is still developing, but also useful in increasing the knowledge and understanding in that field, it does create some problems. Researchers may be motivated and enthused by the challenge provided by the inconsistency, but teachers wishing to use learning styles to improve the effectiveness of their classes may be only daunted by the inconsistency and, thus, unable to select a model and measure of learning styles to use (Cassidy, 2004).

2.2.3. Attempts to compile the models and measures. Eom et al. (2006) claim that there were already 21 models of learning styles in the literature in 1983 and the number has only grown since then. There have been a number of attempts to create a compilation of the various models and measures, so that researchers, teachers and students can easily have an overview of the range

they can choose from. Jonassen and Grabowski (1993) created a list of the learning style instruments that were available (Leite et al., 2010). Mareš (1998) and Šimonová, Bílek, and Poulová (2010) made similar lists, along with descriptions of each instrument (Klement, 2014). Also, Sternberg and Zhang (2001) published a book "discussing the history, traditions, research, and theory around the topic of thinking, learning, and cognitive styles" (Leite et al., 2010, p. 2). There have also been attempts to simplify the field of learning styles through a process of integration and rationalisation of the various models available by finding the common aspects that are included across the models (Cassidy, 2004).However, as of now, there is no consensus on which aspects should or should not be included in a learning style model (Leite et al., 2010).

2.2.4. Selection of a learning style model for the present study. Perhaps the lack of a consensus on which aspects should be included in a learning style model is because some researchers believe that any aspect that affects learning should be included in the model, while others believe that only the cognitive process and perceptual aspects should be included in the model (Leite et al., 2010). Supporting the stance of all aspects being included is an article by Drago and Wagner (2004), in which they state that a learning style needs to be defined by at least four dimensions: cognitive, affective, physiological and psychological. Supporting the stance of only the cognitive process and perceptual aspects being included is an article by Felder and Silverman (1988), in which they state that a learning style needs to be defined by the answers to five questions, three of which pertain to cognitive process preferences and two of which pertain to perceptual preferences. However, Leite et al. (2010) note that most modern learning style theories and models focus on the cognitive process and perceptual aspects that affect learning, and observe that these aspects may be referred to by different terms, such as the cognitive and physiological dimensions, in various theories and models. This study focuses exclusively on the perceptual, or physiological, aspects that affect learning, that is, the senses that are used for learning (Eom et al., 2006).

Traditionally, it was thought that people can perceive information in three ways (visually, auditorily and kinaesthetically) and that most people gain information most effectively when it is made available in one of these three ways, while tending to miss or ignore information when it is made available in one of the other ways (Felder & Silverman, 1988). Thus, people can be classified as visual, auditory or kinaesthetic learners (Felder & Silverman, 1988). Visual learners learn best through pictures, images, diagrams, charts, graphs, infographics, maps, animations, demonstrations and body language (Felder & Silverman, 1988; Gilakjani, 2012; Hawk & Shah,

2007). Auditory learners learn best through lectures, reading out loud, discussions and stories (Felder & Silverman, 1988; Gilakjani, 2012; Hawk & Shah, 2007). Kinaesthetic learners learn best from hands-on experiences, interaction with the physical environment, laboratory experiments, simulations, field trips, case studies, role-play and drama (Baykan & Naçar, 2007; Gilakjani, 2012; Hawk & Shah, 2007). More recently, it has been suggested that humans actually perceive information in four ways (Bhagat et al., 2015). Aside from the visual, auditory and kinaesthetic ways, there is an additional way—reading and writing. Read-write learners learn best from printed text, such as textbooks, lecture notes, handouts, essays, reports, lists and glossaries (Baykan & Naçar, 2007; Hawk & Shah, 2007). In multimedia learning, information is presented verbally and visually and, thus, the most appropriate models and measures of learning styles in multimedia learning would consider the perception of information in two ways: verbal and visual. Therefore, within the perceptual, or physiological, aspects that affect learning, this study focuses specifically on the perception of information in the verbal and visual ways. It is believed that, although students can use both their verbal and visual senses for learning and can switch between the two senses during the learning process, one sense is usually stronger than the other and students tend to rely more heavily on that sense for gaining information (Cassidy, 2004; Lujan & DiCarlo, 2006). This study aimed to check the association between the verbal and visual learning styles.

2.2.5. The Santa Barbara Learning Style Questionnaire, the Verbal-Visual Learning Style Rating and the Learning Scenario Questionnaire. In an attempt to create and validate short self-report measures of verbal/visual learning styles that are economical, Mayer and Massa (2003) developed three original instruments: 1) The Santa Barbara Learning Style Questionnaire (SBLSQ) 2) The Verbal-Visual Learning Style Rating (VVLSR) 3) The Learning Scenario Questionnaire (LSQ). The SBLSQ consists of a set of six questions regarding the student's beliefs about their learning style. Each question is a statement about verbal or visual learning. For example, one of the statements about verbal learning is "I am good at learning from printed text." and one of the questions about visual learning is "I am good at learning from labeled pictures, illustrations, graphs, maps, and animations." The student is required to indicate their level of agreement or disagreement with each statement by selecting one of the options on a seven-point scale (Strongly agree – Moderately agree – Slightly agree – Neither agree nor disagree – Slightly disagree – Moderately disagree – Strongly disagree). The VVLSR consists of a single question that aims to summarise the student's beliefs about their learning style. The question asks the

student "In a learning situation sometimes information is presented verbally (e.g., through printed or spoken words) and sometimes information is presented visually (e.g., with labeled illustrations, graphs, or narrated animations). Please place a check mark indicating your learning preference." The student is required to indicate their preference by selecting one of the options on a seven-point scale (Strongly more verbal than visual – Moderately more verbal than visual – Slightly more verbal than visual – Equally verbal and visual – Slightly more visual than verbal – Moderately more visual than verbal – Strongly more visual than verbal). The LSQ consists of a set of five questions regarding the student's preference of the type of presentation (verbal or visual) in different learning scenarios. For example, one of the questions is "Which format do you prefer in learning a scientific description of an atom?", with the verbal presentation being "a paragraph describing each part" and the visual presentation being "a labeled diagram showing each part". The student is required to indicate their preference of the type of presentation by selecting one of the two available options, verbal or visual.

The reliability of the Santa Barbara Learning Style Questionnaire and the Learning Scenario Questionnaire was assessed by Mayer and Massa (2003). They found that the questionnaires had Cronbach's alpha coefficients of .76 and .38, respectively. The reliability of the Verbal-Visual Learning Style Rating was not assessed as it consists of a single item. The validity of the Santa Barbara Learning Style Questionnaire, the Verbal-Visual Learning Style Rating and the Learning Scenario Questionnaire were assessed by Mayer and Massa (2003) and by Massa and Mayer (2006). They found that the three instruments had a satisfactory validity as they loaded on the same factor as, and correlated positively and strongly with, each other and another traditional verbal-visual learning style questionnaire, that is, the Verbalizer-Visualizer Questionnaire. This study aimed to check the association between the measures of learning style obtained from these three instruments.

2.3. Learning Behaviour

2.3.1. Definition. The descriptions of learning styles "range from relatively fixed student natural dispositions to modifiable preferences for learning and studying" (Hawk & Shah, 2007, p. 2). Cassidy (2004) attempts to explain these two different opinions as due to the terms 'learning styles' and 'learning strategies' being used interchangeably. Cassidy (2004) distinguishes between learning styles, which are automatic, and learning strategies, which are optional. On the one hand, learning styles are the ways in which students process information; they are structural, deeply

ingrained and stable over time (Baukal & Ausburn, 2014; Cassidy, 2004). On the other hand, learning strategies are the techniques, methods or activities that students use to complete a learning task; they are procedural, adaptive to the situation and modifiable over time (Baukal & Ausburn, 2014; Cassidy, 2004). It can be said that the learning strategies that students use influence their learning behaviour, which Leutner and Plass (1998) describe as the observable choices that students make in authentic learning situations. They claim that, in the verbal-visual dimension, the students' learning behaviour would be observable through the choices that they make to receive information in the verbal or visual format.

2.3.2. Advantage over learning styles. When it comes to the predictive value of learning styles and learning behaviour in terms of learning outcomes, Leutner and Plass (1998) suggest that learning behaviour may be more beneficial. This is because learning styles are usually evaluated: 1) using self-report questionnaires filled in by the students, which may result in insufficient reliability and validity 2) in non-authentic learning situations. In comparison, learning behaviour can be evaluated: 1) using direct observations of the students' choices during a learning task 2) in authentic learning situations (Leutner & Plass, 1998).

2.3.3. The Visualizer/Verbalizer Behavioral Observation Scale. Keeping in mind the two benefits of evaluating learning behaviour instead of learning styles, Leutner and Plass (1998) set out to develop a new instrument to evaluate students' learning behaviour in terms of verbal/visual learning preferences. Their premise was that in an authentic learning situation, since a verbal/visual learning preference indicates a preference for either verbal or visual learning material, when given a choice between either receiving information verbally or receiving information visually, a verbal learner would choose to receive it verbally and a visual learner would choose to receive it visually, and when given a choice between either receiving information verbally first and then visually or receiving information visually first and then verbally, a verbal learner would choose to receive it verbally first and a visual learner would choose to receive it visually first. Based on this premise, they created the Visualizer/Verbalizer Behavioral Observation Scale (VV-BOS), an instrument that uses a story in German with 24 words marked to indicate that English translations are available in text as well as graphic format, making the choice between verbal and visual information available to the learner.

For each word, the learner is allowed to opt for neither format, any one format or both formats of the English translations. For each word, the learner's choice is recorded in terms of a

score: '0' if neither format is opted for, '-1' if the text format is opted for and '+1' if the graphic format is opted for (with only the first choice counting if both formats are opted for, for a particular word). The learner's total score for all the words denotes their position on the bipolar verbal/visual dimension. Thus, the VV-BOS places the learner in an authentic learning situation (reading a story in German), requires them to make choices to receive additional information either verbally or visually, and then directly observes and records the learner's behaviour in terms of the choices they make, thus providing a way to measure the strength and consistency of the learner's preference for verbal or visual information (Leutner & Plass, 1998).

The reliability and validity of the VV-BOS were assessed by Leutner and Plass (1998). They found that the instrument had an acceptable Cronbach's alpha coefficient of .92. They also found that it had a satisfactory validity as it correlated positively with the visualiser scales of the VVQ and ELSIE and negatively with the verbaliser scale of the ELSIE. Therefore, they concluded that the VV-BOS was a good alternative to learning style instruments that counted on self-reported data.

2.3.4. The Multimedia Learning Preference Test. Mayer and Massa (2003) used the VV-BOS as the basis for the design of their own instruments to evaluate student's learning behaviour in terms of verbal/visual learning preferences, specifically in multimedia learning—the Multimedia Learning Preference Test-Choice and the Multimedia Learning Preference Test-Rating. These instruments substitute the German story and English translations of marked words with a multimedia lesson on lightning and scientific explanations of marked terms. The lesson consists of five frames on lightning formation, with each frame having one or more marked terms and explanations of the marked terms being available in text (a glossary of the terms) and graphic (a pictorial representation of the terms) format, making the choice between verbal and visual information available to the learner. For example, one of the frames has the content "As the leader stroke nears the ground, it induces an opposite charge, so positively charged particles from the ground rush upward along the same path. This upward motion of current is the return stroke. It produces the bright light that people notice as a flash of lightning.", a glossary that explains the leader stroke and return stroke, and a picture that shows the leader stroke and return stroke.

For each frame, the student is required to opt for the explanation in any one format, view the explanation in that format, view the explanation in the other format, and then select which format they find more useful. The Multimedia Learning Preference Test-Choice counts and records

the number of times the student opts to view the graphic help first, while the Multimedia Learning Preference Test-Rating counts and records the number of times the student finds the graphic help more useful.

The reliability of a paper-based version of the two instruments (the Multimedia Learning Preference Questionnaire) was assessed by Mayer and Massa (2003). They found that the questionnaire had an acceptable Cronbach's alpha coefficient of .80. The validity of the Multimedia Learning Preference Test-Choice and the Multimedia Learning Preference Test-Rating were assessed by Mayer and Massa (2003) and by Massa and Mayer (2006). They found that the two instruments had a satisfactory validity as they loaded on the same factor as, and correlated positively and strongly with, each other and the paper-based version of the two instruments, that is, the Multimedia Learning Preference Questionnaire. This study aimed to check the association between the measures of learning behaviour obtained from these two instruments.

Mayer and Massa (2003) and Massa and Mayer (2006) found that the Santa Barbara Learning Style Questionnaire, the Verbal-Visual Learning Style Rating, the Learning Scenario Questionnaire and the Verbalizer–Visualizer Questionnaire loaded on the same factor (learning style), while the Multimedia Learning Preference Test-Choice, the Multimedia Learning Preference Test-Rating and the Multimedia Learning Preference Questionnaire loaded on a different factor (learning behaviour),. This provides further evidence that learning style and learning behaviour are two different learning characteristics and, thus, should be evaluated separately.

However, Mayer and Massa (2003) and Massa and Mayer (2006) also found that the measures of learning style (the Santa Barbara Learning Style Questionnaire, the Verbal-Visual Learning Style Rating and the Learning Scenario Questionnaire) correlated positively and significantly with the measures of learning behaviour (the Multimedia Learning Preference Test-Choice and the Multimedia Learning Preference Test-Rating). This study aimed to check the association between the measures of learning style and the measures of learning behaviour obtained from these instruments.

2.4. Recall of Important Details

2.4.1. Improvement of learning outcomes with learning styles. Learning styles have been said to define the way in which, and conditions under which, learners can most effectively and efficiently perceive, gather, organise, interpret, interact with and respond to information

(Lujan & DiCarlo, 2006). This would imply that, if a student's learning style is used to provide the student with the corresponding instructional materials and teaching strategies, the student should achieve the maximal learning outcomes. However, opinions on whether learning styles can be used to influence learning outcomes are divided, with some researchers and educators believing that they can be used to improve learning outcomes, and others believing that they have no influence on learning outcomes. Those who believe that learning styles can be used to improve learning outcomes claim that, while a student's learning in class does depend to some degree on their cognitive ability and their preparation for the class, it also depends on how well their learning style and the teacher's teaching style match each other (Dunn et al., 2002; Felder & Silverman, 1988; Klement, 2014). It is the teacher's responsibility to acknowledge that their students have different ways of learning, determine their students' different learning styles, understand the importance of accommodating all the different styles and adapt their teaching strategy to include methods that match all the different styles (Baukal & Ausburn, 2014; Gilakjani, 2012; Hawk & Shah, 2007; Lujan & DiCarlo, 2006; Othman & Amiruddin, 2010). When a student's learning style is determined and the teacher's teaching strategy is adapted to match the learning style, it can result in increased student satisfaction (Dunn et al., 2002; Eom et al., 2006; Gilakjani, 2012; Hawk & Shah, 2007), increased student efficiency (Gilakjani, 2012), increased academic performance (Cassidy, 2004; Dunn et al., 2002; Eom et al., 2006; Gilakjani, 2012; Hawk & Shah, 2007), and deeper and longer-lasting learning (Hawk & Shah, 2007). In addition, when students are first taught using their preferred learning style and then reinforced through other learning styles, it can result in an even further increased academic performance (Dunn et al., 2002) and an increased ability to learn in non-preferred learning styles (Hawk & Shah, 2007).

There are also some proponents of using learning styles to improve learning outcomes who believe that it is the student's, rather than the teacher's, responsibility to use the knowledge of their own learning style to behave according to their style and, thus, benefit maximally from the learning in class, be more motivated to learn, be satisfied with the learning and perform well in tests, without the teacher assisting or accommodating them (Gilakjani, 2012). This would involve the student using their learning style to formulate their learning strategies (Klement, 2014). These learning strategies would be incorporated during self-study time, which is when most learning occurs, and thus the student would not require any assistance or accommodation from the teacher (Husmann & O'Loughlin, 2018). In their paper, Fleming and Baume (2006), the creators of the VARK

Learning Styles Inventory claim that, once a student's learning style is known, it is unrealistic to expect the teacher to adapt their teaching to that style; rather, the student should use certain learning strategies, based on their learning style, so that they can gain the most from the information they receive in class, in terms of motivation for learning, understanding of the content, as well as deeper and longer-lasting learning. Bhagat et al. (2015) take this one step further by suggesting that teachers should help a student to be flexible and adapt their learning strategies, irrespective of their learning style, to cope with all instructional situations and tasks.

2.4.2. No influence on learning outcomes with learning styles. Just as there are those who believe in the use of learning styles to improve learning outcomes, whether by the teachers or by the students, there are also those who believe that learning styles have no influence on learning outcomes. In terms of the teacher's responsibility, a study by Kollöffel (2012) showed that providing study materials that matched or did not match a student's learning style did not bring about a change in learning outcomes, while a study by Bhagat et al. (2015) showed that matching a student's learning style with the teaching strategies did not contribute significantly enough to improving learning outcomes. Such a limited improvement in learning outcomes may not justify the increased investment in time and costs (Husmann & O'Loughlin, 2018). In terms of the student's responsibility, a study by Husmann and O'Loughlin (2018) showed that students who matched their VARK learning style with the corresponding VARK learning strategies (suggested by the creators of the VARK Learning Styles Inventory) did not perform better than those students who did not do so.

While some researchers advise caution regarding the use of learning styles to improve learning outcomes, others are firmer in their opinion. Kirschner (2017) calls learning styles a 'myth' and urges researchers, teachers and administrators to stop propagating this myth. He posits that researchers and teachers who have found that using learning styles works have done so only because of the Pygmalion or Rosenthal effect, due to which higher expectations lead to better performance. If researchers, teachers and students who matched learning styles and teaching strategies believed that they would see improved learning outcomes, they saw these outcomes because of a confirmation bias. Kirschner (2017) claims that the learning styles hypothesis (which suggests that a student will have better learning outcomes when the instructional method is adapted to their learning style), which is a type of attribute treatment hypothesis, should be dismissed due to a number of fundamental problems not only with the concept of learning styles, but also with

the studies that have confirmed the hypothesis. With regard to the concept of learning styles, first, he notes that the way in which most instruments determine a student's learning style is flawed because they conceptualise learning styles along a dichotomous scale and classify students into one style or the other based on which side of the median or mean of the scale they fall on. This would imply that the differences between students make them either one type or the other, whereas the differences between students are usually gradual, making them more of one type and less of the other. Second, he points out that there are a large number of instruments with such dichotomous scales and that there is still a lack of consensus about the concept of learning styles. Third, he reports on a number of studies that have shown low reliability and validity for a variety of instruments intended to determine a student's learning style. With regard to studies that have confirmed the learning styles hypothesis, he emphasises that, in order for a study to prove the hypothesis, it must show a true crossover interaction, in which a student with learning style A has better learning outcomes with instructional method A, and a student with learning style B has better learning outcomes with instructional method B. As of now, there have not been sufficient studies that have been designed well enough to test the crossover interaction correctly, and those that have been designed well enough failed to prove the learning styles hypothesis. Specific to the verbal/visual dimension, Kirschner (2017) lists a number of well-designed studies that did not find a crossover interaction and, thus, failed to prove the learning styles hypothesis.

2.4.3. Basis for the present study. One of the well-designed studies that failed to prove the learning styles hypothesis was the study by Massa and Mayer (2006). After Mayer and Massa (2003) established a number of instruments that could be used to evaluate learning styles and learning behaviour in the verbal/visual dimension, they suggested that future studies should check whether the verbal or visual learning styles and learning behaviour determined by these instruments would affect the learning outcomes from verbal or visual learning material, that is, whether the verbaliser-visualiser hypothesis would be confirmed. According to this hypothesis, a verbal learner has better learning outcomes with verbal learning materials and a visual learner has better learning outcomes with visual learning materials (Mayer & Massa, 2003). Massa and Mayer (2006) used the instruments to evaluate students' learning styles and learning behaviour as verbal or visual, and then used a multimedia lesson in which students were randomly assigned to receive either verbal or visual information to evaluate the students' learning outcomes. Their design checked for a crossover interaction, but their study failed to find such an interaction and prove the

learning styles hypothesis. Note that their study confirmed the existence of students who have either verbal or visual learning styles and learning behaviour, but failed to prove an effect of these learning styles and learning behaviour on the students' learning outcomes from verbal or visual learning material. The present study aimed to check the association between learning style and recall of important details as well as between learning behaviour and recall of important details. Also, the study aimed to find the predictive value of learning style and learning behaviour for recall of important details.

The present study is similar to and dissimilar from the study of Massa and Mayer (2006) in a number of ways, in an effort to pay due consideration to the points made by Kirschner (2017). First, rather than considering a bipolar verbaliser-visualiser dimension and classifying participants as verbal or visual (based on a median split) as done by Massa and Mayer (2006), the present study considered two separate unipolar verbaliser and visualiser dimensions and used the instruments to assign participants with two scores, verbal and visual, so that their tendency for both types of information could be considered. Second, just as done by Massa and Mayer (2006), the present study used the verbal/visual dimension to determine participants' learning styles and behaviour and evaluate their learning outcomes, so that a well-established dimension of learning styles could be used. Third, as reported by Mayer and Massa (2003) and by Massa and Mayer (2006), the present study used instruments that were found to be reliable and valid to determine participants' learning styles and behaviour, so that the scores obtained using them could be acceptable. Fourth, rather than dividing participants into two groups receiving verbal and visual learning material, the present study subjected all participants to the same learning material, since they had not been classified as having verbal or visual learning styles and learning behaviours (and hence a crossover interaction could not be tested). Therefore, rather than a cross-sectional analysis, the present study used a correlational analysis. Fifth, while Massa and Mayer (2006) used a multimedia lesson with separate frames, each containing some text with additional information available either verbally or visually, the present study used a video lesson, in which information was presented continuously and simultaneously through the audio and visuals. Sixth, while Massa and Mayer (2006) used a definition test sheet, a reasoning test sheet and five problem-solving test sheets to evaluate the learning outcomes, the present study used a series of multiple-choice questions to evaluate the learning outcomes in terms of the recall of the important verbal and visual details presented through the audio and visuals, respectively, of the video.

2.5. Recall of Seductive Details

2.5.1. Definition of seductive details. Multimedia learning materials offer opportunities to add seductive details to the instructional materials (Korbach et al., 2016). Seductive details are elements included in the instructional materials that satisfy two conditions: 1) They make the learning materials more interesting 2) They provide additional information that is irrelevant, unimportant and unnecessary to the accomplishment of the instructional objectives of the learning materials (Chang & Choi, 2014; Mayer, 2014b; Park, Flowerday, & Brünken, 2015; Park, Moreno, Seufert, & Brünken, 2011; Rey, 2012; Rey, 2014). The satisfaction of the two conditions implies that seductive details generate emotional interest by increasing learners' curiosity and enjoyment of the material, but do not generate cognitive interest by increasing the learner's structural understanding of the material (Harp & Mayer, 1997; Park, Kim, Lee, Son, & Lee, 2005). While the term 'seductive details' was initially used by Garner, Gillingham, and White (1989) to refer to interesting but unnecessary pieces of text that were added to relevant and necessary pieces of text and that reduced the recall of these relevant and necessary pieces of text, the term is now also used to refer to interesting but unnecessary spoken words, sounds, background music, illustrations, images or video clips (Rey, 2012; Rey, 2014). In multimedia learning, the addition of such elements is called 'seductive augmentation' (Park et al., 2005).

2.5.2. Use of seductive details in the present study. Most of the research studies regarding seductive details have used the addition of seductive details (in the form of pieces of text and/or illustrations) to text and image-based learning materials (Park et al., 2015). However, the present study uses the presence of seductive details (in the form of spoken words and illustrations/animations) in an educational video. Seductive verbal details (in the form of spoken words) were present in the audio and included jokes, sarcastic comments, unnecessary comparisons and unnecessary examples. Seductive visual details (in the form of illustrations/animations) were present in the visuals and included unnecessary animations of elements, complicated graphs/infographics with unnecessary information, visual representation of concepts using unusual objects and out-of-place or decorative items added to scenes.

2.5.3. Learning style/learning behaviour and recall of seductive details. While there has been research regarding the association between the learning style and learning behaviour and the recall of important details, to the best of the researcher's knowledge, there has not been research regarding the association between the learning style and learning behaviour and the recall of

seductive details. A search for relevant literature did not reveal any results, except for a single study by McCrudden and Corkill (2010) about the effect of verbal ability on the recall of important details and seductive details. They found that even though the recall of important details was higher among students with a higher verbal ability than among students with a lower verbal ability, the recall of seductive details was not significantly different between the two groups. However, the findings from their study cannot be applied directly to the present study, since their study considered ability and the present study considers style and behaviour. In the present study, since the educational video used would present the important details and seductive details in the same manner, and since the participants would not be made aware of which details were important and which were not, it can be assumed that they would use the same cognitive processes for both types of details. Because of this assumption, the lack of an association between the learning style and learning behaviour and the recall of important details, as found by Massa and Mayer (2006), would also mean a lack of an association between the learning style and learning behaviour and the recall of seductive details. However, while learners with a verbal or visual learning style/learning behaviour are likely to perceive important details presented in both the verbal and visual format as beneficial to their learning and, thus, pay equal attention to, and equally recall, important information in both formats, they are likely to perceive seductive details presented in both the verbal and visual format as unnecessary for their learning, but also likely to be attracted to and, thus, pay more attention to, and better recall, seductive information in their preferred format. The present study aimed to check the association between learning style and recall of seductive details as well as between learning behaviour and recall of seductive details. Also, the study aimed to find the predictive value of learning style and learning behaviour for recall of seductive details.

Since the present study aimed to check the association between the verbal and visual learning styles, as well as between each learning style or corresponding learning behaviour and the recall of the corresponding type of important details or recall of the corresponding type of seductive details, the study also aimed to check the association between the recall of important verbal details and the recall of important visual details as well as between the recall of seductive verbal details and the recall of seductive visual details.

2.5.4. Seductive details and recall of important details. We need to consider the effect of seductive details on the recall of important details. On the one hand, proponents of including seductive details in learning materials believe they are beneficial because they improve the

learning outcomes. On the other hand, opponents of including seductive details in learning materials believe they are harmful because they impair the learning outcomes.

2.5.4.1. Improvement of learning outcomes with seductive details. The benefits of seductive details on learning outcomes could be based on two theories: 1) Cognitive Affective Theory of Learning with Media 2) Interest Theory. According to the Cognitive Affective Theory of Learning with Media (CATLM), seductive details used in learning materials can bring about a motivational effect, which can lead to cognitive activation, longer spans of attention, increased involvement in and engagement with the learning materials, increased investment of cognitive resources in the learning task and, ultimately, better learning (Magner, Schwonke, Aleven, Popescu, & Renkl, 2014; Mayer, 2014a; Park et al., 2015; Park et al., 2011). According to the Interest Theory, seductive details used repeatedly in learning materials can cause a triggering and maintenance of situational interest, and may even lead to the emergence of individual interest over time, which can lead to cognitive activation, better focusing of attention, increased involvement in and engagement with the learning materials and, ultimately, better learning (Chang & Choi, 2014; Leutner, 2014; Lusk, 2008; Magner et al., 2014; Park et al., 2015; Rey, 2012).

2.5.4.2. Impairment of learning outcomes with seductive details. The harm caused by seductive details on learning outcomes could be based on five theories: 1) Cognitive Load Theory 2) Cognitive Theory of Multimedia Learning 3) Attention Distraction Hypothesis 4) Coherence Disruption Hypothesis 5) Inappropriate Schema/Diversion Hypothesis. According to the Cognitive Load Theory (CLT), the cognitive load imposed by learning material is the sum of the intrinsic load (due to the complexity of the learning task), the extraneous load (due to the inefficiency of the instructional design) and the germane load (due to schema formation and automation), and if the cognitive load is too high for the learners' cognitive capacity, the learning process is negatively affected. If seductive details are added, they cause an extraneous load that adds to the total cognitive load, which can lead to the cognitive load becoming too high and overstraining the learners' cognitive capacity, thus leading to reduced recall of the important details (Korbach et al., 2016; Park et al., 2015; Park et al., 2011; Rey, 2012). According to the Cognitive Theory of Multimedia Learning (CTML), learners have two separate channels for processing information (auditory and visual), learners have a limited capacity for cognitive processing at any given time through each channel, and high-interest information is given priority over low-interest information. If seductive details add to the cognitive load of the important details and are more interesting than

the important details, they take priority over the important details, which can lead to the cognitive capacity being used first for the seductive details and any leftover capacity being used for the important details, and, if the leftover capacity is not sufficient to process the important details, reduced recall of the important details (Chang & Choi, 2014; Leutner, 2014; Mayer, 2014a; Park et al., 2015; Rey, 2012; Rey, 2014). According to the Attention Distraction Hypothesis, if seductive details are more interesting than the important details, they distract the learners' attention from the important details, which can lead to reduced recall of the important details (Chang & Choi, 2014; Mayer, Griffith, Jurkowitz, & Rothman, 2008; Park et al., 2015; Rey, 2012; Rey, 2014; Rowland-Bryant et al., 2009). According to the Coherence Disruption Hypothesis, learners need to detect the relationships between important ideas in the learning material in order to be able to comprehend the content, and these relationships are more easily detected when the important ideas are placed spatially close to each other and if they are repeated. If seductive details are placed between important ideas that need to be related to each other, they hamper the detection of the relationships between these ideas, which can lead to impaired comprehension of the learning material and reduced recall of the important details (Chang & Choi, 2014; Mayer et al., 2008; Park et al., 2015; Rey, 2012; Rey, 2014). According to the Inappropriate Schema/Diversion Hypothesis, if seductive details are placed before the important details, they activate a schema that is relevant only to the seductive details and not to the important details, which can lead to the appropriate schema for the important details not being activated and reduced recall of the important details (Chang & Choi, 2014; Harp & Mayer, 1998; Park et al., 2015; Rey, 2012; Rey, 2014; Rowland, Skinner, Davis-Richards, Saudargas, & Robinson, 2008; Rowland-Bryant et al., 2009).

The harm caused by seductive details on learning outcomes is called the seductive details effect (Korbach et al., 2016). This effect occurs due to the seductive details hypothesis, which states that people learn more deeply from instructional materials that exclude, rather than include, seductive details (Rey, 2012; Rey, 2014). It is interesting that this effect has been found in some studies (Bartsch & Cobern, 2003; Chang & Choi, 2014; Garner et al., 1989; Harp & Maslich, 2005; Harp & Mayer, 1997; Harp & Mayer, 1998; Lehman, Schraw, McCrudden, & Hartley, 2007; Mayer et al., 2008; Rey, 2014; Rowland-Bryant et al., 2009; Sanchez & Wiley, 2006; Shen, McCaughtry, Martin, & Dillion, 2006), while it has not been found in some other studies (Doolittle & Altstaedter, 2009; Lusk, 2008; Magner et al., 2014; Muller, Lee, & Sharma, 2008; Park et al., 2015; Park et al., 2011; Towler et al., 2008). Magner et al. (2014) explain these contradictory

results as due to the existence of both positive and negative effects of seductive details, with a number of contextual factors determining which effects are stronger and, thus, observed. First, most of the studies that found a seductive details effect involved learning material that imposed a high cognitive load (in terms of the learning topic or the instructional design), while most of the studies that found no seductive details effect involved learning material that imposed a low cognitive load (Magner et al., 2014; Park et al., 2015; Park et al., 2011). Second, students who have a low prior knowledge of the topic of the learning material tend to experience a seductive details effect, while those students who have a high prior knowledge of the topic tend to not experience a seductive details effect (Magner et al., 2014; Park, Korbach, & Brünken, 2015; Park et al., 2011; Korbach et al., 2016). Third, students who have a low cognitive capacity/working memory capacity in relation to the cognitive load imposed by the learning materials experience a seductive details effect, while those students who have a high cognitive capacity/working memory capacity in relation to the cognitive load imposed by the learning materials do not experience a seductive details effect (Chang & Choi, 2014; Korbach et al., 2016; Rey, 2012; Rey, 2014; Sanchez & Wiley, 2006). Fourth, most studies that found a seductive details effect involved a time restriction in the study phase and test phase, while most studies that found no seductive details effect did not involve a time restriction in either of the phases (Rey, 2012). Also, it has been found that placing the seductive details before the important details, rather than after the important details, exacerbates the seductive details effect (Harp & Mayer, 1998; Rowland et al., 2008).

In the present study, the learning material imposed a high cognitive load (since it was based on a scientific topic) and the participants were assumed to have no/low prior knowledge of the topic. For these two reasons, it could be assumed that the cognitive load on the participants would be high and the seductive details effect would occur. However, there was no time limit during the study or the test phase of the session and the participants were assumed to have a high cognitive capacity/working memory capacity (since they were all university students). For these two reasons, it could be assumed that even if the cognitive load on the participants would be high, they would be capable of dealing with the load, and the seductive details effect would not occur. The present study aimed to check the association between recall of important verbal details and recall of seductive verbal details as well as between recall of important visual details and recall of seductive visual details.

Finally, the present study aimed to find the predictive value of each recall score for the other recall scores.

2.6. Learning Style, Seductive Details and Learning Outcomes

Until now, research has been performed to study the effect of providing learning material according to students' learning style on the learning outcomes. Research has also been performed to study the effect of providing seductive details on the learning outcomes. A combination of these two fields of research would involve providing seductive details according to students' learning style and checking for the effect on the learning outcomes. The beneficial or harmful effects of the seductive details may be enhanced by providing these details according to the students' learning style. This study is the first one to combine learning styles and seductive details. Therefore, it was thought prudent to use this study to first check the relationship between learning style and seductive details, before combining the two to study their effect on learning outcomes, which could possibly be taken up in a future study.

3. Research Questions

Considering the significant discrepancy between the different opinions regarding the effect of verbal/visual learning styles and learning behaviour on the recall of verbal and visual details from learning materials, the main research question of the study was:

> *What is the association between verbal/visual learning style, verbal/visual learning behaviour, recall of important verbal/visual details and recall of seductive verbal/visual details from an educational video, among university students in The Netherlands?*

To answer the research question, the following research sub-questions were formulated:

1) What is the association between verbal and visual learning styles?
2) What is the association between the measures used for learning style and between the measures used for learning behaviour?
3) What is the association between learning style and learning behaviour?
4) What is the association between learning style and recall of important details?
5) What is the association between learning behaviour and recall of important details?
6) What is the predictive value of learning style and learning behaviour for recall of important details?
7) What is the association between learning style and recall of seductive details?
8) What is the association between learning behaviour and recall of seductive details?
9) What is the predictive value of learning style and learning behaviour for recall of seductive details?
10) What is the association between recall of important verbal details and recall of important visual details and between recall of seductive verbal details and recall of seductive visual details?
11) What is the association between recall of important verbal details and recall of seductive verbal details and between recall of important visual details and recall of seductive visual details?
12) What is the predictive value of each recall score for the other recall scores?

4. Method

4.1. Research Design

A correlational design was used for the study, with learning style, learning behaviour, recall of important details and recall of seductive details as the variables. All the variables were assessed using an online environment that consisted of instruments to measure learning style and learning behaviour, an educational video and a test to measure recall of important details and recall of seductive details from the educational video. All participants went through the same online environment.

4.2. Participants

4.2.1. Inclusion and exclusion criteria. The participants were sought from the University of Twente in Enschede, The Netherlands. The inclusion criteria were: 1) Being a minimum of 18 years old 2) Being fluent in English. The first criterion was set to ensure the ability of participants to give permission for their own participation in the study. The second criterion was set to ensure the ability of participants to understand the information sheet, consent form, instructions and learning material, which were all in English. The exclusion criterion was having a high prior knowledge of, or formal training in, the learning topics used in the study.

4.2.2. Sampling. The sampling that was used was convenience sampling and snowball sampling. Participants were sought through word of mouth and through messages on social media sites/groups frequented by the university students. Participants were also asked to refer/request their friends or classmates to participate in the study. A minimum number of 50 participants was set for the study, since that number of participants would be sufficient to perform a correlational study. However, since 65 people volunteered to participate, they were all tested and included in the sample.

4.2.3. Demographic characteristics. Of the 65 participants, there were 38 (58.50%) men and 27 (41.50%) women, aged 18 to 34 years old (M = 22.48; SD = 3.62). The participants had completed different levels of education: 36 (55.40%) were following a Bachelor's programme at the university, 19 (29.20%) had completed their Bachelor's Degree, 8 (12.30%) had completed their Master's Degree, and 2 (3.10%) had completed their PhD Degree. The participants had completed their degrees in different fields: of those who had completed a Bachelor's, Master's or PhD Degree, 22 had studied technical sciences and 6 had studied social sciences. It was assumed that the participants were fluent in English, since all the participants were university students. It

was also assumed that none of the participants had a high prior knowledge of, or formal training in, the learning topics used in the study, because the learning topics were all from the field of astrophysics and none of the participants were from that field.

4.3. Instruments

4.3.1. Learning style instruments. The sheer variety and inconsistency in the learning style models and instruments made the task of selecting an appropriate instrument difficult. Cassidy (2004) stresses the need for a "deliberate and documented choice" (p. 441) of the learning style model and measures used in research studies and suggests three points to be considered when making the choice. First, the objectives of the research should be clear and the instrument should be matched with those objectives. Since the present study aimed to measure how much information the participants gained through the audio and visuals of an educational video, the verbal/visual modes of information processing were deemed to be important (Leutner & Plass, 1998) and it was decided to use an instrument that evaluated the participants' learning style based on their verbal/visual learning preferences. Second, the reliability and validity of the instrument should be assessed and found to be sufficient. For the present study, three learning style instruments were considered, so that they could be used to validate each other. The Santa Barbara Learning Style Questionnaire, the Verbal-Visual Learning Style Rating and the Learning Scenario Questionnaire had been found to be reliable and valid (except for the reliability of the Learning Scenario Questionnaire) by Mayer and Massa (2003) and by Massa and Mayer (2006). Third, the extent to which the instrument has been used should be taken into account. The Santa Barbara Learning Style Questionnaire and the Learning Scenario Questionnaire had been used by Mayer and Massa (2003) and by Massa and Mayer (2006), while the Verbal-Visual Learning Style Rating had been used by Baukal and Ausburn (2014), by Mayer and Massa (2003) and by Massa and Mayer (2006). Since the three instruments had not been used by many studies, it was decided to use them for the present study to increase the availability of data based on their use.

The three learning style instruments were used in their original form. The only modification that was made was to the last statement pertaining to verbal learning in the Santa Barbara Learning Style Questionnaire, which was changed from "I am good at learning from printed text." to "I am good at learning from printed text and spoken words." This was done to accommodate the inclusion of both, printed text and spoken words, in 'verbal learning', as defined for this study.

4.3.2. Learning behaviour instruments. For the present study, two learning behaviour instruments were considered, so that they could be used to validate each other. Since the Multimedia Learning Preference Test-Choice and the Multimedia Learning Preference Test-Rating had been found to be reliable and valid by Mayer and Massa (2003) and by Massa and Mayer (2006), it was decided to use them for the present study. However, the original Multimedia Learning Preference Test developed and used by Mayer and Massa (2003) was modified for the present study. The original test consists of five frames of a multimedia lesson on lightning, while the modified test consisted of six frames of a multimedia lesson on satellites and orbits. The topic of the test was changed to be more appropriate to the age of the participants and to make the content more challenging for them. However, though the topic was changed, the functioning of the test remained the same. Each frame consisted of two sentences of text, which included one or more underlined words, and 'Textual Help' and 'Graphic Help' buttons, which could be individually clicked to reveal additional information about the underlined words. For example, one of the frames had the content "A geostationary satellite appears motionless, at a fixed position in the sky, to ground observers. This is because it follows a geostationary orbit, which is an orbit defined by a particular altitude, inclination, eccentricity and synchronicity.", a Textual Help button that revealed a sentence explaining a geostationary orbit, and a Graphic Help button that revealed a picture showing a geostationary orbit. In the original Multimedia Learning Preference Test, the information provided in the textual and graphic help is not always the same. However, in the modified Multimedia Learning Preference Test, care was taken to ensure that the information provided in both types of help was the same to ensure that learners did not see a difference in the two types of help in the first frame, think of one type of help as more informative, and therefore pick that type of help in the remaining frames because they thought it would be more informative (negating a genuine learning preference).

For each frame, the participants were required to read the text and think about the underlined words. They were required to then: 1) select whether they thought they would prefer a verbal or visual explanation of the underlined words, by clicking the appropriate option from the 'Textual Help' and 'Graphic Help' buttons 2) go through the verbal or visual explanation as per their selection 3) go through the other type of explanation 4) select which type of explanation they actually preferred and rate how strongly they preferred it, by selecting one of the options on a seven-point scale (Strongly prefer Textual – Moderately prefer Textual – Slightly prefer Textual

– Equally like Textual and Graphic – Slightly prefer Graphic – Moderately prefer Graphic – Strongly prefer Graphic). It was thought possible that, in the first step, participants would not make an actual selection and would simply click the buttons in a left-right or right-left sequence, leading to results that showed strongly verbal or visual participants. In order to avoid this, on odd-numbered frames, the Textual Help button was shown on the left and the Graphic Help button was shown on the right, while on even-numbered frames, the positions of the two buttons were switched. The participants were made aware of the possibility of the changing positions of the buttons, so that they did not (incorrectly) anticipate a particular positioning and click the undesired Help button by mistake. Additionally, it was explained to the participants that their final selection and rating of the explanation they actually preferred was independent of their initial selection of the type of explanation they thought they would prefer. It was also explained to the participants that their initial and final selections for any one frame were independent of their initial and final selections for the rest of the frames.

4.4. Materials

The entire study was conducted through the use of an online environment, which consisted of seven sections: 1) Demographic questions 2) Santa Barbara Learning Style Questionnaire 3) Verbal-Visual Learning Style Rating 4) Learning Scenario Questionnaire 5) Modified Multimedia Learning Preference Test 6) Video lesson 7) Recall of important details and seductive details test. Each section of the online environment started with a set of instructions, so the participants would know what they were required to do in that section. Also, every question in each section was mandatory, and the participants had to provide an answer for every question in the current section before they could progress to the next section.

4.4.1. Section 1: Demographic questions. The first section consisted of four demographic questions regarding the sex, age, educational level and educational field of the participants (refer Appendix A).

4.4.2. Section 2: Santa Barbara Learning Style Questionnaire. The second section was the Santa Barbara Learning Style Questionnaire developed and used by Mayer and Massa (2003) (refer Appendix B). In order to ensure that all participants had the same understanding of ‘verbal learning’ and ‘visual learning’, a script was created and used by the researcher to explain what each type of learning involved (refer Appendix C). This script was not read out to the participants, but rather was memorised and narrated by rote, by the researcher.

4.4.3. Section 3: Verbal-Visual Learning Style Rating. The third section was the Verbal-Visual Learning Style Rating developed and used by Mayer and Massa (2003) (refer Appendix D).

4.4.4. Section 4: Learning Scenario Questionnaire. The fourth section was the Learning Scenario Questionnaire developed and used by Mayer and Massa (2003) (refer Appendix E).

4.4.5. Section 5: Multimedia Learning Preference Test. The fifth section was the modified Multimedia Learning Preference Test (refer Appendix G), based on the original test developed and used by Mayer and Massa (2003) (refer Appendix F). In the first session, one of the participants was unsure of what they needed to do in this section. Therefore, a script was created and used by the researcher to explain what exactly was to be done by the participants in this section (refer Appendix H). This script was not read out to the participants, but rather was memorised and narrated by rote, by the researcher.

4.4.6. Section 6: Video lesson. The sixth section was a video lesson titled 'Conquering Space', which consisted of two parts: 1) Space Elevator 2) Moon Base (refer Appendix I for sample screenshots from the video lesson). The video lesson was created from two original videos that were made available by the 'Kurzgesagt: In a Nutshell' channel on YouTube: 1) Space Elevator – Science Fiction or the Future of Mankind? (www.youtube.com/watch?v=qPQQwqGWktE) and 2) How We Could Build a Moon Base TODAY – Space Colonization 1 (https://www.youtube.com/watch?v=NtQkz0aRDe8). The two original videos were joined together and edited to remove unnecessary content, such as advertisements for the Kurzgesagt channel.

The video about the space elevator explained what an orbit is, how conventional rockets get an object into orbit, how space elevators get an object into orbit, how a space elevator can reduce the costs of getting objects into orbit, the four parts of a space elevator, the challenges with building a space elevator, the risks of building a space elevator, the possible ways to attempt to build a space elevator, and the overall advantages of building a space elevator. The video about the moon base explained how colonisation of the New World took place in three phases, how colonisation of the Moon can also be done in the same three phases, what would happen in each phase, the challenges that would be faced in each phase, the accomplishments that would be made in each phase, the possible future considerations regarding the colonists of the Moon, and the overall advantages of colonising the Moon. The main content covered in each video was

supplemented by a number of seductive details, both in the audio as well as the visuals. Seductive details in the audio included jokes, sarcastic comments, unnecessary comparisons and unnecessary examples. Seductive details in the visuals included unnecessary animations of elements, complicated graphs/infographics with unnecessary information, visual representation of concepts using unusual objects and out-of-place or decorative items added to scenes.

Each of the two videos was made in a modern and interesting style and consisted of an audio narration accompanied by animated visuals. The videos were modified in multiple places to ensure that content used as a basis for the questions in the next section was presented either only in the audio or only in the visuals. If the content used as a basis for a question was presented in the audio and visuals, the video was edited to remove the content from either the audio or the visuals. For example, in Question 6, the participant is asked how much a space elevator would reduce the cost of sending one kilogram of payload into space. The information to answer this question was available in the audio as well as the visuals from 02:18 to 02:25 in the original video about the space elevator. Therefore, the video was edited to remove the information from the audio and make it available only in the visuals.

The total duration of the final video lesson was 13:10, of which 05:18 comprised the Space Elevator part, 07:41 comprised the Moon Base part, and 00:11 were the introduction and conclusion screens. The participants were allowed to Play/Pause/Replay the video and to re-watch certain sections of the video. They were also allowed to take notes while watching the video, but were not allowed to refer to the notes during the test. In the instructions for this section, the participants were informed that they should pay careful attention to the video lesson because they would be subjected to a test based on the content from the lesson. They were also informed that once they elected to start the test, they would not have access to the lesson again.

4.4.7. Section 7: Recall of important details and seductive details test. The seventh section was a test of the participants' recall of the important details and seductive details from the video (refer Appendix J). The test consisted of 40 questions. These questions were divided into two main categories: verbal and visual. The verbal questions were based on information from the audio, while the visual questions were based on information from the visuals. Within each main category, there were two sub-categories: important details and seductive details. The important details questions were based on relevant information that was key to understanding the topic of the lesson, while the seductive details questions were based on irrelevant information that was not

necessary in the lesson, but made the lesson more interesting. Thus, there were 4 categories of 10 questions each: important verbal details, seductive verbal details, important visual details and seductive visual details.

Most of the seductive details were content that could only be recalled, without any potential for understanding, applying or analysing. Therefore, in order for the important details and seductive details to be tested at the same level, so that the correlations between the important details scores and seductive details scores could be checked, all questions were formulated to test the participants at Level 1, that is, Recall, of Bloom's Taxonomy. All questions could be answered by directly remembering the information that was either in the audio or the visuals of the video lesson, without understanding, applying or analysing the information, and without the inference of additional information. Each question was a text-based multiple-choice question with four to seven options. Participants could select one or more options to answer each question, and for each question, one to four options were correct.

4.5. Procedure

4.5.1. Preparation. Before starting data collection, the Ethics Committee was asked for approval of this study. Once approval was received, an initial message was used to seek participants. This message was sent out individually to potential participants and in WhatsApp or Facebook groups that included potential participants. Those who responded to the initial message were also requested to ask their classmates and friends to participate in the study. Participants were asked to sign themselves up for one of the study sessions that were scheduled during the week when the study would be conducted. During this week, there were six sessions scheduled for each of the five days, and thus participants could select any one of the thirty available sessions, as per their availability and convenience. Participants were requested to bring their own laptops and headphones, so that the researcher could test multiple participants in each session, if necessary. A quiet room was booked at the University of Twente Library for conducting the sessions. The room could comfortably seat up to 10 participants at a time, so that each participant could have their own space to work. Some sessions were not booked by any participants, while some were booked by 1 to 6 participants. The learning topics were not revealed to the participants in advance, in order to prevent the participants from preparing themselves for the tests.

4.5.2. Sessions. Each session was scheduled for 75 minutes, so that participants would have sufficient time to answer the online questionnaire. However, no time limit on any part of the

questionnaire, or on the overall session, was communicated to the participants, and they were allowed to take as much time as they wanted to read the information sheet, fill in the consent form and answer the questionnaire. At the start of the session, participants were asked to pick a convenient seat for themselves in the room. Once they were settled in comfortably, they were provided with the information sheet and asked to fill in and sign the consent form. The information sheet was used to give participants all the information they needed before taking part in the study. The sheet included information regarding the eligibility criteria for the study, the purpose of the study, the tasks to be performed by the participants during the study, the duration of the study session, and the potential risks and benefits of participating in the study. The sheet also included the participants' responsibilities regarding the integrity of the research, and the researcher's responsibilities regarding the confidentiality of the data and the sharing of the results. In addition, the sheet informed the participants that their participation in the study was voluntary and that they had the right to withdraw from the study at any point. The consent form was used to obtain the participants' written acknowledgement of the information in the information sheet and to obtain their consent to use their data from the study.

Once the participants had understood what they were required to do and had provided their consent, they were sent the link to the online questionnaire, so that they could access it and fill it in using their own laptops. The participants were asked to pause when they reached the Santa Barbara Learning Style Questionnaire, so that the researcher could explain what was meant by 'verbal learning' and 'visual learning', using the script prepared for this. The participants were also asked to pause when they reached the Multimedia Learning Preference Test, so that the researcher could explain what exactly was to be done by the participants in this section (and guide the participants through the first frame), using the script prepared for this. In sessions that had more than one participant, the participants sometimes had to wait a few minutes for all the participants to reach the Santa Barbara Learning Style Questionnaire and the Multimedia Learning Preference Test, so that the researcher could give all the participants the explanations at the same time and avoid creating a disturbance by giving the explanations to each participant individually. However, after the delivery of these two explanations, participants were allowed to work at their own pace and finish the questionnaire at different times.

Participants took varying amounts of time to complete all sections of the online environment, ranging from 29 minutes and 37 seconds to 63 minutes and 27 seconds (M = 42

minutes and 54.82 seconds; *SD* = 7 minutes and 53.56 seconds). As each participant finished and submitted the questionnaire, they were taken to a separate area, where they were thanked and debriefed, using the script prepared for this. The debriefing script was created and used by the researcher to explain the exact nature of the study to the participants. The first part of the script thanked the participants for taking part in the study. The second part included a simple explanation of the three sets of variables that were measured using the questions in the three parts of the questionnaire (learning styles, learning behaviour and recall of details from the video lesson), and informed the participants that the study aimed to look into the correlation between these sets of variables. The third part included an explanation of why some of the questions based on the video lesson may have seemed 'odd', 'weird' or 'irrelevant' to the participants, that is, that they were used to test the participants' absorption of irrelevant or distracting information in the audio or visuals of the video lesson, described how the questions in the final test were divided into four categories (important verbal details, seductive verbal details, important visual details and seductive visual details), and informed the participants that the study aimed to look into the correlation between the scores for each of these categories. The final part included instructions to avoid talking about what they did in the session or what the learning topics were, in order to prevent later participants from preparing themselves for the tests. Participants were also offered the possibility of further contact with the researcher and the chance to obtain their personal results, the overall results of the study, or the final report of the study.

4.6. Data Analysis

All the data gathered during the study was quantitative and was recorded and analysed using SPSS.

4.6.1. Measures. Learning style, learning behaviour, recall of important details and recall of seductive details were each measured using multiple measures (as shown in Table 1), with a total of 14 measures per participant. Each of these 14 measures was calculated based on the data collected from the online questionnaire. For each of these 14 measures, the data that was used and the method of calculation that was employed have been elaborated in Table 2. While in the present study, from each of the learning style and learning behaviour instruments, two separate (verbal and visual) scores were calculated, which indicated the participant's positions on two separate unipolar verbaliser and visualiser scales, in the studies by Mayer and Massa (2003) and Massa and Mayer (2006), from each of the learning style and learning behaviour instruments, a single score

was calculated, which indicated the participant's position on a bipolar verbaliser-visualiser scale. The method of calculation of these single scores is elaborated in Table 3.

Cronbach's alpha coefficients were computed to evaluate the internal consistency of the instruments used for the measures of learning style and learning behaviour as well as the internal consistency of the recall test (as shown in Table 4). Acceptable alpha coefficients were found for the SBLSQ verbal and visual scores. The VVLSR verbal and visual scores were obtained from a single-item questionnaire. Therefore, the alpha coefficients of these scores were not computed. Low alpha coefficients were found for the LSQ verbal and visual scores, MLPT-C verbal and visual scores and MLPT-R verbal and visual scores. For these variables, the Cronbach's alpha coefficients were computed again to check whether removal of one of the items would improve the reliability to an acceptable level. However, there were no such items found for any of these variables. Therefore, for these variables, Guttman's lambda coefficients were computed. However, low lambda coefficients were found for these variables (also shown in Table 4). Since multiple reliability tests produced low coefficients for the LSQ verbal and visual scores, MLPT-C verbal and visual scores and MLPT-R verbal and visual scores, it was concluded that the Learning Scenario Questionnaire and the Multimedia Learning Preference Test were not reliable instruments and a decision was taken to not consider the variables obtained from these instruments for the statistical tests and results of the study. The instruments used to find the participants' SBLSQ scores, VVLSR scores, LSQ scores, MLPT-C scores and MLPT-R scores were the same as those used by Mayer and Massa (2003). For the LSQ scores, the method of calculation employed was the same, but the Cronbach's alpha coefficient found in this study (.13) was lower than that found in the study by Mayer and Massa (2003) (.38). For the SBLSQ scores, MLPT-C scores and MLPT-R scores, the methods of calculation employed for each measure were different; therefore, the Cronbach's alpha coefficients found in this study cannot be compared with those found in the study by Mayer and Massa (2003). Finally, an acceptable alpha coefficient was found for the recall test score.

Table 1

Measures Used for Each Learning Characteristic

Learning characteristic	Measures
Learning style	SBLSQ verbal score
	SBLSQ visual score
	VVLSR verbal score
	VVLSR visual score
	LSQ verbal score
	LSQ visual score
Learning behaviour	MLPT-C verbal score
	MLPT-C visual score
	MLPT-R verbal score
	MLPT-R visual score
Recall of important details	Important verbal details score
	Important visual details score
Recall of seductive details	Seductive verbal details score
	Seductive visual details score

Table 2

Data Used and Method of Calculation Employed for Each Measure

Measure	Section	Question(s)	Values	Calculation
SBLSQ verbal score	2: Santa Barbara Learning Style Questionnaire	2, 4, 6	For each question: 7: “Strongly agree” 6: “Moderately agree” 5: “Slightly agree” 4: “Neither agree nor disagree” 3: “Slightly disagree” 2: “Moderately disagree” 1: “Strongly disagree”	Score = Sum of values from 3 questions Max: 21 Min: 3

SBLSQ visual score	2: Santa Barbara Learning Style Questionnaire	1, 3, 5	For each question: 7: “Strongly agree” 6: “Moderately agree” 5: “Slightly agree” 4: “Neither agree nor disagree” 3: “Slightly disagree” 2: “Moderately disagree” 1: “Strongly disagree”	Score = Sum of values from 3 questions Max: 21 Min: 3
VVLSR verbal score	3: Verbal-Visual Learning Style Rating	1	7: “Strongly more verbal than visual” 6: “Moderately more verbal than visual” 5: “Slightly more verbal than visual” 4: “Equally verbal and visual” 3: “Slightly more visual than verbal” 2: “Moderately more visual than verbal” 1: “Strongly more visual than verbal”	Rating = Value from the single question Max: 7 Min: 1

VVLSR visual score	3: Verbal-Visual Learning Style Rating	1	7: "Strongly more visual than verbal" 6: "Moderately more visual than verbal" 5: "Slightly more visual than verbal" 4: "Equally verbal and visual" 3: "Slightly more verbal than visual" 2: "Moderately more verbal than visual" 1: "Strongly more verbal than visual"	Rating = Value from the single question Max: 7 Min: 1
LSQ verbal score	4: Learning Scenario Questionnaire	1, 2, 3, 4, 5	For each question: 1: Verbal presentation selected 0: Visual presentation selected	Score = Sum of values from 5 questions Max: 5 Min: 0
LSQ visual score	4: Learning Scenario Questionnaire	1, 2, 3, 4, 5	For each question: 1: Visual presentation selected 0: Verbal presentation selected	Score = Sum of values from 5 questions Max: 5 Min: 0

MLPT-C verbal score	5: Multimedia Learning Preference Test	1 (Choice), 2 (Choice), 3 (Choice), 4 (Choice), 5 (Choice), 6 (Choice)	For each question: 1: Textual Help selected 0: Graphic Help selected	Score = Sum of values from 6 questions Max: 6 Min: 0
MLPT-C visual score	5: Multimedia Learning Preference Test	1 (Choice), 2 (Choice), 3 (Choice), 4 (Choice), 5 (Choice), 6 (Choice)	For each question: 1: Graphic Help selected 0: Textual Help selected	Score = Sum of values from 6 questions Max: 6 Min: 0
MLPT-R verbal score	5: Multimedia Learning Preference Test	1 (Rating), 2 (Rating), 3 (Rating), 4 (Rating), 5 (Rating), 6 (Rating)	For each question: 7: “Strongly prefer Textual” 6: “Moderately prefer Textual” 5: “Slightly prefer Textual” 4: “Equally like Textual and Graphic” 3: “Slightly prefer Graphic” 2: “Moderately prefer Graphic” 1: “Strongly prefer Graphic”	Rating = Sum of values from 6 questions Max: 42 Min: 6

MLPT-R visual score	5: Multimedia Learning Preference Test	1 (Rating), 2 (Rating), 3 (Rating), 4 (Rating), 5 (Rating), 6 (Rating)	For each question: 7: "Strongly prefer Graphic" 6: "Moderately prefer Graphic" 5: "Slightly prefer Graphic" 4: "Equally like Textual and Graphic" 3: "Slightly prefer Textual" 2: "Moderately prefer Textual" 1: "Strongly prefer Textual"	Rating = Sum of values from 6 questions Max: 42 Min: 6
Important verbal details score	7: Recall of important details and seductive details test	1, 5, 9, 13, 17, 21, 25, 29, 33, 37	For each question: 1: Answered correctly 0: Answered incorrectly	Score = Sum of values from 10 questions Max: 10 Min: 0
Important visual details score	7: Recall of important details and seductive details test	2, 6, 10, 14, 18, 22, 26, 30, 34, 38	For each question: 1: Answered correctly 0: Answered incorrectly	Score = Sum of values from 10 questions Max: 10 Min: 0

Seductive verbal details score	7: Recall of important details and seductive details test	4, 8, 12, 16, 20, 24, 28, 32, 36, 40	For each question: 1: Answered correctly 0: Answered incorrectly	Score = Sum of values from 10 questions Max: 10 Min: 0
Seductive visual details score	7: Recall of important details and seductive details test	3, 7, 11, 15, 19, 23, 27, 31, 35, 39	For each question: 1: Answered correctly 0: Answered incorrectly	Score = Sum of values from 10 questions Max: 10 Min: 0

Table 3

Method of Calculation of Single Scores (Not Used in Present Study)

Instrument	Score
Santa Barbara Learning Style Questionnaire	Weight of provisual ratings minus weight of proverbal ratings (-18 to +18); 3 = strongly agree–disagree, 2 = moderately agree–disagree, 1 = slightly agree–disagree
Verbal-Visual Learning Style Rating	Weight of rating (-3 to +3); +3 = strongly more visual than verbal; -3 = strongly more verbal than visual
Learning Scenario Questionnaire	Number of tasks on which visual mode is preferred (0 to 5)
Multimedia Learning Preference Test-Choice	Number of frames in which visual help was chosen first (0 to 5)
Multimedia Learning Preference Test-Rating	Number of frames in which visual help was rated higher (0 to 5)

Table 4

Reliability Coefficients for Each Measure

Measure	Alpha	Lambda 1	Lambda 2	Lambda 3	Lambda 4	Lambda 5	Lambda 6
SBLSQ verbal score	.89	-	-	-	-	-	-
SBLSQ visual score	.88	-	-	-	-	-	-
VVLSR verbal score	NA	-	-	-	-	-	-
VVLSR visual score	NA	-	-	-	-	-	-
LSQ verbal score	.13	.11	.23	.13	.38	.24	.18
LSQ visual score	.13	.11	.23	.13	.38	.24	.18
MLPT-C verbal score	.46	.39	.52	.46	.62	.53	.52
MLPT-C visual score	.46	.39	.52	.46	.62	.53	.52
MLPT-R verbal score	.29	.24	.38	.29	.38	.37	.38
MLPT-R visual score	.29	.24	.38	.29	.38	.37	.38
Recall test score	.77	-	-	-	-	-	-

Note. The verbal and visual versions of the LSQ scores, MLPT-C scores and MLPT-R scores were both calculated from the participant's responses in the same instrument. Therefore, the internal consistency, in terms of Cronbach's alpha coefficients and Guttman's lambda coefficients, for the verbal and visual versions of each of these measures were the same.

4.6.2. Statistical tests. For each research question, the measures that were considered and the number of tests that were to be performed are elaborated in Table 5. However, since a decision was taken to not consider the variables obtained from the Learning Scenario Questionnaire and the Multimedia Learning Preference Test, the statistical tests involving these variables were not performed. First, the descriptive statistics for the remaining 8 measures of the variables were determined. Second, the associations between the 8 measures were determined. Since Shapiro-Wilk tests of normality revealed that none of the 8 measures had a normal distribution, Pearson's correlation tests were not used and Spearman's correlation tests were used instead. Third, the predictive value of the measures of learning style for the four recall scores (important verbal details score, important visual details score, seductive verbal details score and seductive visual details score), as well as the predictive value of the four recall scores for each other, was determined using multiple linear regression tests. Since the verbal and visual versions of the VVLSR score were

both calculated from the participant's responses in the same instrument, they would have the same predictive value. Therefore, only the verbal version of this score was considered for prediction of the verbal recall scores, and only the visual version of this score was considered for prediction of the visual recall scores.

Table 5

Statistical Tests to Answer Research Questions

Question	Measures considered	Number of tests
1	SBLSQ verbal and visual scores VVLSR verbal and visual scores LSQ verbal and visual scores	3 (1 for the SBLSQ scores; 1 for the VVLSR scores; 1 for the LSQ scores)
2	SBLSQ verbal and visual scores VVLSR verbal and visual scores LSQ verbal and visual scores	6 – 3 verbal; 3 visual (1 for each pair of learning style measures)
2	MLPT-C verbal and visual scores MLPT-R verbal and visual scores	2 – 1 verbal; 1 visual (1 for the pair of learning behaviour measures)
3	SBLSQ verbal score VVLSR verbal score LSQ verbal score MLPT-C verbal score MLPT-R verbal score	6 (1 for each pair of learning style measure and learning behaviour measure)
3	SBLSQ visual score VVLSR visual score LSQ visual score MLPT-C visual score MLPT-R visual score	6 (1 for each pair of learning style measure and learning behaviour measure)
4	SBLSQ verbal score VVLSR verbal score LSQ verbal score Important verbal details score	3 (1 for each pair of learning style measure and important details score)

4	SBLSQ visual score VVLSR visual score LSQ visual score Important visual details score	3 (1 for each pair of learning style measure and important details score)
5	MLPT-C verbal score MLPT-R verbal score Important verbal details score	2 (1 for each pair of learning behaviour measure and important details score)
5	MLPT-C visual score MLPT-R visual score Important visual details score	2 (1 for each pair of learning behaviour measure and important details score)
6	SBLSQ verbal and visual scores VVLSR verbal score LSQ verbal score MLPT-C verbal score MLPT-R verbal score Important verbal details score	1 (1 for the important verbal details score)
6	SBLSQ verbal and visual scores VVLSR visual score LSQ visual score MLPT-C visual score MLPT-R visual score Important visual details score	1 (1 for the important visual details score)
7	SBLSQ verbal score VVLSR verbal score LSQ verbal score Seductive verbal details score	3 (1 for each pair of learning style measure and seductive details score)

7	SBLSQ visual score VVLSR visual score LSQ visual score Seductive visual details score	3 (1 for each pair of learning style measure and seductive details score)
8	MLPT-C verbal score MLPT-R verbal score Seductive verbal details score	2 (1 for each pair of learning behaviour measure and seductive details score)
8	MLPT-C visual score MLPT-R visual score Seductive visual details score	2 (1 for each pair of learning behaviour measure and seductive details score)
9	SBLSQ verbal and visual scores VVLSR verbal score LSQ verbal score MLPT-C verbal score MLPT-R verbal score Seductive verbal details score	1 (1 for the seductive verbal details score)
9	SBLSQ verbal and visual scores VVLSR visual score LSQ visual score MLPT-C visual score MLPT-R visual score Seductive visual details score	1 (1 for the seductive visual details score)
10	Important verbal and visual details scores	1 (1 for the important details scores)
10	Seductive verbal and visual details scores	1 (1 for the seductive details scores)
11	Important verbal details score Seductive verbal details score	1 (1 for the verbal scores)

11	Important visual details score Seductive visual details score	1 (1 for the visual scores)
12	Important verbal and visual details scores Seductive verbal and visual details scores	1 (1 for the important verbal details score)
12	Important verbal and visual details scores Seductive verbal and visual details scores	1 (1 for the important visual details score)
12	Important verbal and visual details scores Seductive verbal and visual details scores	1 (1 for the seductive verbal details score)
12	Important verbal and visual details scores Seductive verbal and visual details scores	1 (1 for the seductive visual details score)

5. Results

This study was conducted to evaluate the association between learning style, learning behaviour, recall of important details and recall of seductive details from an educational video among university students in The Netherlands. For illustrative purposes, the descriptive statistics of the measures of the variables used to answer the research questions are presented. After these descriptive statistics are presented, the results of the statistical tests used to answer the research questions, that is, the association between the variables and the predictive value of the variables, are described.

5.1. Descriptive Statistics

The mean and standard deviation for each of the remaining 8 measures of the variables are shown in Table 6.

Table 6

Descriptive Statistics for Each Measure

Measure	Possible Values	*M*	*SD*
SBLSQ verbal score	3 to 21	14.92	3.63
SBLSQ visual score	3 to 21	16.98	3.05
VVLSR verbal score	1 to 7	3.32	1.77
VVLSR visual score	1 to 7	4.68	1.77
Important verbal details score	0 to 10	6.58	2.05
Important visual details score	0 to 10	5.85	1.90
Seductive verbal details score	0 to 10	5.85	1.81
Seductive visual details score	0 to 10	4.97	1.59

Note. The verbal and visual versions of the VVLSR score were both calculated from the participant's responses in the same instrument. Therefore, the standard deviations for the verbal and visual versions of this measure were the same.

5.2. Correlational Tests

The Spearman correlation coefficients for all possible pairings of the remaining 8 measures of the variables are shown in Table 7. Correlation coefficients with a significance of $p > .05$ were considered insignificant, with a significance of $p < .05$ were considered significant and with a significance of $p < .01$ were considered highly significant.

There was a weak and insignificant correlation between the SBLSQ verbal and visual scores. There was a perfect negative correlation (-1.00) between the VVLSR verbal and visual scores because the verbal and visual versions of each of this measure were both calculated from the participant's responses in the same instrument. There were strong and highly significant correlations between the SBLSQ verbal score and the VVLSR verbal score and between the SBLSQ visual score and the VVLSR visual score. Also, there were moderate to strong, but significant, correlations between the important verbal details score, important visual details score, seductive verbal details score and seductive visual details score.

The measures of learning style (Measures 1, 2, 3, 4) did not correlate significantly with the measures of recall of details from the video (Measures 5, 6, 7, 8), except for weak, but significant, correlations between the SBLSQ verbal score and the important verbal details score and seductive visual details score (which was unexpected and probably coincidental).

Table 7

Correlation Matrix for the Eight Measures

Measure	1	2	3	4	5	6	7	8
1. SBLSQ verbal score	—							
2. SBLSQ visual score	-.22	—						
3. VVLSR verbal score	.58**	-.52**	—					
4. VVLSR visual score	-.58**	.52**	-1.00**	—				
5. Important verbal details score	-.27*	-.04	-.11	.11	—			
6. Important visual details score	-.14	-.09	-.01	.01	.53**	—		
7. Seductive verbal details score	-.14	-.02	.07	-.07	.59**	.34**	—	
8. Seductive visual details score	-.25*	-.09	-.10	.10	.35**	.33**	.29*	—

* $p < .05$. ** $p < .01$

Note. The verbal and visual versions of the VVLSR score were both calculated from the participant's responses in the same instrument. Therefore, the correlation between the verbal and visual versions of this measure is perfect (-1.00). Also, the correlations between the verbal and visual versions of this measure with the other measures are the same (but with the opposite sign).

5.3. Multiple Linear Regression Tests

For all linear regression tests, regression coefficients with a significance of $p > .05$ were considered insignificant, with a significance of $p < .05$ were considered significant and with a significance of $p < .01$ were considered highly significant.

Four multiple linear regression tests were performed using the stepwise method to determine whether the measures of learning style (SBLSQ scores and VVLSR scores) significantly predicted the four recall scores (important verbal details score, important visual details score, seductive verbal details score and seductive visual details score). Regression analysis revealed that, for each of the four recall scores, there was no significant model, which means that none of the measures of learning style were significant predictors of the four recall scores.

Four multiple linear regression tests were performed using the stepwise method to determine whether the four recall scores significantly predicted each other. For the important verbal details score, there was a significant model, $R^2 = .44$, $F\ (2, 62) = 24.57$, $p < .001$, with the important visual details score ($\beta = .40$, $p < .001$) and the seductive verbal details score ($\beta = .47$, $p < .001$) being significant predictors. For the important visual details score, there was a significant model, $R^2 = .31$, $F\ (1, 63) = 27.73$, $p < .001$, with the important verbal details score ($\beta = .51$, $p < .001$) being a significant predictor. For the seductive verbal details score, there was a significant model, $R^2 = .33$, $F\ (1, 63) = 31.00$, $p < .001$, with the important verbal details score ($\beta = .51$, $p < .001$) being a significant predictor. For the seductive visual details score, there was a significant model, $R^2 = .14$, $F\ (1, 63) = 10.47$, $p < .01$, with the seductive verbal details score ($\beta = .33$, $p < .01$) being a significant predictor.

An overview of the results of the multiple linear regression tests using the stepwise method are presented in Appendix K. All the multiple linear regression tests were repeated using the enter method to determine the significant or insignificant predictive values of each potential predictor. The results of these tests are also presented in Appendix K.

6. Discussion and Conclusion

The aim of the current study was to investigate the association between learning style, learning behaviour, recall of important details and recall of seductive details from an educational video, among university students in The Netherlands.

6.1. Findings

The study found that one of the measures of learning style (LSQ scores) and both the measures of learning behaviour (MLPT-C scores and MLPT-R scores) were not reliable, therefore, they were not considered for the statistical tests. The study found that there were significant correlations between the measures of learning style and between the measures of recall of important details and recall of seductive details. However, there were no significant correlations between the measures of learning style and the measures of recall of important details and recall of seductive details. This suggests that a person's learning style is not related to their learning performance. The study included twelve research questions, of which some could be answered, while others could be partially answered or not answered due to some of the variables being not considered. In the following paragraphs, each research question is discussed in detail.

6.1.1. Research question 1. The first research question was "What is the association between verbal and visual learning styles?". Results showed that the SBLSQ verbal score and the SBLSQ visual score were weakly but insignificantly correlated (r = -.22). Also, even though results showed that the VVLSR verbal score and the VVLSR visual score were perfectly negatively and highly significantly correlated (r = -1.00), this negative correlation was because the verbal and visual versions of each of this measure were calculated from the participant's responses in the same instrument. The association between the LSQ verbal score and the LSQ visual score could not be checked as these scores were not sufficiently reliable.

The lack of a significant correlation between verbal and visual learning styles indicates that the verbaliser-visualiser dimension should not be considered bipolar. Rather than considering verbal and visual as opposite ends of a single dimension, they should be considered as two separate dimensions (Kirby, Moore, & Schofield, 1988). This means that, rather than evaluating students along a single scale for verbal and visual, it is more beneficial to evaluate them along two separate scales for verbal and visual.

6.1.2. Research question 2. The second research question was "What is the association between the measures used for learning style and between the measures used for learning

behaviour?". Results showed that the SBLSQ verbal score and the VVLSR verbal score were strongly and highly significantly correlated (r = .58). Similarly, the SBLSQ visual score and the VVLSR visual score were strongly and highly significantly correlated (r = .52). The association between the SBLSQ scores and the LSQ scores as well as between the VVLSR scores and the LSQ scores could not be checked as the LSQ scores were not sufficiently reliable. Also, the association between the MLPT-C scores and the MLPT-R scores could not be checked as these scores were not sufficiently reliable.

The Santa Barbara Learning Style Questionnaire was used to obtain two separate scores, with each score indicating the participant's opinion of their preference for and strength at verbal or visual learning. The Verbal-Visual Learning Style Rating was also used to obtain two separate scores, with each score indicating the participant's opinion of the difference between their strength at verbal and visual learning. Thus, while both instruments measured learning style along the verbaliser-visualiser dimension, the first instrument produced individual values for the participant's strength at verbal learning and the participant's strength at visual learning, while the second instrument produced the difference between the participant's strength at verbal learning and the participant's strength at visual learning. The positive correlation between the SBLSQ scores and the VVLSR scores indicates that a stronger self-perceived verbal learning strength was associated with a stronger self-perceived difference between verbal learning strength and visual learning strength, while a weaker self-perceived verbal learning strength was associated with a stronger self-perceived difference between visual learning strength and verbal learning strength. The same existed in the case of self-perceived visual learning strength.

The Multimedia Learning Preference Test-Choice was used to understand the participant's initial tendency for verbal or visual information (before seeing the actual information) while learning about satellites. The Multimedia Learning Preference Test-Rating was used to understand the participant's final preference of verbal or visual information (after seeing the actual information) while learning about satellites. Thus, while both instruments measured learning behaviour along the verbaliser-visualiser dimension, the first instrument indicated what the participant thought they would like, while the second instrument indicated what the participant actually liked. Given that the Multimedia Learning Preference Test was found to not be sufficiently reliable, it might be interesting to improve the reliability of this test or to develop other reliable

instruments in an effort to successfully measure what participants think they would like and what participants actually liked, so that the correlation between the two can be checked.

The positive correlations between two of the measures of learning style used in this study (the Santa Barbara Learning Style Questionnaire and the Verbal-Visual Learning Style Rating) are consistent with the results of the studies by Mayer and Massa (2003) and by Massa and Mayer (2006), which showed that the measures of learning style loaded on the same factor as, and correlated positively with, each other. However, the results pertaining to the Learning Scenario Questionnaire and the Multimedia Learning Preference Test, which showed that these instruments are not sufficiently reliable, differ from the results of the studies by Mayer and Massa (2003) and by Massa and Mayer (2006), which showed that the Multimedia Learning Preference Test is reliable.

It is possible that the reliability and usefulness of a learning behaviour instrument depends on the learning topic it uses (Leutner & Plass, 1998). Therefore, the change in the topic of the Multimedia Learning Preference Test, from lightning to satellites, could account for the change in the reliability of the test. However, since both topics were scientific and the functioning of the test remained the same, it is unlikely that the change in topic caused the change in reliability. It is more likely that the test itself is unreliable because of the low chance that participants would pick the same type of explanation (verbal or visual) for every item. Not only may participants feel that different topics are better explained by either a verbal or a visual explanation, but also, within a topic, participants may feel a particular piece of information is better explained by either a verbal or a visual explanation, leading to different types of explanation being picked for different items, and, ultimately, a low reliability of the test. This suggests that, while learning style may be more consistent over time, learning behaviour may change for different learning content and in different learning contexts. This is further evidence that learning style and learning behaviour are two separate learning characteristics and, thus, should be evaluated separately

Due consideration needs to be given to whether the Learning Scenario Questionnaire is a learning style instrument or a learning behaviour instrument. It seems to lie somewhere between a learning styles instrument and a learning behaviour instrument—not placing the participant in an authentic learning situation in which a choice has to be made makes it similar to a learning style instrument, while at the same time describing a learning situation in which a choice has to be made makes it similar to a learning behaviour instrument (Mayer & Massa, 2003). Mayer and Massa

(2003) initially categorised it as a learning behaviour instrument, but finally concluded it was a learning style instrument based on the factor analysis and correlations. Hence, it was used as a learning style instrument in this study. However, given that each item of the instrument deals with different learning content, which might result in participants preferring different types of explanation for different items, and supported by the low reliability of the instrument, it can be concluded that the Learning Scenario Questionnaire is a learning behaviour instrument.

6.1.3. Research question 3. The third research question was "What is the association between learning style and learning behaviour?". This association could not be checked because both measures of learning behaviour, the MLPT-C scores and the MLPT-R scores, were not sufficiently reliable.

Given that the Learning Scenario Questionnaire and the Multimedia Learning Preference Test were found to not be sufficiently reliable, it might be interesting to improve the reliability of these tests or to develop other reliable instruments of learning behaviour, so that the correlation between learning style and learning behaviour can be checked.

6.1.4. Research question 4. The fourth research question was "What is the association between learning style and recall of important details?". Results showed that the SBLSQ verbal score and the important verbal details score were weakly and significantly correlated (r = -.27), and the VVLSR verbal score and the important verbal details score were weakly and insignificantly correlated (r = -.11).Similarly, results showed that the SBLSQ visual score and the important visual details score were weakly and insignificantly correlated (r = -.09), and the VVLSR visual score and the important visual details score were weakly and insignificantly correlated (r = .01). The association between the LSQ verbal score and the important verbal details score as well as between the LSQ visual score and the important visual details score could not be checked as the LSQ scores were not sufficiently reliable.

The overall lack of a correlation between learning style and recall of important details is consistent with the results of the study by Massa and Mayer (2006), which found no significant interaction effect between verbal or visual learning style and verbal or visual treatment on learning outcomes. Though the present study is different from the study by Massa and Mayer (2006) in a number of ways (as detailed in the Theoretical Framework), the results of the present study and the study by Massa and Mayer (2006) both show that there is no relationship between learning style and recall of important details.

6.1.5. Research question 5. The fifth research question was "What is the association between learning behaviour and recall of important details?". This association could not be checked because both measures of learning behaviour, the MLPT-C scores and the MLPT-R scores, were not sufficiently reliable. Therefore, in terms of the relationship between learning behaviour and recall of important details, the results of the present study could not be compared to the results of the study by Massa and Mayer (2006).

6.1.6. Research question 6. The sixth research question was "What is the predictive value of learning style and learning behaviour for recall of important details?". Results showed that neither the SBLSQ scores nor the VVLSR scores had a significant predictive value for the recall of important verbal details or for the recall of important visual details. The predictive values of the LSQ scores, MLPT-C scores and MLPT-R scores could not be checked as these scores were not sufficiently reliable.

The results of the multiple linear regression tests matched the results of the correlation tests—that there is no relationship between learning style and recall of important details.

6.1.7. Research question 7. The seventh research question was "What is the association between learning style and recall of seductive details?". Results showed that the SBLSQ verbal score and the seductive verbal details score were weakly and insignificantly correlated (r = -.14), and the VVLSR verbal score and the seductive verbal details score were weakly and insignificantly correlated (r = .07).

Similarly, results showed that the SBLSQ visual score and the seductive visual details score were weakly and insignificantly correlated (r = -.09), and the VVLSR visual score and the seductive visual details score were weakly and insignificantly correlated (r = .10). The association between the LSQ verbal score and the seductive verbal details score as well as between the LSQ visual score and the seductive visual details score could not be checked as the LSQ scores were not sufficiently reliable.

The overall lack of a correlation between learning style and recall of seductive details cannot be compared and contrasted with the results of another study, since there is a lack of research involving learning style and recall of seductive details. However, the present study added to the knowledge about learning style gained from the study by Massa and Mayer (2006), since it showed that the lack of a correlation exists not only between learning style and recall of important details, but also between learning style and recall of seductive details.

6.1.8. Research question 8. The eighth research question was "What is the association between learning behaviour and recall of seductive details?". This association could not be checked because both measures of learning behaviour, the MLPT-C scores and the MLPT-R scores, were not sufficiently reliable. Therefore, in terms of the relationship between learning behaviour and recall of seductive details, the present study could not add to the knowledge about learning behaviour gained from the study by Massa and Mayer (2006)..

6.1.9. Research question 9. The ninth research question was "What is the predictive value of learning style and learning behaviour for recall of seductive details?". Results showed that neither the SBLSQ scores nor the VVLSR scores had a significant predictive value for the recall of seductive verbal details or for the recall of seductive visual details. The predictive values of the LSQ scores, MLPT-C scores and MLPT-R scores could not be checked as these scores were not sufficiently reliable.

The results of the multiple linear regression tests matched the results of the correlation tests—that there is no relationship between learning style and recall of seductive details.

The lack of a relationship between learning style and the recall of important details or the recall of seductive details from the video is explained by Fleming and Baume (2006). They clarify that learning preferences should not be mistaken for learning ability. A particular learning style indicates a preference for learning in a particular way, but it does not indicate an ability to learn better in that way. Dunn et al. (2002) note that learning styles determine how students learn content, but they stipulate that, irrespective of their learning styles, most students can learn the same content. In this way, no learning style brings about stronger or weaker cognitive abilities or determines how well learners will perform.

6.1.10. Research question 10. The tenth research question was "What is the association between recall of important verbal details and recall of important visual details and between recall of seductive verbal details and recall of seductive visual details?". Results showed that the important verbal details score and the important visual details score were strongly and highly significantly correlated (r = .53), while the seductive verbal details score and the seductive visual details score were weakly and significantly correlated (r = .29).

The positive correlation between the verbal and visual scores could be explained by the fact that the participants were informed at the start of their session that they were participating in a study on verbal and visual learning and expected content to be presented in both the audio and

the visuals of the educational video and, therefore, they paid attention to the information presented in both modalities equally. Those participants who had a higher cognitive capacity and/or who had a higher motivation to learn would have had a tendency to learn more. As per the results of the tests to answer questions 4, 5 and 6, we can assume that their verbal or visual learning style would not be associated with recalling more details presented in a particular modality. Therefore, if they learned more, they would have recalled more details presented in both modalities. Similarly, those participants who had a lower cognitive capacity and/or who had a lower motivation to learn would have had a tendency to learn less and would have recalled less details presented in both modalities, bringing about the positive correlation between the verbal and visual scores.

6.1.11. Research question 11. The eleventh research question was "What is the association between recall of important verbal details and recall of seductive verbal details and between recall of important visual details and recall of seductive visual details?". Results showed that the important verbal details score and the seductive verbal details score were strongly and highly significantly correlated (r = .59), while the important visual details score and the seductive visual details score were moderately and highly significantly correlated (r = .33).

The positive correlation between the important details and seductive details scores could be explained by the fact that the educational video used in the study presented the important details and the seductive details in the same manner and the participants were not made aware of which details were important and, therefore, they paid attention to the important and seductive information equally. Those participants who had a higher cognitive capacity and/or who had a higher motivation to learn would have had a tendency to learn more. As they lacked the knowledge of which details were important and which were seductive, we can assume that they did not distinguish between the two types of information and did not recall more details of a particular type. Therefore, if they learned more, they would have recalled more details of both types. Similarly, those participants who had a lower cognitive capacity and/or who had a lower motivation to learn would have had a tendency to learn less and would have recalled less details of both types, bringing about the positive correlation between the important details and seductive details scores.

Another point to consider is that, until now, most of the studies that tested the seductive details effect used text and images as the learning material. In these cases, participants would have had the ability to focus their attention qualitatively, in terms of strength of observation, and

quantitatively, in terms of duration of observation, separately on each important detail and seductive detail. Participants with low prior knowledge would have not known which were the important details and which were the seductive details (unless they were marked) and, therefore, could have been distracted by the more interesting seductive details and paid qualitatively and quantitatively more attention to the seductive details than to the important details. This could have produced a negative correlation between the recall of important details and the recall of seductive details. The present study used a video as the learning material. In this case, even though participants could have paid qualitatively more attention to the seductive details than to the important details, it would have been difficult or inconvenient for them to have paid quantitatively more attention to the seductive details than to the important details, since the video determined how much time each detail was available for. In this situation, the negative effects of the seductive details, in terms of distraction, may have been minimised, and the positive effects of the seductive details, in terms of increased motivation and interest, may have dominated over the negative effects. This could be a second explanation for the positive correlation between the important details and seductive details scores.

Finally, as per the modality effect proposed by Mayer (2014b), people learn better from narration and animations than from text and animations, since the cognitive load is lower in the first condition. The lower cognitive load imposed by the video in the present study (as compared to the text and images in previous studies) could have prevented a cognitive overload caused by the additional extraneous load of the seductive details (Park et al., 2015; Park et al., 2011). Therefore, the negative effects of the seductive details, in terms of cognitive overload, may have been prevented, and the positive effects of the seductive details, in terms of increased motivation and interest, may have dominated over the negative effects. This could be a third explanation for the positive correlation between the important details and seductive details scores.

6.1.12. Research question 12. The twelfth research question was “What is the predictive value of each recall score for the other recall scores?”. Results showed that the recall of important visual details and seductive verbal details had a significant predictive value for the recall of important verbal details, the recall of important verbal details had a significant predictive value for the recall of important visual details, the recall of important verbal details had a significant predictive value for the recall of seductive verbal details, and the recall of seductive verbal details had a significant predictive value for the recall of seductive visual details.

The results of the multiple linear regression tests did not match the results of the correlation tests. While the correlation tests showed highly significant associations between all four recall scores, the multiple linear regression tests showed that each recall score was significantly predicted by only one or two of the other three recall scores. To check the results of the correlation tests, simple linear regression tests (each considering the prediction of a recall score by only one of the other three recall scores at a time) were performed. The results of these tests showed that each recall score could be highly significantly predicted by each of the other three recall scores (refer Appendix L), thus matching the results of the correlation tests. To further check the results of the correlation tests, scatterplots of each recall score versus each of the other three recall scores were created. The plots showed that the relationships between all pairs of the recall scores were sufficiently linear (refer Appendix M), thus justifying the results of the correlation tests. Therefore, it was concluded that, since all the recall scores were correlated with each other, when the multiple linear regression test for a particular recall score was performed, the predictive values of each of the other three recall scores overlapped each other, and therefore the one or two recall scores that were sufficient to explain the regression were included in the model, while the other recall scores that did not have a significant additional contribution to explain the regression were eliminated from the model.

6.2. Theoretical Implications

The results of this study lead to four main theoretical implications. First, for the verbaliser-visualiser dimension, this study's results showed that verbal and visual aspects are not at opposite ends of the same dimension, but rather are two separate factors. This implies that they should be evaluated separately using two separate scales. Second, for learning style and learning behaviour, this study showed that learning style and learning behaviour are two separate learning characteristics that should be evaluated separately with instruments that have been proven to measure the appropriate characteristic. Third, for the verbaliser-visualiser hypothesis, this study failed to find evidence that supports the hypothesis in the case of high-cognitive-capacity students learning from an educational video. While this study joins a large number of other studies that failed to find evidence to support the verbaliser-visualiser hypothesis for important details, it is also the first study to fail to find evidence to support the verbaliser-visualiser hypothesis for seductive details. A stronger verbal learning style does not relate with a higher recall of verbal details from an educational video. Similarly, a stronger visual learning style does not relate with a

higher recall of visual details from an educational video. Fourth, for the seductive details hypothesis, this study failed to find evidence to support the hypothesis in the case of high-cognitive-capacity students learning from an educational video. A stronger recall of seductive details does not relate with a weaker recall of important details, even when learners have a low prior knowledge of the learning topic. Instead, the results of this study suggest that the recall of both important and seductive details may be similarly influenced by an external factor, such as cognitive capacity or motivation, resulting in the higher or lower recall of both types of details. An important point is that this study did not include a time restriction on the study or test phases, which may have also contributed to maintaining a low cognitive load and preventing the seductive details effect. Therefore, the findings cannot be generalised to all high-cognitive-capacity students learning from educational videos—it is possible that imposing a time restriction on the study or test phases may result in a seductive details effect.

6.3. Practical Implications

The field of research on learning styles has been fraught with controversy and there has been a lack of consensus on appropriate instruments for evaluating verbal/visual learning styles. The various available instruments evaluate verbal/visual learning styles using descriptions that are not always related to learning. Also, since most learning style instruments require self-report by the students, understanding of the learning styles may be insufficient and interpretation of the questions may vary. This study has shown that the Santa Barbara Learning Style Questionnaire and the Verbal-Visual Learning Style Rating can be used effectively and efficiently to evaluate verbal/visual learning styles. The questions in these questionnaires are direct and do not use analogies or non-learning situations, thus leaving little room for misinterpretation of the questions by the students. Also, the questionnaires are relatively short and do not require much time to answer. This makes these two questionnaires ideal for accurately and quickly evaluating students' learning styles. The information obtained from these learning style questionnaires about what students think is their preferred way of receiving information can be supplemented with the information obtained from learning behaviour instruments about what way of receiving information students choose in an authentic learning situation. This combined information can be used to create a better picture of students' learning preferences. Given that the Learning Scenario Questionnaire and the Multimedia Learning Preference Test were found to not be sufficiently

reliable, it would be beneficial to improve the reliability of these tests or to develop other reliable instruments of learning behaviour.

The lack of evidence supporting the verbaliser-visualiser hypothesis suggests that it is not beneficial for teachers to adapt their teaching styles to match the learning styles of their students or for teachers to provide instructional materials suitable for each learning style. Instead, teachers should teach each topic according to the strategy that is best suited for the type of topic and learners should be flexible enough to adapt themselves to the strategy being used in each situation. The lack of evidence supporting the seductive details hypothesis suggests that teachers can choose to include seductive details in educational videos, in situations involving low-cognitive-load content and high-cognitive-capacity students, even when learners have a low prior knowledge of the topic. In such situations, seductive details do not have a negative effect on the recall of important details and can be used to increase the motivation and interest of the students, in an attempt to bring about positive effects on the learning outcomes. An important point is that this study did not provide evidence that seductive details do bring about positive effects on the learning outcomes. The association between the recall of seductive details and the recall of important details may have been due to the influence of an external factor, such as cognitive capacity or motivation, which brought about the higher or lower recall of both types of details.

6.4. Limitations

It is important to note that this study has a few limitations. First, the results of the study cannot be generalised to all populations of students, to all learning topics or to all types of learning materials. With regard to the population, this study's participants were university students in The Netherlands, which meant that their English proficiency was relatively high, they were used to studying content from multimedia learning materials and their cognitive capacity was relatively high. Participants who are less proficient in English may have to use some part of their cognitive capacity to understand the language and participants who have less experience with studying from multimedia learning materials may have to use some part of their cognitive capacity to understand how the technology works, thus leaving a reduced cognitive capacity for processing the actual content of the learning material and potentially producing different results. With regard to the learning topic, the Multimedia Learning Preference Test evaluated the participants' learning behaviour in an authentic learning situation, that is, when they were learning about satellites. While the choice of topic is appropriate because it is from the same subject (astrophysics) as the topic for

the recall of important details and seductive details test, the authentic learning situation creates a limitation because the participants' learning behaviour is recorded for a specific topic (satellites) and the behaviour cannot be generalised to all other learning topics. It is possible that a different learning topic may produce a more consistent selection of a particular type of explanation, leading to more reliable measures from this test. Also, the recall of important details and seductive details test mainly used the conquering of space as the topic of the learning content. It is possible that the relative recall of verbal and visual details or the relative recall of important and seductive details is different when the learning content is from a different learning topic. With regard to the type of learning materials, the learning content for the recall of important details and seductive details test was presented in the form of a video. It is possible that the relative recall of verbal and visual details or the relative recall of important and seductive details is different when the learning content is presented using a different type of learning material.

Second, the Learning Scenario Questionnaire and the Multimedia Learning Preference Test allowed the participants to only select one form (verbal or visual) in which they wanted to view the information for each situation/frame. However, it is possible that the participants wanted to view both types of information for a better and more comprehensible explanation. Third, it could be argued that the association between learning behaviour and recall of details should have been studied using the same type of learning material, that is, either text and images or a video. Unfortunately, the evaluation of learning behaviour (the observation of choices between verbal and visual information) is not possible using a video, and the evaluation of recall of details from a video is only possible using a video.

Fourth, the seductive details in the video that were used for the recall test were identified and classified as seductive details by the researcher. While only details that satisfied the criteria of interesting and irrelevant were selected, due to the limited duration of the study, there was no pre-study to evaluate the level of interestingness or the level of irrelevance of each of these details, in order to confirm their classification as seductive details. Fifth, the participants' prior knowledge of the learning topic for the recall test was not evaluated. While it was assumed that the participants' prior knowledge was negligible as none of them were from that field, due to the limited duration of the study, there was no pre-test to evaluate each participant's prior knowledge and confirm it as being low or negligible. A lack of a pre-test also meant that there was no pre-test score to compare with the post-test score, in order to obtain a learning outcomes score in terms of

increase in knowledge, rather than a learning outcomes score in terms of absolute knowledge. However, a pre-test would have been inappropriate in this study for two reasons: 1) The post-test evaluated the participants only at the recall level, and a post-test-minus-pre-test score is usually beneficial in situations where the post-test evaluates the participants at the comprehension or application level. 2) The post-test evaluated the participants for their recall of seductive details and, since the participants would not have seen these details in advance, the recall of such details would not be possible in a pre-test.

Sixth, as mentioned in the previous point, the post-test evaluated the participants only for immediate recall. Again, due to the limited duration of the study, there was no evaluation of long-term retention, which may show different results. Seventh, the post-test used a multiple-choice question format, which meant that, even if participants did not know the answer to a particular question, they could select a random option and have a 25% chance of answering the question correctly, thus increasing their score for the relevant category of question. Future studies that have recall tests using a multiple-choice question format could possibly include an "I don't know" option for each question, along with a request to participants to honestly select that option if they don't know the answer. However, there is no guarantee that participants will select that option as there will often be an element of motivation to achieve as high a score as possible and, therefore, there may be an attempt to guess the correct answer to the question. Eighth, on the subject of motivation to achieve as high a score as possible, the participants in this study did not have any incentive to learn as much as possible and attempt the post-test to the best of one's ability, since all the participants were volunteers and their scores on the post-test did not contribute to their grades for their study programme. Future studies that have recall tests that do not have an effect on students' grades could possibly include some other form of motivation to achieve as high a score as possible.

6.5. Future Research

The limitations of this study can be used to drive future research. To achieve a more reliable measure of learning behaviour, more items can be designed and included in the Learning Scenario Questionnaire. To understand students' learning behaviour better, the Multimedia Learning Preference Test can be modified to allow participants to select one or both forms (verbal and visual) to view the information in and include a slider for participants to indicate what percentage of help they want in each form. The test can also be supplemented with a qualitative evaluation, in

which an interview or survey with open-ended questions could be used to record why people selected verbal or visual help for each frame in the Multimedia Learning Preference Test, thus providing useful insight into the reasons why students' specific learning behaviour matches their generic learning style for some frames/in some situations and why students' specific learning behaviour does not match their generic learning style for some other frames/in some other situations. Also, as an alternative to the Learning Scenario Questionnaire and Multimedia Learning Preference Test, future researchers can attempt to design new tests to measure learning behaviour.

To understand the association between learning style or learning behaviour and learning outcomes better, future studies can check for the association using long-term retention tests, in addition to immediate recall tests, since, in authentic learning situations, most learning content needs to be remembered for the long term. Thus, long-term retention can be used to test and provide further insight on the verbaliser-visualiser hypothesis. To understand the effect of seductive details on learning outcomes better, future studies can include a pre-study to identify the most interesting and irrelevant details to include in the learning material. Also, they can focus on a comparison of the seductive details effect when different types of seductive details are included in the learning material (verbal/visual, nice to know/completely irrelevant) and when different types of learning materials are used (text and image/video). Thus, the moderating factors can be used to test and provide further insight on the seductive details hypothesis. Finally, research is also needed to determine whether the provision of seductive details according to the verbal/visual preference of the learners improves learning outcomes. While previous studies have checked for the effect of verbal/visual seductive details on the recall of important details, they have not mapped the recall of these seductive details with the verbal/visual learning preferences of the learners. Also, while this study has checked for the recall of verbal/visual seductive details in relation to the verbal/visual learning preferences of the learners, it has not mapped the recall of important details when the seductive details are/are not provided in accordance with the learning preferences of the learners.

The field of research on learning styles needs a new outlook, with the accelerated changes not only in the type of learning materials that are being used by students, but also in the cognitive processing abilities of the students. Dede (2005) describes how rapid and significant improvements in information technology have made the teaching through simulations, virtual reality and augmented reality possible and how the development of 'millennial' and 'neomillennial' learning

styles among students have made the learning through such technologies possible. Students now know how to operate different kinds of media and are capable of multi-tasking to absorb information from multiple sources simultaneously. In this rapidly-changing environment, research is required to understand the neomillennial learning styles and how learning outcomes can be optimised for students with such learning styles.

6.6. Conclusion

This study aimed to contribute to the field of research on learning styles by providing data that can be beneficial to the understanding of the association between learning styles and learning outcomes from learning materials. While there have already been a number of studies in this field, this study endeavoured to add to the field in three significant ways: 1) Using an educational video as the learning material, as opposed to using text and image-based material as done in most previous studies 2) Considering learning behaviour, in addition to learning styles 3) Considering recall of seductive details, in addition to recall of important details. Thus, the objective of the study was to find the association between learning style, learning behaviour, recall of important details and recall of seductive details from an educational video, among university students in The Netherlands. The study found that there were significant positive correlations between the measures of learning style and between the measures of recall of important details and recall of seductive details, but no significant correlations between the measures of learning style and the measures of recall of important details or recall of seductive details. This suggests that a person's learning style is not related to their learning performance. Due consideration needs to be given to these findings, as they failed to support the verbaliser-visualiser hypothesis and can influence whether or not educators choose to adapt their teaching strategies for learners with different learning styles. The study also found that there was a significant positive correlation between recall of verbal and visual details and between recall of important and seductive details. This suggests that a person's recall of details in all four categories (important verbal, seductive verbal, important visual, seductive visual) is affected by a common factor, possibly cognitive capacity or motivation to learn. Due consideration needs to be given to these findings as well, as they failed to support the seductive details hypothesis and can influence whether or not educators choose to include seductive details in their teaching material.

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Appendix A: Demographic Questions

Please answer the following demographic questions.

1. What is your sex?
   - Male
   - Female

2. What is your age?

   ____

3. What is your highest (completed) educational qualification?
   - High School Diploma
   - Bachelor's Degree
   - Master's Degree
   - PhD Degree

4. What was the field of your highest (completed) educational qualification? (for example, psychology, business, physics, mathematics, mechanical engineering, chemical engineering)

   _____

Appendix B: Santa Barbara Learning Style Questionnaire

For each statement, select the option that best indicates your level of agreement or disagreement.

1. I prefer to learn visually.

   ○ Strongly agree ○ Moderately agree ○ Slightly agree ○ Neither agree nor disagree ○ Slightly disagree ○ Moderately disagree ○ Strongly disagree

2. I prefer to learn verbally.

   ○ Strongly agree ○ Moderately agree ○ Slightly agree ○ Neither agree nor disagree ○ Slightly disagree ○ Moderately disagree ○ Strongly disagree

3. I am a visual learner.

   ○ Strongly agree ○ Moderately agree ○ Slightly agree ○ Neither agree nor disagree ○ Slightly disagree ○ Moderately disagree ○ Strongly disagree

4. I am a verbal learner.

   ○ Strongly agree ○ Moderately agree ○ Slightly agree ○ Neither agree nor disagree ○ Slightly disagree ○ Moderately disagree ○ Strongly disagree

5. I am good at learning from labelled pictures, illustrations, graphs, maps and animations.

   ○ Strongly agree ○ Moderately agree ○ Slightly agree ○ Neither agree nor disagree ○ Slightly disagree ○ Moderately disagree ○ Strongly disagree

6. I am good at learning from printed text and spoken words.

   ○ Strongly agree ○ Moderately agree ○ Slightly agree ○ Neither agree nor disagree ○ Slightly disagree ○ Moderately disagree ○ Strongly disagree

Appendix C: Verbal and Visual Learning Explanation Script

As you know, this study is about verbal and visual learning. However, before you answer the questions about verbal and visual learning, it is important that you understand what exactly is meant by ‘verbal’ and ‘visual’, so that everybody has the same understanding of the words.

For the purpose of this study, ‘verbal’ learning is learning from spoken words or printed text. For example, when you listen to your teacher talking during a lecture or when you read a textbook. On the other hand, ‘visual’ learning is learning from depictions of information without the significant use of words. For example, when you look at pictures, illustrated diagrams, charts, graphs, maps and animations. Keep in mind that text in the form of paragraphs is ‘verbal’, while text in the form of the labels in diagrams is ‘visual’.

Is the difference between verbal and visual learning clear? If not, you can clarify any doubts you have before you start answering the questions.

Appendix D: Verbal-Visual Learning Style Rating

For the question, select the option that best indicates your learning preference.

In a learning situation, sometimes information is presented verbally (for example, through printed text or spoken words) and sometimes information is presented visually (for example, through labelled illustrations, graphs or narrated animations). Which type of presentation do you prefer?

○ Strongly more verbal than visual	○ Moderately more verbal than visual	○ Slightly more verbal than visual	○ Equally verbal and visual	○ Slightly more visual than verbal	○ Moderately more visual than verbal	○ Strongly more visual than verbal

Appendix E: Learning Scenario Questionnaire

For each situation, select the option that best indicates your preferred content format.

1. Learning a scientific description of an atom
   - A paragraph describing each part
   - A labelled diagram showing each part

2. Learning a scientific explanation of how a bicycle tire pump works
   - An essay describing what happens when you pull up on the handle and when you push down on the handle
   - A series of labelled diagrams showing the status of each part of the pump when you pull up on the handle and when you push down on the handle

3. Following directions for how to get somewhere on a new college campus
   - Verbal directions including when to turn left and when to turn right in getting from the starting point to the stopping point
   - A map showing the roads and buildings along with a line from the starting point to the stopping point

4. Following instructions for how to set the time on a stopwatch
   - A section of printed text with a list of the steps
   - A labelled diagram showing the steps

5. Describing the mathematics test scores for 6th grade boys and girls for the last five years
   - A list of the scores for boys in one sentence and a list of the scores for girls in another sentence
   - A line graph with one line showing the scores for boys and another line showing the scores for girls

Appendix F: Original Multimedia Learning Preference Test

Frame 1:

Cool, moist air moves over a warmer surface and becomes heated. Warmed moist air near the earth's surface rises rapidly. As the air in this updraft cools, water vapor condenses into water droplets and forms a cloud. The cloud's top extends above the freezing level. At this altitude, the air temperature is well below freezing so the upper portion of the cloud is composed of tiny ice crystals.

Help Screen 1:

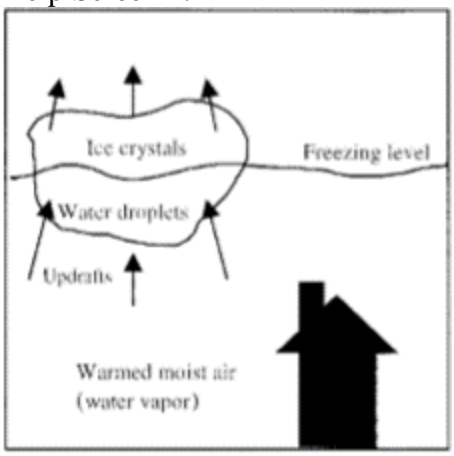
"water vapor" MEANS moisture in air that is in gas form such as in rising air before it condenses into a cloud

"water drops" MEANS moisture in air that is in liquid form such as in the part of a cloud below the freezing level

"ice crystals" MEANS moisture in air that is in solid form such as in the part of a cloud above the freezing level

"freezing level" MEANS at some point above the surface of the earth there is an imaginary line in the sky so that above the line water in a cloud will freeze into ice crystals and below the line water in a cloud will stay as water droplets

Help Screen 2:



Which of the two help screens do you prefer?

○ Strongly prefer 1	○ Moderately prefer 1	○ Slightly prefer 1	○ Equally like 1 and 2	○ Slightly prefer 2	○ Moderately prefer 2	○ Strongly prefer 2

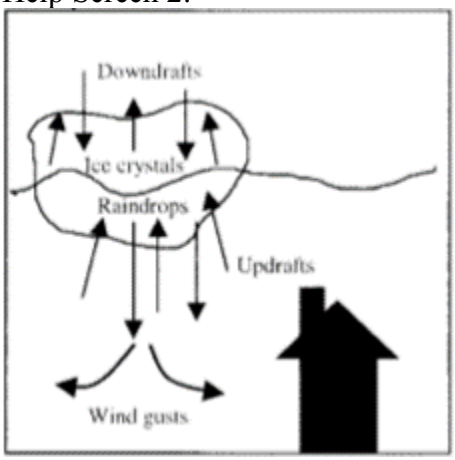
Frame 2:

Eventually, the water droplets and ice crystals become too large to be suspended by the updrafts. As raindrops and ice crystals fall through the cloud, they drag some of the air in cloud downward, producing downdrafts. When downdrafts strike the ground, they spread out in all directions, producing the gusts of cool wind people feel just before the start of the rain.

Help Screen 1:

"updraft" MEANS that a body of air is moving upward because it is warmer than the surrounding air
"downdraft" MEANS that a body of air is moving downward because it is cooler than the surrounding air

Help Screen 2:



Which of the two help screens do you prefer?

○ Strongly prefer 1	○ Moderately prefer 1	○ Slightly prefer 1	○ Equally like 1 and 2	○ Slightly prefer 2	○ Moderately prefer 2	○ Strongly prefer 2

Frame 3:

Within the cloud, the rising and falling air currents cause electrical charges to build. The charge results from the collision of the cloud's rising water droplets against heavier, falling pieces of ice. The negatively-charged particles fall to the bottom of the cloud and most of the positively-charged particles rise to the top.

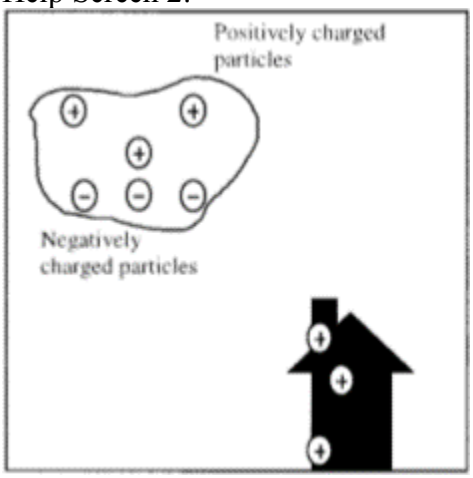
Help Screen 1:

"electrical charge" MEANS the negatively-charged particles and positively-charged particles in material have been separated

"negatively-charged particle" MEANS a part of the material in clouds that has a negative electrical charge, which normally is attracted to positively-charged particles

"positively-charged particle" MEANS a part of the material in clouds that has a positive electrical charge, which normally is attracted to negatively-charged particles

Help Screen 2:



Which of the two help screens do you prefer?

○ Strongly prefer 1	○ Moderately prefer 1	○ Slightly prefer 1	○ Equally like 1 and 2	○ Slightly prefer 2	○ Moderately prefer 2	○ Strongly prefer 2

Frame 4:

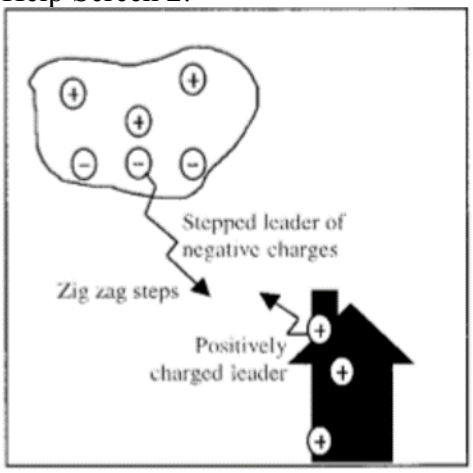
A stepped leader of negative charges moves downward in a series of zig-zag steps. It nears the ground. A positively charged leader travels upward from such objects as trees and buildings. The two leaders generally meet about 165 feet above the ground. Negatively-charged particles then rush from the cloud to the ground along the path created by the leaders. It is not very bright.

Help Screen 1:

"stepped leader of negative charges" MEANS that negatively-charged particles from the bottom of the cloud move downward toward the positively-charged particles in objects on the earth's surface

"positively charged leader" MEANS that positively-charged particles from objects on the earth's surface move upward toward the stepped leader of negative charges

Help Screen 2:



Which of the two help screens do you prefer?

○ Strongly prefer 1	○ Moderately prefer 1	○ Slightly prefer 1	○ Equally like 1 and 2	○ Slightly prefer 2	○ Moderately prefer 2	○ Strongly prefer 2

Frame 5:

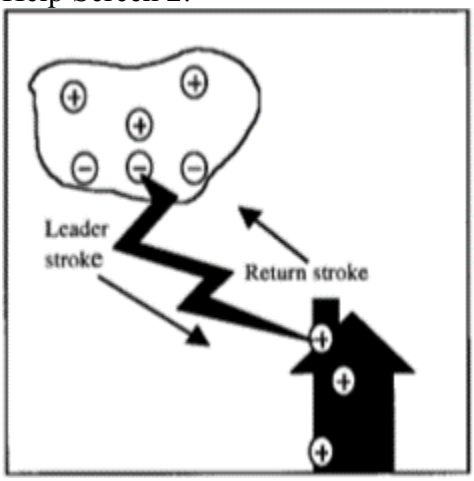
As the leader stroke nears the ground, it induces an opposite charge, so positively charged particles from the ground rush upward along the same path. This upward motion of current is the return stroke. It produces the bright light that people notice as a flash of lighting.

Help Screen 1:

"leader stroke" MEANS that negatively-charged particles travel all the way from the cloud to the ground

"return stroke" MEANS that positively-charged particles travel all the way from the ground to the cloud

Help Screen 2:



Which of the two help screens do you prefer?

○ Strongly prefer 1	○ Moderately prefer 1	○ Slightly prefer 1	○ Equally like 1 and 2	○ Slightly prefer 2	○ Moderately prefer 2	○ Strongly prefer 2

Appendix G: Modified Multimedia Learning Preference Test

Please go through a short lesson on 'Satellites', which consists of six chunks of information. To understand each chunk better, you need to click the Textual Help button and the Graphic Help button. You can click the buttons in any order you prefer.

Note: The position of the Textual Help button and Graphic Help button changes for each question.

Frame 1:

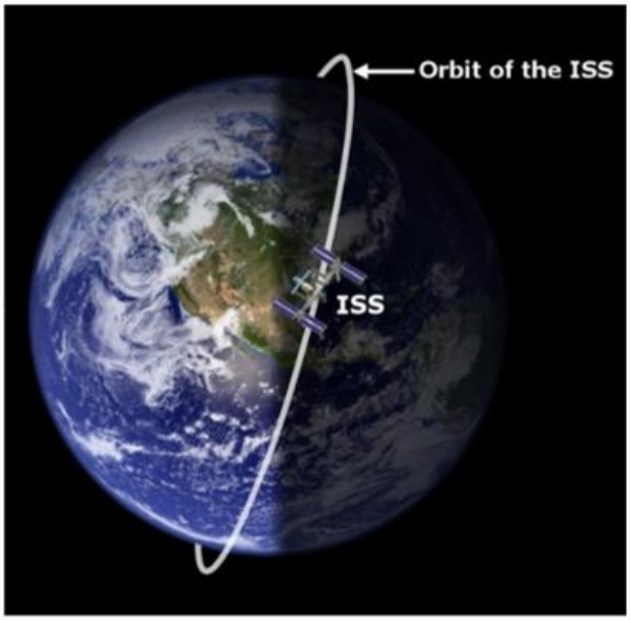
In the context of space, an artificial satellite is a man-made object that has been intentionally placed into orbit around another object.

On the next few slides, we will take a look at the different kinds of orbits, based on their altitude, inclination, eccentricity and synchronicity.

Textual Help:

An orbit is the gravitationally-curved trajectory of an object.

Graphic Help:



Which of the two Help screens do you prefer? (If you like, you can view them again below.)

○ Strongly prefer Textual	○ Moderately prefer Textual	○ Slightly prefer Textual	○ Equally like Textual and Graphic	○ Slightly prefer Graphic	○ Moderately prefer Graphic	○ Strongly prefer Graphic

Frame 2:

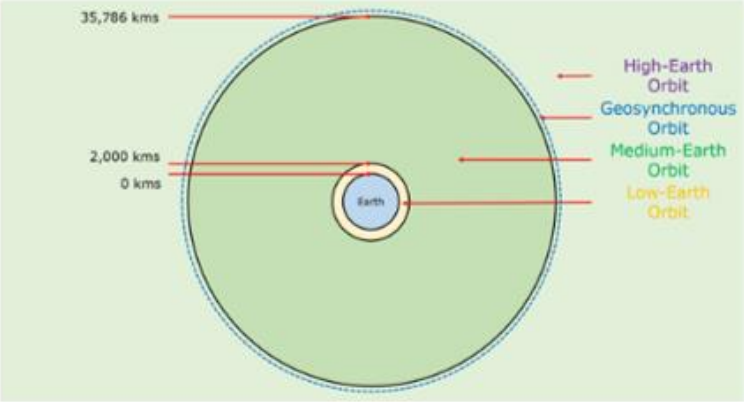
The altitude of an orbit is the height of the orbit above the surface of the Earth.

Based on their altitude, orbits can be classified as low-Earth orbits, medium-Earth orbits, geosynchronous orbits and high-Earth orbits.

Graphic Help

Textual Help

Graphic Help:



Textual Help:

A low-Earth orbit is an orbit around Earth with an altitude between 160 kms and 2,000 kms above the surface of the Earth.

A medium-Earth orbit is an orbit around Earth with an altitude between 2,000 kms and just below 35,786 kms above the surface of the Earth.

A geosynchronous orbit is an orbit around Earth with an altitude of 35,786 kms above the surface of the Earth.

A high-Earth orbit is an orbit around Earth with an altitude of more than 35,786 kms above the surface of the Earth.

Which of the two Help screens do you prefer? (If you like, you can view them again below.)

○ Strongly prefer Textual	○ Moderately prefer Textual	○ Slightly prefer Textual	○ Equally like Textual and Graphic	○ Slightly prefer Graphic	○ Moderately prefer Graphic	○ Strongly prefer Graphic

Frame 3:

The inclination of an orbit is the angle between a plane of reference and the plane in which the orbit exists.

Based on their inclination, some common types of orbits are polar orbits, equatorial orbits, and ecliptic orbits.

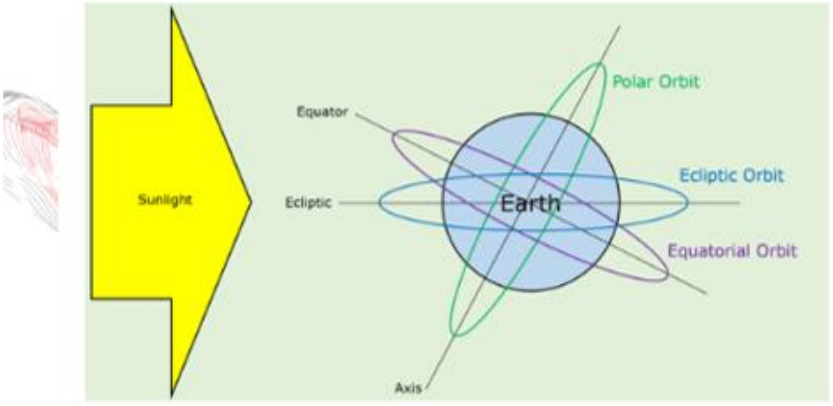
Textual Help:

A polar orbit is an orbit that passes above or nearly above both poles of the Earth on each revolution. Therefore, it has an inclination of (or very close to) either 90 degrees or −90 degrees to the equatorial plane.

An equatorial orbit is an orbit that remains above the equator of the Earth throughout its revolution. Therefore, it has an inclination of 0 degrees to the equatorial plane.

An ecliptic orbit is an orbit that remains above the path of the Sun's motion on the surface of the Earth throughout its revolution. Therefore, it has an inclination of 0 degrees to the ecliptic plane.

Graphic Help:



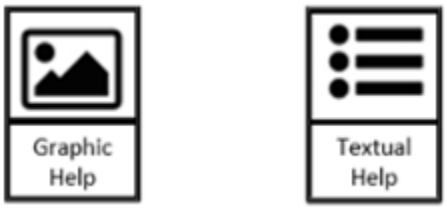
Which of the two Help screens do you prefer? (If you like, you can view them again below.)

○ Strongly prefer Textual	○ Moderately prefer Textual	○ Slightly prefer Textual	○ Equally like Textual and Graphic	○ Slightly prefer Graphic	○ Moderately prefer Graphic	○ Strongly prefer Graphic

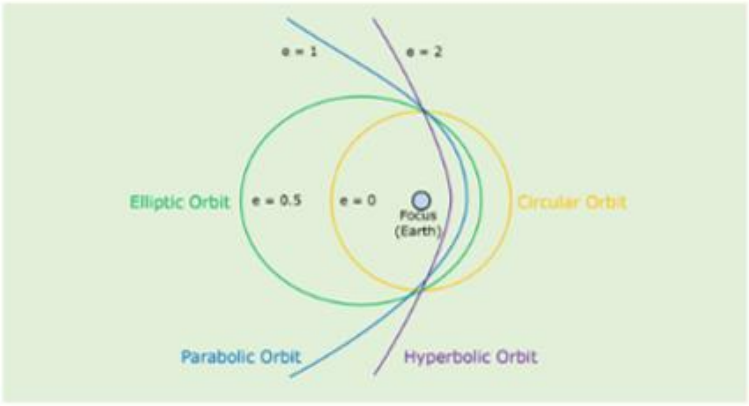
Frame 4:

The eccentricity of an orbit is a measure of the amount by which the shape of an orbit deviates from a perfect circle.

Based on their eccentricity, orbits can be classified as circular orbits, elliptic orbits, parabolic orbits and hyperbolic orbits.



Graphic Help:



Textual Help:

A circular orbit traces the path of a circle and has an eccentricity of 0.

An elliptic orbit traces the path of an ellipse and has an eccentricity of less than 1.

A parabolic orbit traces the path of a parabola and has an eccentricity of 1.

A hyperbolic orbit traces the path of a hyperbola and has an eccentricity of more than 1.

Which of the two Help screens do you prefer? (If you like, you can view them again below.)

○ Strongly prefer Textual	○ Moderately prefer Textual	○ Slightly prefer Textual	○ Equally like Textual and Graphic	○ Slightly prefer Graphic	○ Moderately prefer Graphic	○ Strongly prefer Graphic

Frame 5:

The synchronicity of an orbit is the relation between the period of the orbit and the rotational period of the body being orbited.

Based on their synchronicity, orbits can be classified as synchronous orbits, semi-synchronous orbits, supersynchronous orbits and subsynchronous orbits.

Textual Help:

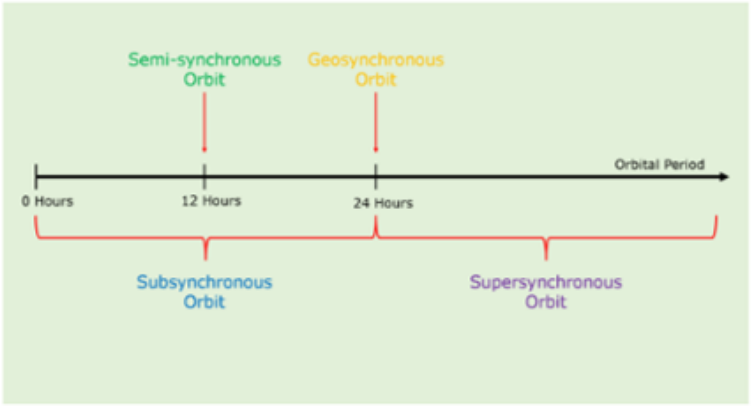
A geosynchronous orbit is an orbit whose period is equal to the average rotational period of the Earth (that is, 23 hours, 56 minutes, 4.091 seconds) and in the same direction of rotation as the Earth.

A semi-synchronous orbit is an orbit whose period is equal to half of the average rotational period of the Earth (that is, just under 12 hours) and in the same direction of rotation as the Earth.

A subsynchronous orbit is an orbit whose period is less than the average rotational period of the Earth (that is, less than 24 hours).

A supersynchronous orbit is an orbit whose period is greater than the average rotational period of the Earth (that is, more than 24 hours).

Graphic Help:



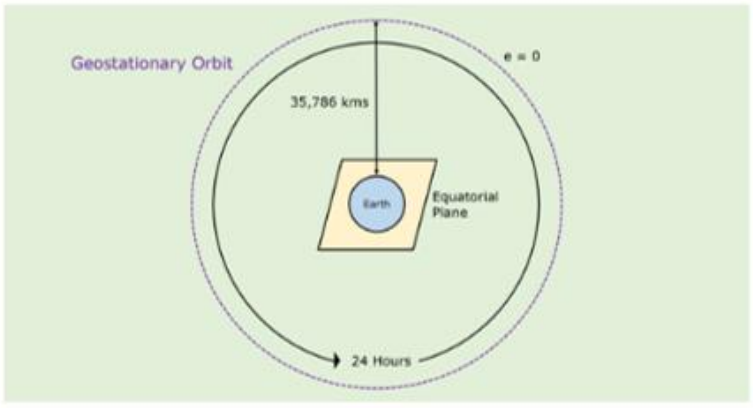
Which of the two Help screens do you prefer? (If you like, you can view them again below.)

○ Strongly prefer Textual	○ Moderately prefer Textual	○ Slightly prefer Textual	○ Equally like Textual and Graphic	○ Slightly prefer Graphic	○ Moderately prefer Graphic	○ Strongly prefer Graphic

Frame 6:

A geostationary satellite appears motionless, at a fixed position in the sky, to ground observers. This is because it follows a geostationary orbit, which is an orbit defined by a particular altitude, inclination, eccentricity and synchronicity.

Graphic Help:



Textual Help:

A geostationary orbit is a geosynchronous orbit (with an altitude of 35,786 km above the surface of the Earth and an orbital period equal to the average rotational period of the Earth) that has an inclination of 0 degrees to the equatorial plane and traces a circular path above the equator.

Which of the two Help screens do you prefer? (If you like, you can view them again below.)

○ Strongly prefer Textual	○ Moderately prefer Textual	○ Slightly prefer Textual	○ Equally like Textual and Graphic	○ Slightly prefer Graphic	○ Moderately prefer Graphic	○ Strongly prefer Graphic

Appendix H: Multimedia Learning Preference Test Instruction Script

As you can see, you will now go through a short lesson on satellites. This lesson is made up of six frames, and for each frame, you need to perform the same set of tasks. I'll guide you through the tasks for the first frame, and then you can continue with the rest of the frames on your own.

So, whenever you're ready, click the Next button…

Now you should see the first frame. This is what every frame will look like: two lines of text with one or more words underlined and 'Textual Help' and 'Graphic Help' buttons below it. What you need to do is read the text, think about the word or words that are underlined – in this case, 'orbit', decide whether you would prefer to receive an explanation of the words through text or a graphic, click either the Textual Help or Graphic Help button and click the Next button. Go ahead and do that…

After you click the Next button, you should be able to see the text or graphic that explains what an orbit is. Read the text or look at the graphic, and when you're done, click the Next button…

Now, I know you selected a particular kind of explanation, but I'd like you to also take a look at the other kind of explanation, so you can compare. Click the button for the other kind and click the Next button…

After you click the Next button, you should be able to see the text or graphic that explains what an orbit is. Read the text or look at the graphic, and when you're done, click the Next button…

Now, you can see both the explanations you received. Take your time to review them, think about which one you prefer and how strongly you prefer it, and indicate your preference by selecting one of the options on the seven-point scale provided. That will be the end of the tasks for the first frame.

Keep in mind that your final selection and rating of the explanation you actually preferred is independent of your initial selection of the type of explanation you thought you would prefer. Also, your initial and final selections for a frame are independent of your initial and final selections for the rest of the frames. Every selection you make in this section is independent of every other selection in this section.

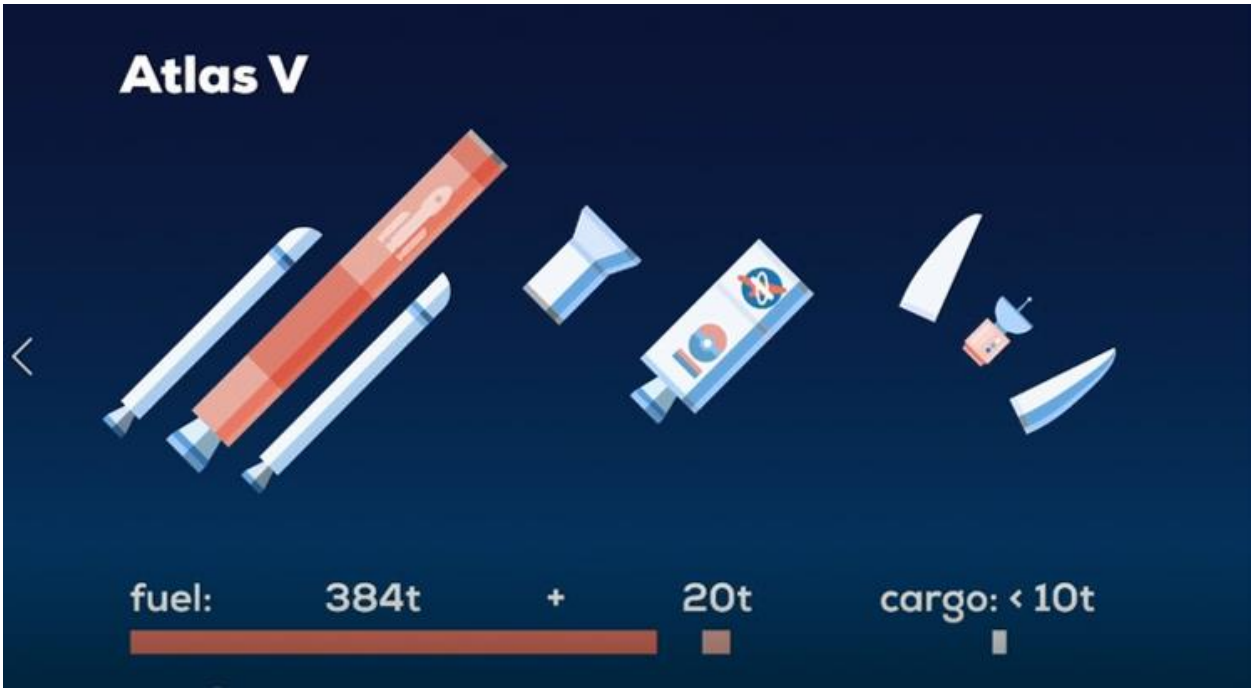
When you've indicated your preference on the seven-point scale provided, click the Next button to proceed with the next five frames…

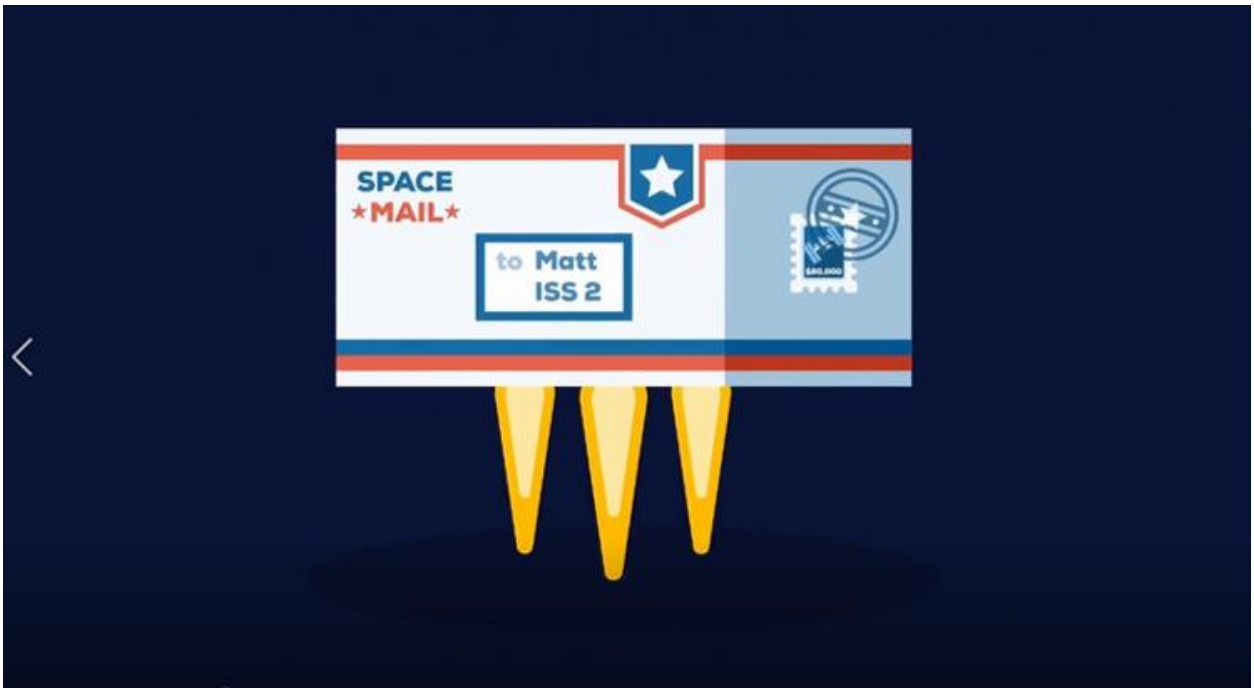
Appendix I: Video Lesson Screenshots

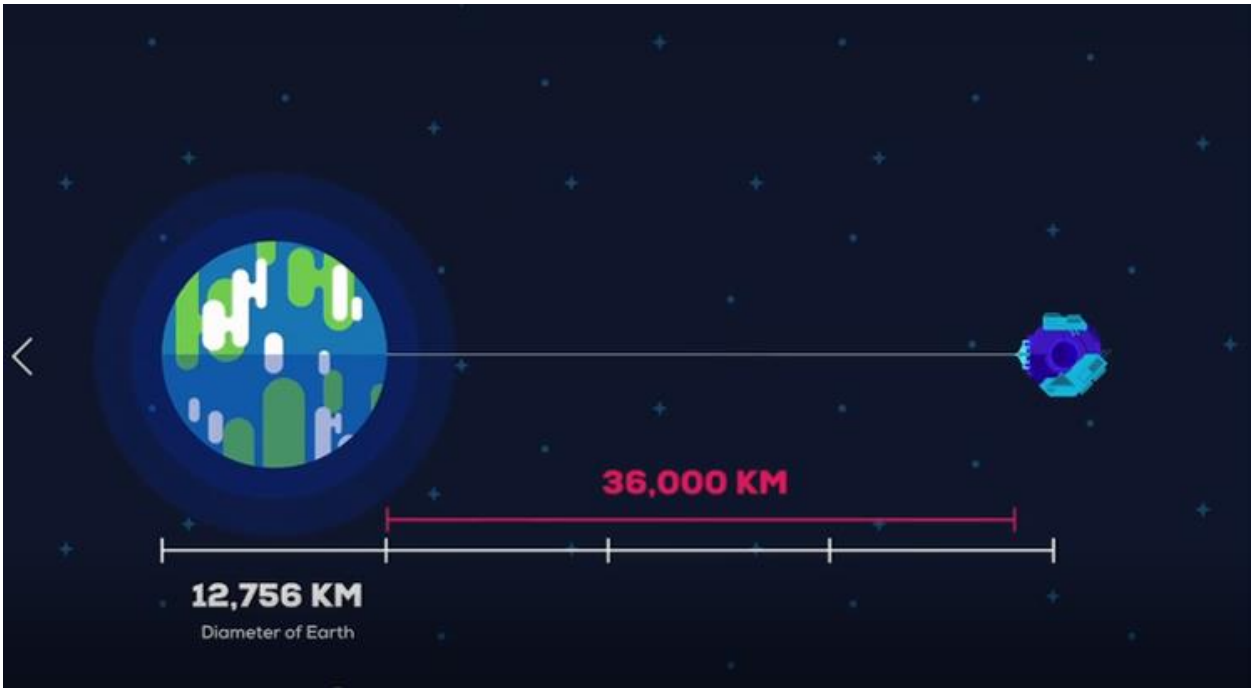
Please watch the video below. You can use the standard YouTube controls to Play/Pause/Replay the video and to rewatch certain sections. If you like, you can also take notes during the video.

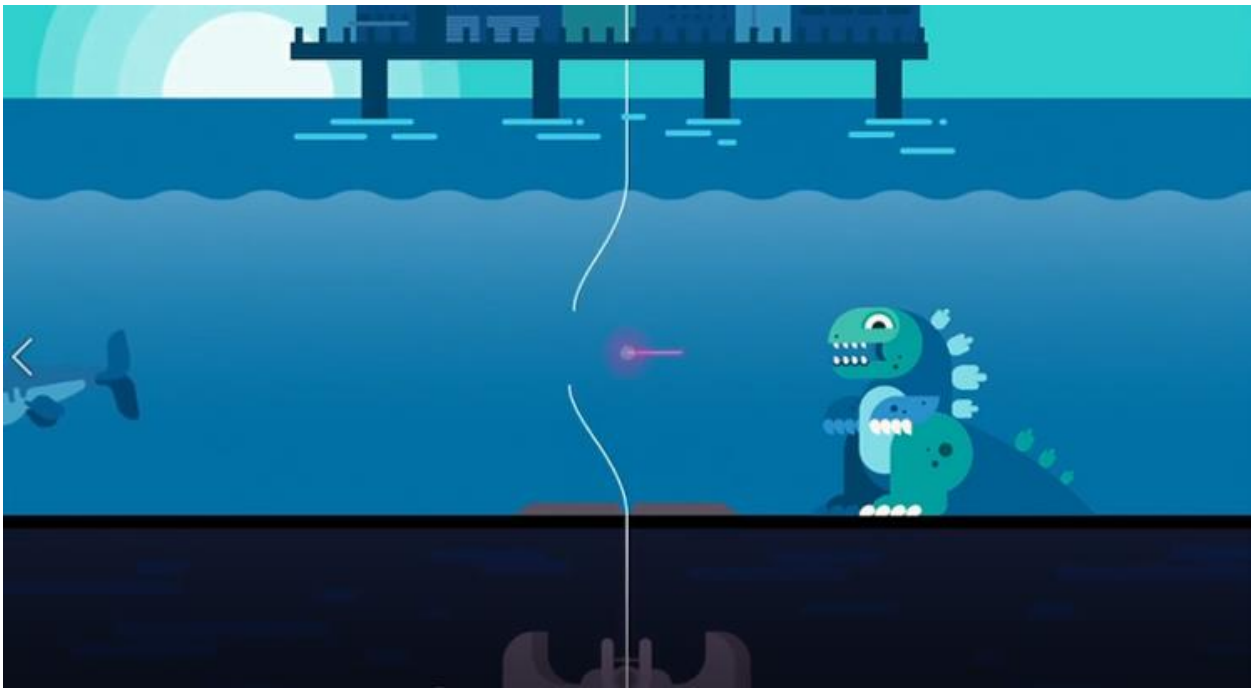
Once you are done watching the video, click the Next button to start the test. Once you click the Next button, you will not be able to watch the video again.

Note: Feel free to take as much or as little time as you like to watch and learn from the video, but keep in mind that you will need to take a test on the content you learned from the video.



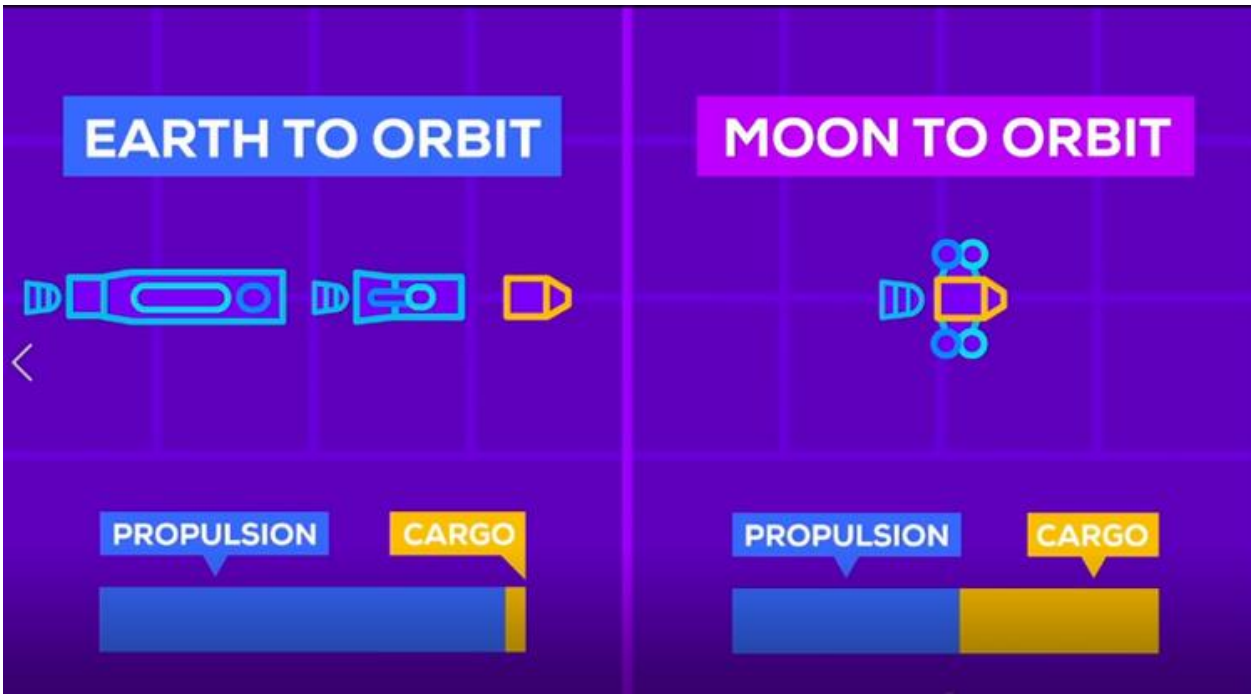

SPACE
★MAIL★
to Matt
ISS 2


36,000 KM
12,756 KM
Diameter of Earth

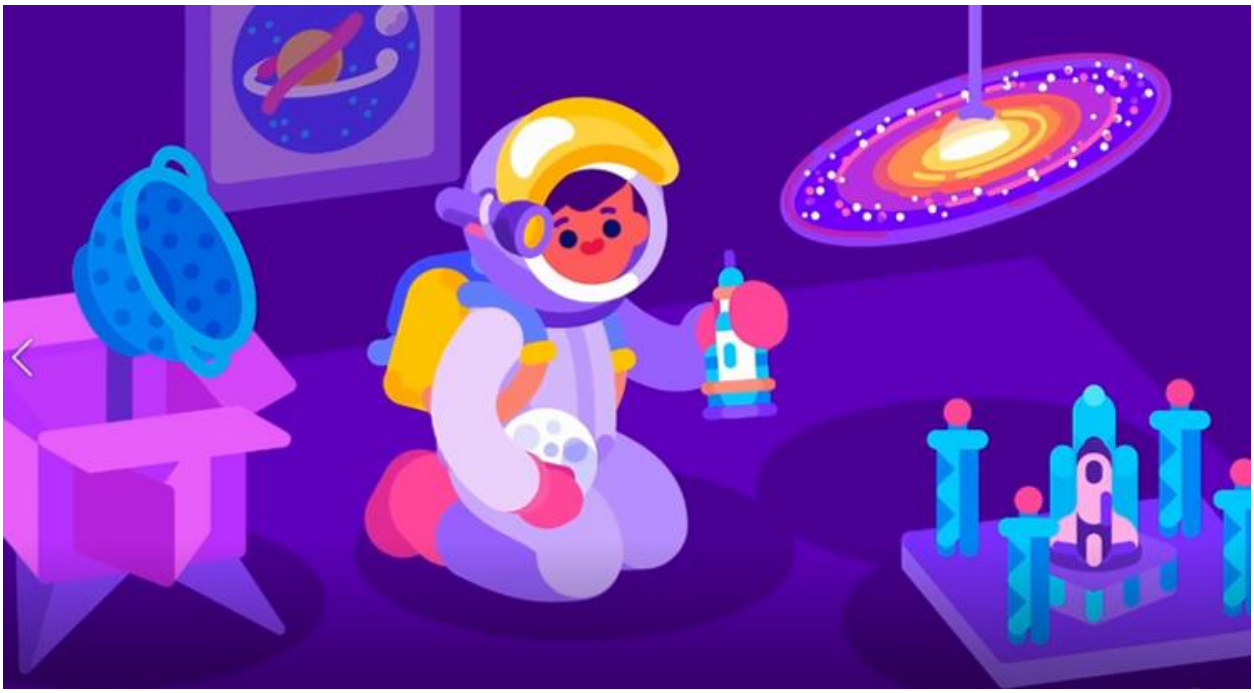



MAX. 127°C
MIN. -173°C


PHASE 3


EARTH TO ORBIT
MOON TO ORBIT
PROPULSION
CARGO
PROPULSION
CARGO


We the
People
of the
MOON



Appendix J: Recall of Important Details and Seductive Details Test

You will now be presented with 40 questions based on the video you just watched.

For each question, select the correct answer(s).

1. When you are in orbit, what prevents you from falling to the surface of the Earth?
   - Anchoring yourself to the surface of the Earth using a tether
   - Pulling yourself away from the surface of the Earth using a counterweight
   - Moving vertically away from the surface of the Earth fast enough
   - Moving sideways in line with the surface of the Earth fast enough

2. How much rocket fuel is required to launch 10 tonnes of cargo using an Atlas V rocket?
   - Approximately 200 tonnes
   - Approximately 400 tonnes
   - Approximately 600 tonnes
   - Approximately 800 tonnes

3. Who was the Space Mail addressed to (used to illustrate the cost of launching one kilo of payload into space)?
   - Jim
   - Dave
   - Matt
   - Alex

4. Which are the only two types of people who can get to space today?
   - Astronauts
   - Scientists
   - Contractors
   - Billionaires

5. What are the required characteristics of the material used to produce the tether in a Space Elevator?
    - Lightweight
    - Strong/Stable
    - Flexible
    - Resistant to corrosion
    - Resistant to radiation
    - Good conductor of electricity
    - Affordable

6. What is the projected cost of launching one kilo of payload using a Space Elevator versus using a rocket?
    - 1/100
    - 2/100
    - 4/100
    - 10/100

7. When was the NASA budget (adjusted for inflation) the highest (used to illustrate the significant cost of human space flight)?
    - Right after it was established
    - Just after the Apollo missions
    - Around the time of the launch of the International Space Station
    - Just before the launch of the Curiosity rover

8. To which mode of travel is the cost of human space flight compared?
    - Travel by sports car
    - Travel by Hyperloop
    - Travel by airplane
    - Travel by Skylon

9. What sources of energy could be used to power the climber of a Space Elevator?
    - A laser beam near the anchor
    - A set of solar panels on the roof of the climber
    - A nuclear reactor in the base of the climber
    - A large magnet at the base of the counterweight
    - A battery charged by the rotation of the Earth

10. Which is the only part of the Space Elevator that moves in relation to the other parts?
    - Anchor
    - Tether
    - Climber
    - Counterweight

11. Which object is used to represent a kilo of payload (used to illustrate the difference in cost between using a rocket and using a Space Elevator)?
    - A dumbbell
    - A hammer
    - A pineapple
    - A carton of milk

12. How much weight would you need to launch using the Space Elevator before you recoup the cost of building it?
    - Similar to two cars
    - Similar to two rockets
    - Similar to two International Space Stations
    - Similar to two Moons

13. What are the main challenges for building a Space Elevator today?
    - Finding a safe place on the surface of the Earth to stabilize the anchor
    - Finding the right type and quantity of material for the tether
    - Finding a source of the energy required to power the climber
    - Finding the right people willing to man the launchbase in the counterweight

14. With respect to the surface of the Earth, what should be the height of the counterweight in a Space Elevator?
    - 12,756 kms
    - 20,000 kms
    - 24,000 kms
    - 36,000 kms

15. What colour was the laser beam used to power the climber of the Space Elevator?
    - Pink
    - Blue
    - Orange
    - White

16. When naming the four parts of the Space Elevator, which part does the narrator mention last?
    - Anchor
    - Tether
    - Climber
    - Counterweight

17. What is the significant risk of building a Space Elevator?
    - The anchor destabilizing the ground and causing earthquakes
    - The tether breaking off and wrapping around the Earth
    - The climber falling to the ground and killing all the passengers
    - The counterweight crashing into pre-existing satellites in space

18. Which material could be used to produce the tether for a Space Elevator on the Moon?
    - Concrete
    - Graphene
    - Diamonds
    - Kevlar

19. What was the reason for the tether of the Space Elevator breaking close to the anchor?
    - A fibre optic Internet cable
    - A fast-moving submarine
    - An underwater earthquake
    - A green and blue dinosaur

20. How does the narrator describe the collapse of the Space Elevator if the tether breaks?
    - “Spectacular style”
    - “Devastating destruction”
    - “Fascinating view”
    - “Significant impact”

21. What is the biggest reason we are not building a Moon Base already?
    - Lack of the technical knowledge
    - Lack of the required materials
    - Lack of Government funding
    - Lack of benefits from the project

22. What is the maximum temperature in the sunlight on the Moon?
    - 127° Celsius
    - 137° Celsius
    - 143° Celsius
    - 173° Celsius

23. Which animal was shown in the settlement in Phase 2 of colonisation of the New World?
    - Cow
    - Horse
    - Goat
    - Chicken

24. Which country's budget surplus in 2017 is similar to the cost of building a Moon Base?
    - The Netherlands
    - Germany
    - France
    - The United States

25. What are the three reasons why the Moon is not a welcoming place for living things?
    - It has a very low gravitational field and things cannot stay grounded
    - It has no atmosphere to provide a shield against meteorites and cosmic radiation
    - It has a layer of jagged dust covering the surface
    - It is very dry and there is no humidity to support plant or animal life
    - It has extreme temperatures in the sunlight and shade

26. How soon can Phase 2 of colonisation of the Moon be completed?
    - 2028
    - 2038
    - 2060
    - 2118

27. How many people were leaning out of the windows of the train (used to show Phase 3 of colonisation of the New World)?
    - Three
    - Four
    - Six
    - Eight

28. How does the narrator describe the payoff from building a Moon Base?
    - "Unfathomable"
    - "Inestimable"
    - "Incalculable"
    - "Immeasurable"

29. Why would the Moon habitats be regularly temporarily abandoned during Phase 2 of colonisation of the Moon?
    - Depletion of the raw materials required for further construction
    - Depletion of the food and water resources for the crew
    - Inability to find sufficient resources to sustain plant and animal life
    - Inability to generate solar power during the Moon's night

30. What is the crew capacity suggested for each Moon habitat?
    - 4
    - 8
    - 12
    - 16

31. What colour was used to represent the cargo (when comparing the proportion of rocket fuel to cargo for rocket launches from the Earth and the Moon)?
    - Blue
    - Purple
    - Yellow
    - Red

32. What is the benefit of colonising the Moon, as compared to colonising the New World?
    - It will be easier because the location is already known
    - It will cost less in terms of raw materials for settlements
    - It will take less time to go from Phase 1 to Phase 3
    - It will not involve murdering innocent people

33. What is the definition of Phase 3 of colonisation of the Moon?
    - The Moon colony supports itself and exports materials to Earth
    - The Moon colony succeeds in converting lunar ice to rocket fuel
    - The Moon colony is able to produce concrete and steel for construction
    - The Moon colony population crosses 1,000

34. Compared to rocket launches from the Earth, what happens to the ratio of rocket fuel to cargo required for rocket launches from the Moon?
    - It decreases
    - It stays the same
    - It increases
    - It depends on the cargo

35. What was the name of the country on the Passport of a Moon citizen?
    - Republic of the Moon
    - Democracy of the Moon
    - United States of the Moon
    - United Kingdom of the Moon

36. Which equipment is mentioned as studying the Moon during Phase 1 of colonisation of the Moon?
    - Lunar Reconnaissance Orbiter
    - Lunar Crater Observation and Sensing Satellite
    - Apollo Lunar Roving Vehicle
    - Yutu Rover

37. Which material is specifically mentioned as a good export from the Moon to the Earth?
    - Helium-3
    - Concrete
    - Gold
    - Uranium

38. Which precious metals can be mined from craters on the Moon?
    - Gold
    - Platinum
    - Palladium
    - Rhodium
    - Iridium
    - Titanium
    - Uranium

39. What was the picturisation on the flag of the Moon?
    - The Moon with a Space Elevator constructed on it
    - The Moon with a satellite revolving around it
    - A rocket flying from the Earth to the Moon
    - A rocket flying from the Moon to the Earth

40. Which country's lunar exploration programme is looking into the use of Helium-3 in nuclear fusion reactors?
    - USA
    - Russia
    - Iran
    - China

Appendix K: Results of the Multiple Linear Regression Tests

Stepwise Method

Outcome	Predictor	R^2	F	p	β	t	p
Important verbal details score	SBLSQ verbal score	No significant model			-	-	-
	SBLSQ visual score				-	-	-
	VVLSR verbal score				-	-	-
Important visual details score	SBLSQ verbal score	No significant model			-	-	-
	SBLSQ visual score				-	-	-
	VVLSR visual score				-	-	-
Seductive verbal details score	SBLSQ verbal score	No significant model			-	-	-
	SBLSQ visual score				-	-	-
	VVLSR verbal score				-	-	-
Seductive visual details score	SBLSQ verbal score	No significant model			-	-	-
	SBLSQ visual score				-	-	-
	VVLSR visual score				-	-	-
Important verbal details score	Important visual details score	.442	24.569	.000	.403	3.533	.001
	Seductive verbal details score				.465	3.895	.000
	Seductive visual details score				-	-	-
Important visual details score	Important verbal details score	.306	27.728	.000	.511	5.266	.000
	Seductive verbal details score				-	-	-
	Seductive visual details score				-	-	-
Seductive verbal details score	Important verbal details score	.330	31.004	.000	.507	5.568	.000
	Important visual details score				-	-	-
	Seductive visual details score				-	-	-
Seductive visual details score	Important verbal details score	.143	10.470	.002	-	-	-
	Important visual details score				-	-	-
	Seductive verbal details score				.331	3.236	.002

Enter Method

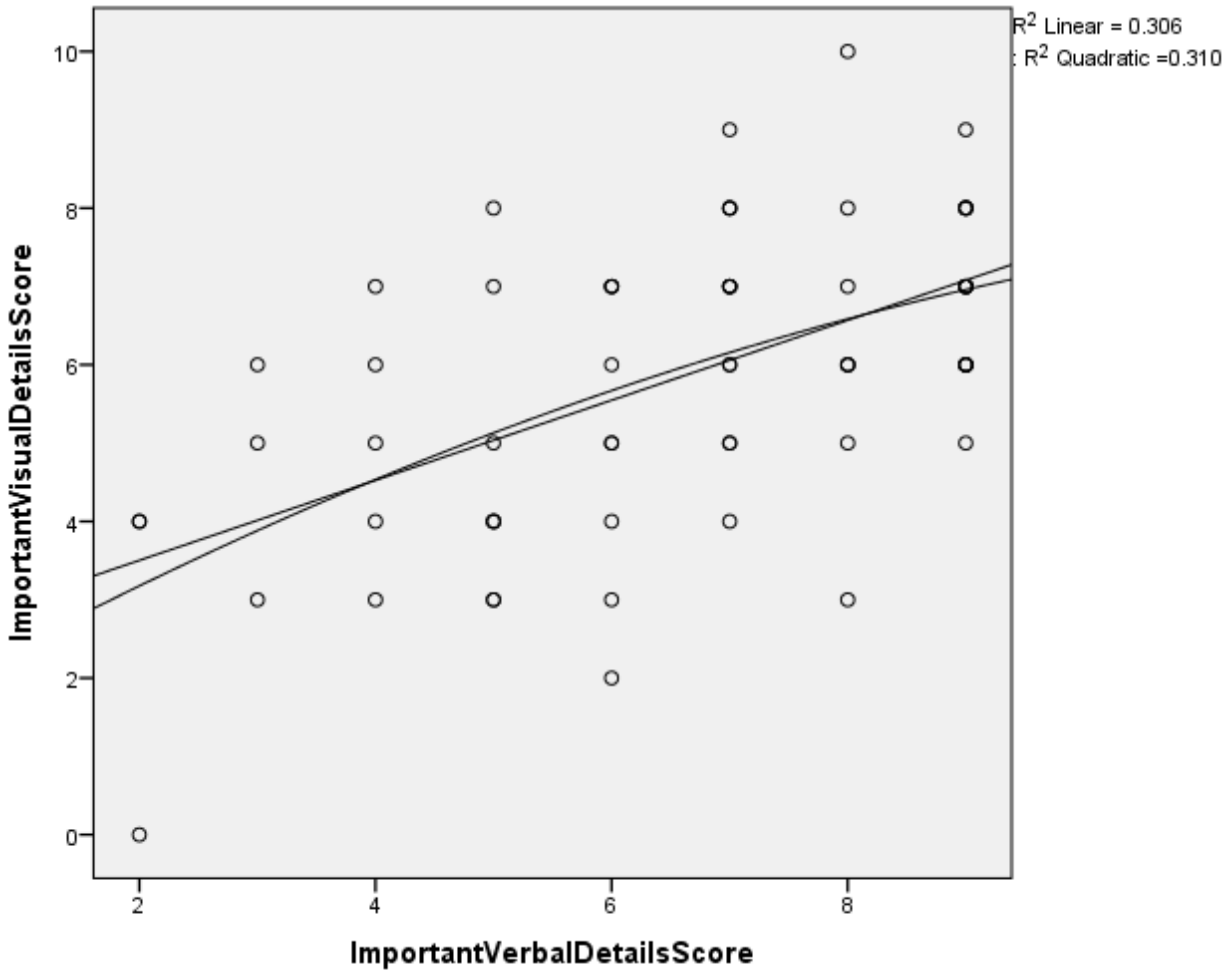
Outcome	Predictor	R^2	F	p	β	t	p
Important verbal details score	SBLSQ verbal score	.056	1.205	.316	-.130	-1.503	.138
	SBLSQ visual score				-.023	-.228	.820
	VVLSR verbal score				-.027	-.128	.899
Important visual details score	SBLSQ verbal score	.042	.901	.446	-.069	-.857	.395
	SBLSQ visual score				-.122	-1.280	.205
	VVLSR visual score				.041	.210	.834
Seductive verbal details score	SBLSQ verbal score	.058	1.247	.301	-.143	-1.878	.065
	SBLSQ visual score				-.009	.101	.920
	VVLSR verbal score				.233	1.264	.211
Seductive visual details score	SBLSQ verbal score	.051	1.092	.360	-.100	-1.488	.142
	SBLSQ visual score				-.023	-.292	.771
	VVLSR visual score				.007	.044	.965
Important verbal details score	Important visual details score	.446	16.341	.000	.387	3.282	.002
	Seductive verbal details score				.445	3.576	.001
	Seductive visual details score				.084	.614	.541
Important visual details score	Important verbal details score	.349	10.901	.000	.388	3.282	.002
	Seductive verbal details score				.142	1.047	.299
	Seductive visual details score				.192	1.426	.159
Seductive verbal details score	Important verbal details score	.378	12.380	.000	.389	3.576	.001
	Important visual details score				.124	1.047	.299
	Seductive visual details score				.207	1.649	.104
Seductive visual details score	Important verbal details score	.192	4.840	.004	.073	.614	.541
	Important visual details score				.168	1.426	.159
	Seductive verbal details score				.207	1.649	.104

Appendix L: Results of the Simple Linear Regression Tests

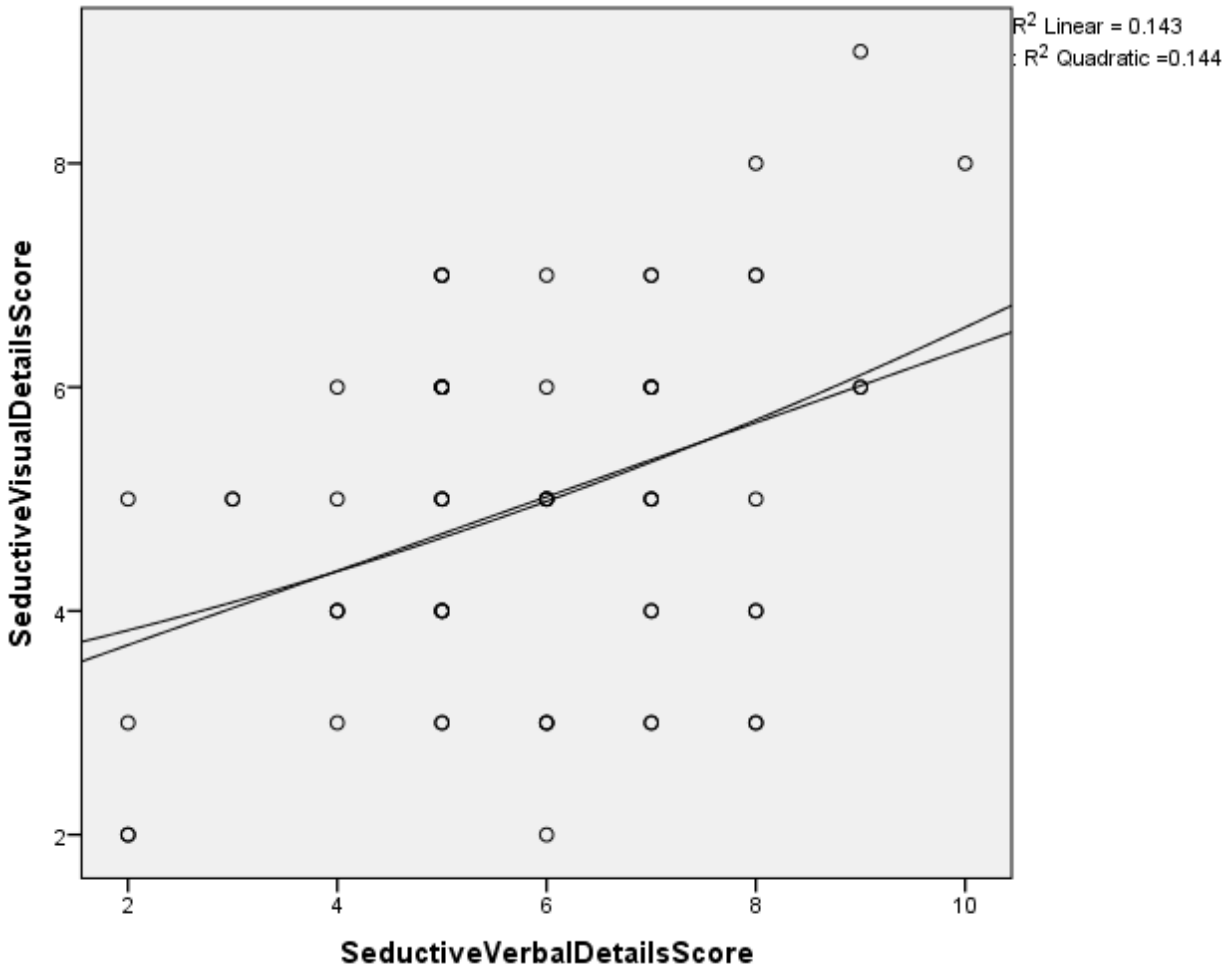
Outcome	Predictor	R^2	F	p	β	t	p
Important verbal details score	Important visual details score	.306	27.728	.000	.598	5.266	.000
	Seductive verbal details score	.330	31.004	.000	.650	5.568	.000
	Seductive visual details score	.116	8.262	.006	.439	2.874	.006
Important visual details score	Important verbal details score	.306	27.728	.000	.511	5.266	.000
	Seductive verbal details score	.192	14.955	.000	.458	3.867	.000
	Seductive visual details score	.126	9.118	.004	.424	3.020	.004
Seductive verbal details score	Important verbal details score	.330	31.004	.000	.507	5.568	.000
	Important visual details score	.192	14.955	.000	.419	3.867	.000
	Seductive visual details score	.143	10.470	.002	.430	3.236	.002
Seductive visual details score	Important verbal details score	.116	8.262	.006	.264	2.874	.006
	Important visual details score	.126	9.118	.004	.298	3.020	.004
	Seductive verbal details score	.143	10.470	.002	.331	3.236	.002

Appendix M: Scatterplots for Visualising the Relationships between the Recall Scores

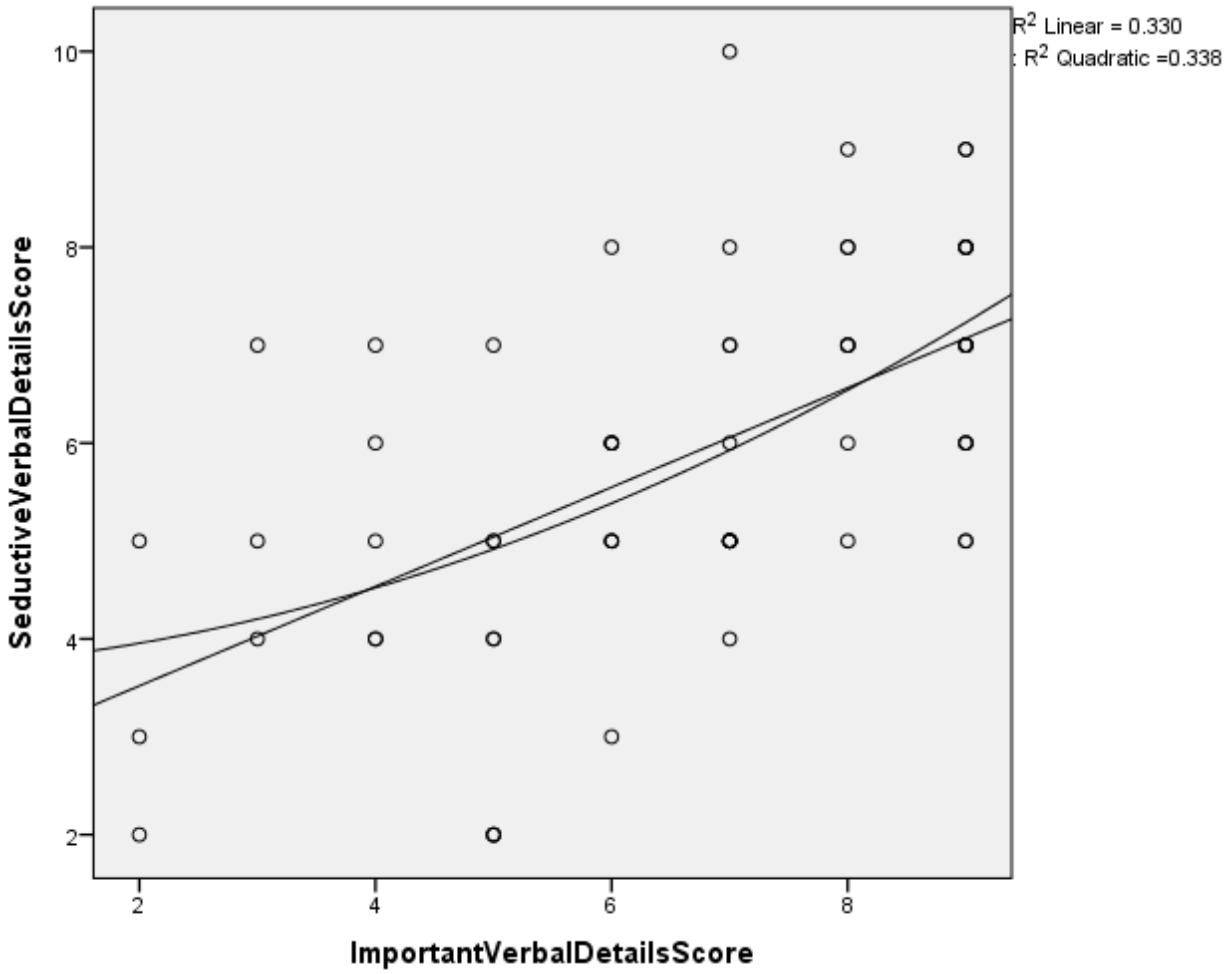
Important Verbal Details Score versus Important Visual Details Score



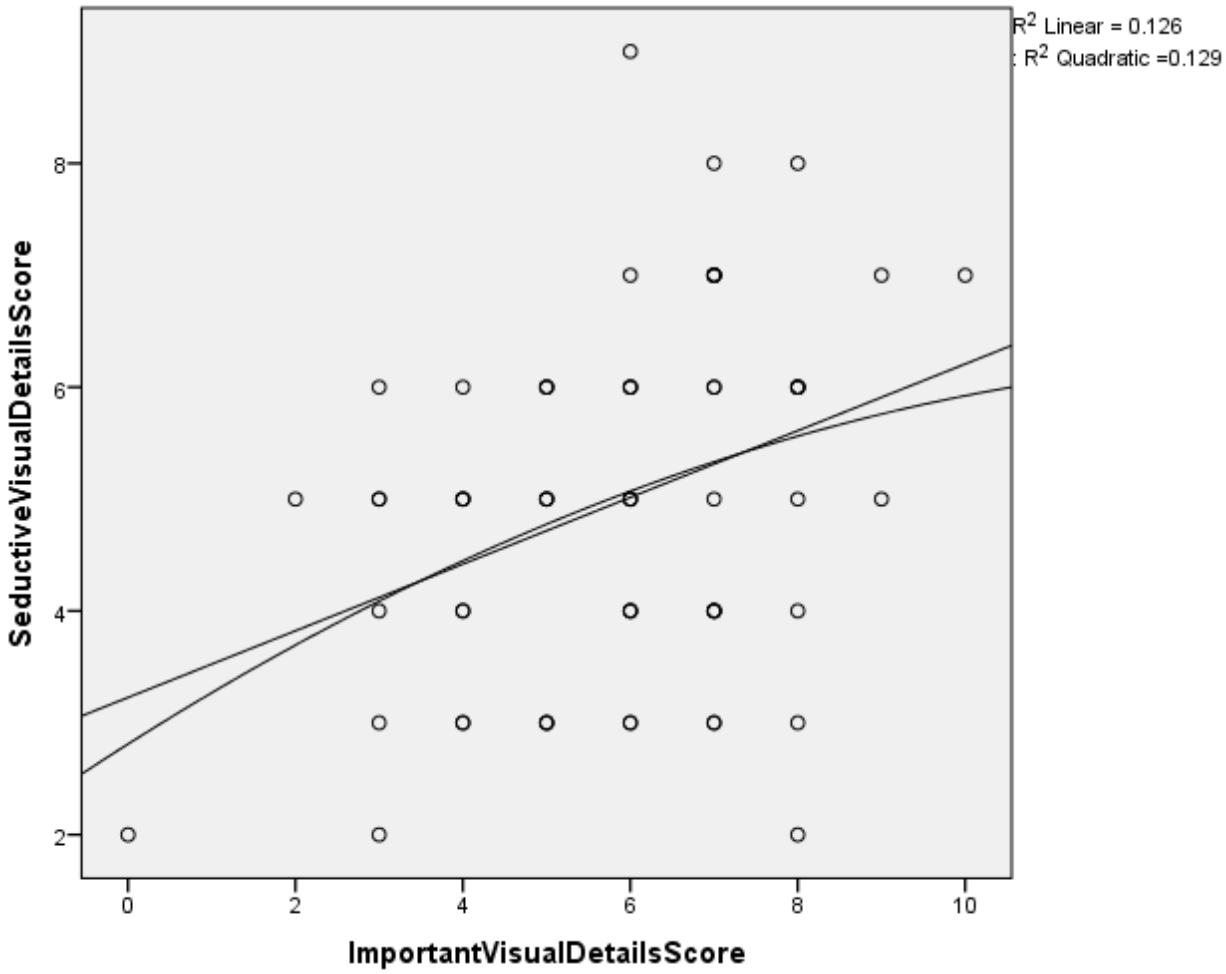
Seductive Verbal Details Score versus Seductive Visual Details Score



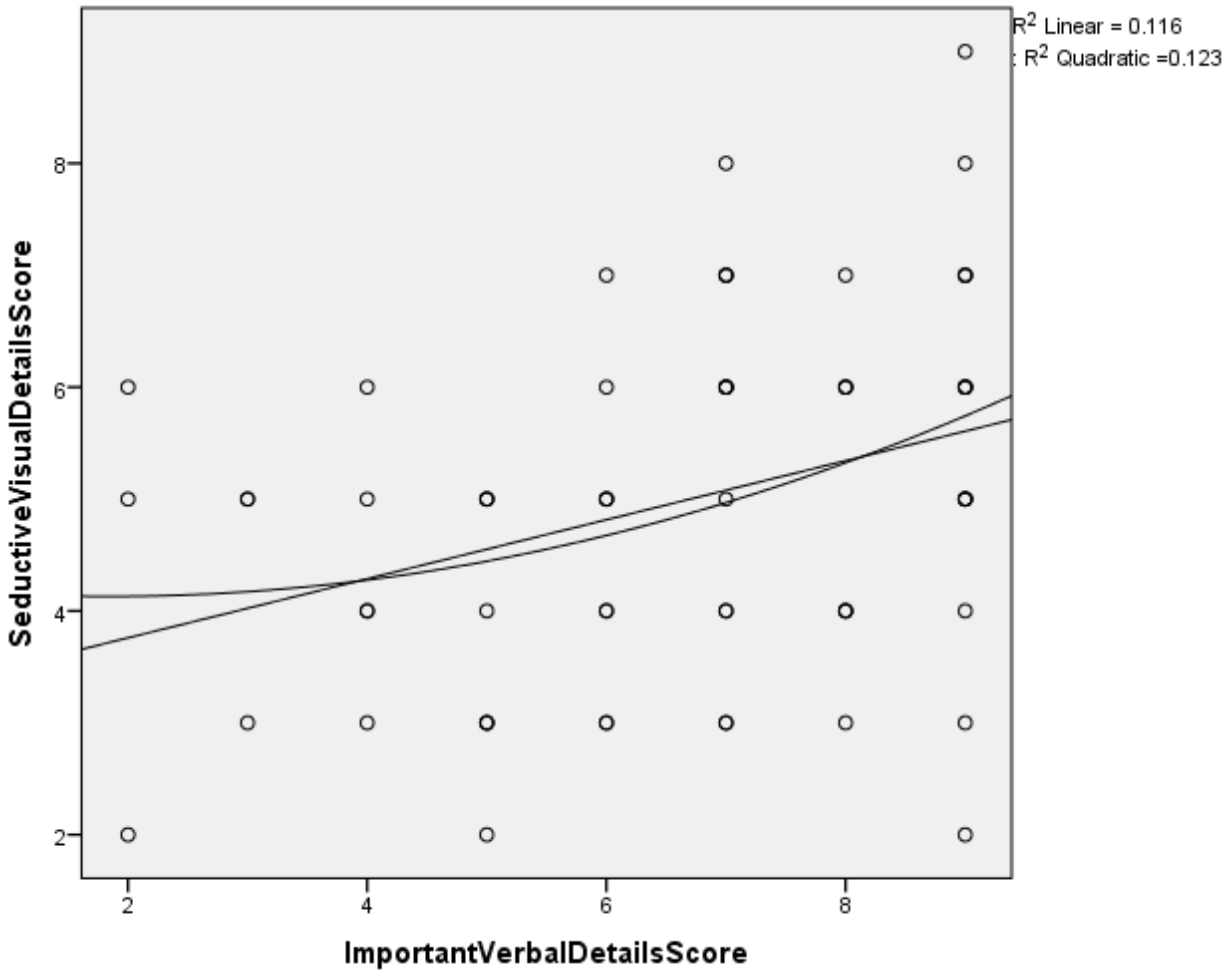
Important Verbal Details Score versus Seductive Verbal Details Score



Important Visual Details Score versus Seductive Visual Details Score



Important Verbal Details Score versus Seductive Visual Details Score



Important Visual Details Score versus Seductive Verbal Details Score