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基於學習情緒感知之多媒體網路適性化學習系統發展與學習成效評估研究(第 3 年)

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中文摘要： 由於網路技術與數位媒體的發展，使得多媒體影音教材已成為線上學習課程的趨勢，常見的多媒體影音教材類型包含現場教學錄播、配音簡報與子母畫面等不同方式呈現之多媒體教材。然而，過去只有極少數研究針對不同類型多媒體教材對於學習成效的影響進行探討，因此深入探究多媒體影音教材類型對於學習者的學習品質與學習成效影響有其必要性。本計畫基於二因子實驗設計、腦波偵測、情緒感知設備、認知負荷量表與學習成效測驗卷，探討圖像型與文字型認知風格學習者在使用上述三種常見的多媒體影音教材進行線上自主學習時，對於其持續專注力、情緒、認知負荷與學習成效的影響差異。結果顯示三種不同類型的多媒體影音教材均可有效提升學習者的學習成效，其中現場教學錄播與子母畫面類型的學習成效顯著優於配音簡報型。此外，配音簡報型所引發的持續專注力明顯高於子母畫面型，並且文字型認知風格學習者在三種不同類型多媒體影音教材上的學習持續專注力顯著高於圖像型認知風格學習者。但是三種多媒體影音教材類型對於學習者的正負面學習情緒影響無明顯的差異。再則，配音簡報類型所引起的認知負荷不但明顯高於現場教學錄播與子母畫面類型，圖像型認知風格學習者在配音簡報類型學習情境下的認知負荷也顯著高於文字型認知風格學習者。本計畫之研究成果有助於多媒體影音教材的設計，也可作為線上學習多媒體體影音教材的選擇參考。

中文關鍵詞： 影音教材、多媒體教材、資訊呈現型態、持續注意力、學習情緒、認知負荷、學習成效

英文摘要： Multimedia materials have become a trend in the production of online courseware because of the development of network technology and digital media. The common used video lectures contain the types of lecture capture, voice over presentation, and picture-in-picture, which present multimedia lecture information by different styles. Nevertheless, little research has discussed the effects of the different video lecture types on learning performance from the aspect of learners. To enhance the quality and effectiveness of video lectures, a deep exploration is therefore necessary. Based on a two-factor experimental design, the brainwave detection, the emotion sensing equipment, the cognitive load scale, and the learning performance test sheet, this study tends to explore the effects of the verbalizers and visualizers presented with the three common used video lectures on sustained attention, emotion, cognitive load, and learning performance in an autonomous online learning scenario. This work confirms that the learning performance of the learners applying the three different video lecture types is enhanced, but the learning performance with the lecture capture and picture-in-picture types are higher than the voice over presentation type. The sustained attention induced by the voice over presentation type is remarkably higher than the picture-in-picture type as well as the sustained attention of verbalizers is significantly higher than visualizers while learning three considered video lecture types. Moreover, the learners' positive and negative emotion induced by the three considered video lecture types do not appear significantly differences. The cognitive load induced by the voice over presentation type is significantly higher than it induced by the lecture capture and picture-in-picture types as well as the cognitive load of visualizers presented with the voice over presentation type is significantly higher than verbalizers presented with the voice over presentation type. It is expected that the research results could assist in future video lecture design and be the reference of selecting the video lecture for online learning.

英文關鍵詞： video lecture, multimedia courseware, information presentation type, sustained attention, emotion, cognitive load, learning performance

行政院科技部專題研究計畫成果報告

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中文摘要

由於網路技術與數位媒體的發展，使得多媒體影音教材已成為線上學習課程的趨勢，常見的多媒體影音教材類型包含現場教學錄播、配音簡報與子母畫面等不同方式呈現之多媒體教材。然而，過去只有極少數研究針對不同類型多媒體教材對於學習成效的影響進行探討，因此深入探究多媒體影音教材類型對於學習者的學習品質與學習成效影響有其必要性。本計畫基於二因子實驗設計、腦波偵測、情緒感知設備、認知負荷量表與學習成效測驗卷，探討圖像型與文字型認知風格學習者在使用上述三種常見的多媒體影音教材進行線上自主學習時，對於其持續專注力、情緒、認知負荷與學習成效的影響差異。結果顯示三種不同類型的多媒體影音教材均可有效提升學習者的學習成效，其中現場教學錄播與子母畫面類型的學習成效顯著優於配音簡報型。此外，配音簡報型所引發的持續專注力明顯高於子母畫面型，並且文字型認知風格學習者在三種不同類型多媒體影音教材上的學習持續專注力顯著高於圖像型認知風格學習者。但是三種多媒體影音教材類型對於學習者的正負面學習情緒影響無明顯的差異。再則，配音簡報類型所引起的認知負荷不但明顯高於現場教學錄播與子母畫面類型，圖像型認知風格學習者在配音簡報類型學習情境下的認知負荷也顯著高於文字型認知風格學習者。本計畫之研究成果有助於多媒體影音教材的設計，也可作為線上學習多媒體體影音教材的選擇參考。

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Abstract

Multimedia materials have become a trend in the production of online courseware because of the development of network technology and digital media. The common used video lectures contain the types of lecture capture, voice over presentation, and picture-in-picture, which present multimedia lecture information by different styles. Nevertheless, little research has discussed the effects of the different video lecture types on learning performance from the aspect of learners. To enhance the quality and effectiveness of video lectures, a deep exploration is therefore necessary.

Based on a two-factor experimental design, the brainwave detection, the emotion sensing equipment, the cognitive load scale, and the learning performance test sheet, this study tends to explore the effects of the verbalizers and visualizers presented with the three common used video lectures on sustained attention, emotion, cognitive load, and learning performance in an autonomous online learning scenario. This work confirms that the learning performance of the learners applying the three different video lecture types is enhanced, but the learning performance with the lecture capture and picture-in-picture types are higher than the voice over presentation type. The sustained attention induced by the voice over presentation type is remarkably higher than the picture-in-picture type as well as the sustained attention of verbalizers is significantly higher than visualizers while learning three considered video lecture types. Moreover, the learners' positive and negative emotion induced by the three considered video lecture types do not appear significantly differences. The cognitive load induced by the voice over presentation type is significantly higher than it induced by the lecture capture and picture-in-picture types as well as the cognitive load of visualizers presented with the voice over presentation type is significantly higher than verbalizers presented with the voice over presentation type. It is expected that the research results could assist in future video lecture design and be the reference of selecting the video lecture for online learning.

Keywords: video lecture, multimedia courseware, information presentation type, sustained attention, emotion, cognitive load, learning performance

1. Introduction

Although the vast majority of university classes are still taught by traditional face-to-face instruction, many traditional classroom courses are now digitalized as video lectures to make them available on the web for students to learn anytime and anywhere. A video lecture can be created as simple as uploading a video recording of a lecturer discussing a topic, or it can be much more complex, being paired with a slide presentation, having interactive quizzes and demonstrations (Osborn, 2010). In recent years, applying video lectures to support online learning is becoming more and more popular and many organizations, higher education institutions, and open learning systems are employing video lectures as a main- or self-study medium, such as Coursera, Khan Academy, and TED. The main advantages of using video lectures to support online learning include that video lectures can provide additional learning time to students who cannot fully understand the course material through the classroom lectures as well as students can view and learn the instructor's lectures through video lectures as often as they wish until they understand course material (Brecht & Ogilby, 2008). Additionally, video lectures that include lecturer's instruction with audio and video further enrich the learning experience, where students can see and listen to the facilitator, much like a real-life classroom.

Currently, the lecture capture (or termed as talking-head lecture) (Ilioudi, Giannakos, & Chorianopoulos, 2013; Wiese & Newton, 2013; Danielson, Preast, Bender, & Hassall, 2013), voice over presentation (Griffin, Mitchell, & Thompson, 2009), picture-in-picture (Chorianopoulos &

Giannakos, 2013), and Khan Style video lecture (Chorianopoulos & Giannakos, 2013), which present multimedia information by different styles, are common used video lecture types applied in online learning. The main challenges of creating a video lecture include how to promote students' learning motivation and performance, satisfy the needs of individual differences in learning styles, and rethink the format of video lectures to best facilitate learning (Hornbæk, Engberg, & Gomme, 2002). Moreover, attention in cognitive psychology was viewed as a set of processes enabling and guiding selection of incoming perceptual information and limiting external stimuli processed by the bounded cognitive system of humans to avoid its overload (Driver, 2001). Importantly, effective identification, learning, and memory do not exist in a learning process without sustained attention (Broadbent, 1958). In other words, sustained attention to learning content is regarded as the premise of effective learning. Consequently, whether or not video lectures with different information presentation types affect sustained attention in online learning scenario should be considered. Moreover, many studies have also argued that affective state (i.e., considering a learner's emotional state) should be considered as an important factor in designing multimedia materials or video lectures as well as the correlations between learner emotions and learning performance exist (Chen & Wang, 2010; Chen & Sun, 2012). However, relatively few empirical studies have focused on how learning performance, learner emotions and sustained attention are affected by different video lecture types. Such research could provide a valuable reference when designing video lectures.

Moreover, Sweller, Van Merriënboer and Paas (1998) indicated that limited working memory is one of the defining aspects of human cognitive architecture and, accordingly, all instructional designs should be analyzed from a cognitive load perspective. Also, education research has confirmed that it is important to consider individual learning style preferences in learning rather than attempt to instruct all learners with one style (Dunn & Griggs, 2000). Identifying individual differences in learning styles for processing video lectures are important because they add to existing knowledge of processing preferences and enhance our understanding and the predictive ability of personality variables. Among cognitive styles relating to multimedia learning, the visualizer–verbalizer hypothesis is particularly relevant to the individual difference of using different video lecture types to support online learning because video lectures typically present information to learners using audio, video, and slides with texts and pictures simultaneously as well as information is presented with different styles (Mayer & Massa, 2003).

Although many educational organizations are motivated to create and share video lectures, there is no single standard way or right way of creating a video lecture as well as there are no guidelines about designing the presentation styles of video lectures (Ilioudi, Giannakos, & Chorianopoulos, 2013). More importantly, the advantages and the drawbacks of each different video lecture type on supporting online learning have not been deeply studied yet. In short, although there is a growing number and variety of educational video lectures online, there is limited understanding of their effectiveness in terms of learning and usability (Chorianopoulos& Giannakos, 2013). To fill the research gap, it is worth exploring the effects of video lecture with different information presentation styles on different aspects of learning performance (Ilioudi, Giannakos, & Chorianopoulos, 2013). Thus, the study examined the effects of verbalizers and visualizers presented with three considered video lecture types with different information presentation styles on sustained attention, emotion, cognitive load, and learning performance. The research findings of the study contribute useful knowledge on how to select appropriate video lecture type for effectively supporting online learning of individual students and maximizing learning performance in autonomous learning context.

2. Literature Review

2.1 Video lecture design based on cognitive load, multimedia learning and media richness theories

Generally, people tend to process and remember visual images much more efficiently than things read or heard (Shorter & Dean 1994). Therefore, recent years have seen enormous growth of online educational video lectures, spanning K-12 tutorials to university lectures. With the development trend, the different types of video lectures, such as the lecture capture, voice over presentation, picture-in-picture, and Khan Style video lecture, in which present multimedia information by different styles, are proposed. (Ilioudi, Giannakos, & Chorianopoulos, 2013; Griffin, Mitchell, & Thompson, 2009; Chorianopoulos & Giannakos, 2013). Developing a video lecture is a complex process that requires thorough planning and an implementation procedure. Knowledge of learning theories and instructional implications is a prerequisite for successful realization of the learning contents of video lecture with the most appropriate delivery components (Chorianopoulos & Giannakos, 2013). Cognitive Load Theory (CLT) (Chandler & Sweller, 1991) and the Cognitive Theory of Multimedia Learning (CTML) (Mayer, 2001) are two prominent theoretical frameworks that study the characteristics of multimedia materials and provide design guidelines for educationally effective multimedia materials. CLT suggests that multimedia learning should be created in way that leads to a reduction in cognitive load and optimizes the use working memory (Chandler & Sweller, 1991). CTML (Mayer, 2001) states that multimedia narration and graphical images produce verbal and visual mental representations, which integrate with prior knowledge to construct new knowledge. The CLT distinguishes three types of cognitive load including intrinsic load, extraneous load, and germane load that compete for the limited resources of working memory when complex visual and verbal information is processed (Sweller, 1999). Intrinsic load is inherent to the materials being learned. The more complex the material, the greater the intrinsic load. Extraneous load is associated with the mental effort imposed by the instructional activities, their design and presentation. Extraneous load does not directly contribute to understanding of the material being taught. Finally, germane load is the mental effort that is exerted by learners to process the new information and to integrate it into existing knowledge structures. Intrinsic cognitive load cannot be manipulated, but extraneous and germane cognitive load can. Both extraneous and germane cognitive load can be influenced by instructional design, but extraneous load interferes with learning whereas germane load aids learning. Moreover, from a theoretical perspective, Mayer's (2001) CTML suggests that information being presented in the visual and auditory modalities operating simultaneously results in superior learning, particularly in increased retention and transfer of information, as it reduces the student's cognitive load and optimizes the use of working memory. Mayer (2001) asserts that multimedia learning combining animation with narration generally improves performance on retention tests better than when information is presented as either text or narration alone. Although CLT and CTML have been widely applied in multimedia design, the applicability of CLT and CTML to lecture-style multimedia presentations needs still to be further studied (Day, Foley, & Catrambone, 2006).

Moreover, Sweller, Van Merriënboer and Paas (1998) proposed multimedia instructional design techniques that include the goal-free effect, worked example effect, completion problem effect, split-attention effect, modality effects, redundancy effect, and the variability effect based on CLT. This work summarized that redundancy effect, modality effects, and split-attention effect are particularly related to video lecture design and affect sustained attention, emotion, cognitive load, and learning performance. The redundancy effect occurs when information that can be fully understood in isolation, as either visual or auditory information, is presented to both channels as essentially the same information (Sorden, 2005). Integrating redundant information in both working memories can actually increase cognitive load (Sorden, 2005). In contrast, Chandler and Sweller (1991) demonstrated that eliminating redundant information can reduce extraneous cognitive load. Modality effect asserts that effective working memory capacity can be increased by using auditory and visual working memory together rather than using one or the other alone (Sorden, 2005). Mousavi, Low, and Sweller (1995) argued that cognitive load is reduced by the use of dual-mode (visual-auditory) instructional techniques and that the limited capacity of working memory is increased if information is processed using both the visual and auditory channels. Moreover, split-attention effect occurs when learners are required to split their attention for learning material with multiple sources of information that have to be integrated before they can be understood, where each source of information is essential for understanding the material (Ayres & Sweller, 2005; Sorden, 2005; Mayer & Moreno, 1998). Split-attention effect will increase cognitive load due to the need that mentally integrate the multiple sources of information (Ayres & Sweller, 2005).

Moreover, Media Richness Theory (MRT) developed by Daft and Lengel (1986) suggests that different media have different degrees of richness based on their ability to reproduce the information transmitted over them. Lee et al. (2007) indicated that if a communication medium is rich, there will be less uncertainty and equivocality associated with the task and hence there will be less effort required to use it. Lim and Benbasat (2000) have also found that a medium that allows for sending and receiving of multiple cues to be perceived as useful. Therefore, a rich medium should be able to transmit sufficient amount of correct information in order to reduce uncertainty and should be able to process rich information in order to reduce equivocality (Sun & Cheng, 2007). Bassili (2008) used MRT to explain why some students prefer to watch lectures online rather than to attend face-to-face lectures. Therefore, whether or not the three considered video lecture types with different degrees of media richness affect learning performance is valuable to be studied.

2.2 The effects of video lectures with different information presentation types on learning performance

Currently, the lecture capture, voice over presentation, picture-in-picture, and Khan Style video lecture, which present multimedia information by different styles, are common used video lectures in online learning environments (Ilioudi, Giannakos, & Chorianopoulos, 2013; Griffin, Mitchell, & Thompson, 2009; Chorianopoulos & Giannakos, 2013). Lecture capture type involves the recording of an instructor's presentation and making the recording available for students on the web. Typically, PowerPoint slides and the instructor's voice are captured, and sometimes a video recording of the instructor and writing on a whiteboard are included. Voice over PowerPoint presentation type synchronizes lecture's audio recordings to the accompanying PowerPoint slides by specialized lecture recording software, such as Microsoft Producer or PowerCam (http://www.powercam.cc/). The picture-in-picture type is designed with the overlay of an instructor's video over lecture slides and also contains instructor's audio, subtitle, or even flash animation feature. Thus, it provides usable cuts between the instructor's video feed and the slides, but it requires elaborate post-production. Khan Style video lecture relies mainly on handwritten tutorials, produced using a digital pen and tablet, with an audio voice-over from the lecturer. However, to the best of our knowledge and literature review, relatively few empirical studies have focused on how online learning performance is affected by different video lecture types. Among few empirical studies, Ilioudi, Giannakos and Chorianopoulos's study (2013) explored the differences among the lecture capture, the Khan Style video lecture, and the traditional paper book in the learning performance of supporting the self-study of mathematics in the secondary education. Their study confirmed that the lecture capture is more effective than the book for complex topics as well as there was higher performance in the case of the lecture capture over the Khan Style video lecture. Furthermore, Griffin, Mitchell and Thompson's study (2009) assessed the possible pedagogical benefits of video lectures with different presentation formats including the types of synchronously presenting PowerPoint and voice, and asynchronously presenting PowerPoint and audio files. Their study demonstrated that the learning performance of the synchronous mode is significantly higher than the asynchronous mode. Homer, Plass and Blake's study (2008) on two versions of a computer-based multimedia presentation: video, which included a video of a lecture with synchronized slides, or no video, which included the slides but only an audio narration of the lecture suggest that having video as well as PowerPoint slides created a split attention effect, which caused increased cognitive load. Typically, increased cognitive load results in reduced learning (Sweller, 1994). Moreover, Wiese and Newton's study (2013) summarized several benefits of lecture capture use including increased student satisfaction, enhanced understanding of content and clarification of difficult topics, improved generation of course notes, increased accessibility to students with disabilities and non-native English speakers, and for the instructor, decreased requests for content clarification.

Moreover, a number of studies associated with multimedia learning have investigated multiple channel presentation and the resulting phenomenon of split attention (Mayer & Moreno, 1998; Schmidt-Weigand, Kohnert, & Glowalla, 2010). Also, most of video lectures do not only transmit the slides or the board content but also an additional video of the instructor, thus leading to the divided attention problem. That is, although every learner only has a single locus of attention, the attention of the learner is demanded by two areas of the screen: the video window showing the instructor and the board or slides area (Friedland, 2004). Also, Chen and Wang's study (2011) explored how multimedia materials with different information presentation styles affect learner emotions and learner performance. Their results confirmed that the video-based multimedia material generates the best learning performance and most positive emotion among the static text and image-based multimedia material, video-based multimedia material containing moving images with audio, and animated interaction-based multimedia materials, which contain text and animated images and have interactive features. Additionally, Chen and Lin's study (2014) claimed that suitable text display type for mobile reading in different reading contexts should be considered, such that learners can effectively read content by mobile devices with small screen. Their study designed a mobile reading experiment with a two-factor experimental design to assess the effects of the selected static, dynamic, and designed mixed text types, which were respectively presented in sitting, standing, and walking contexts, on reading comprehension, sustained attention, and cognitive load of learners. Their study concluded that the three reading contexts with the three text types have both advantages and disadvantages for reading comprehension, sustained attention, and cognitive load. As a result, text display type for mobile reading on small screens should be adjusted according to reading context or to improve reading comprehension, attention, or cognitive load.

In recent years, although online educational video lectures develop very rapid; however, there is limited understanding of their effectiveness in terms of learning and usability (Chorianopoulos& Giannakos, 2013). Therefore, to examine the effects of video lecture types with different information presentation styles on sustained attention, emotion, cognitive load, and learning performance contributes useful knowledge on how to select appropriate video lecture type for effectively supporting online learning of individual students and maximizing learning performance in autonomous learning context.

2.3 The effects of learning styles on learning performance in multimedia leaning environments

A learning style is a set of student's individual characteristics that are reflected in his learning behavior which includes how the student learns, how the student should be taught, and how the student interacts with the learning environment (Ocepek, Bosnić, Šerbec, & Rugelj, 2013). Carter (1985) identified perceptions of various learning environments and found that respondents perceived environments differently depending on their preferred learning style. A variety of previous studies have demonstrated that student learning styles are the key factor affecting learning performance in multimedia learning environments (Chen & Sun, 2012; Ocepek, Bosnić, Šerbec, & Rugelj, 2013; Cheng, Cheng, & Chen, 2012). Among the many learning styles addressed in previous studies, the visualizer–verbalizer hypothesis of Mayer and Massa (2003) states that some people process words more effectively (verbalizers) and some people process pictorial representations more effectively (visualizers). The visualizer–verbalizer hypothesis is particularly relevant to the design of multimedia materials because multimedia materials typically present information to learners using words and pictures simultaneously (Mayer & Massa, 2003). Further, Massa and Mayer (2006) tested the attribute-treatment interaction (ATI) hypothesis, which asserts that visualizers will perform best on tests of learning when they receive visual rather than verbal methods of instruction, whereas verbalizers will perform best on tests of learning when they receive verbal rather than visual methods of instruction. However, their study concluded that there was not strong support for the ATI hypothesis. Moreover, Chen and Sun's study (2012) assessed whether or not the visual and verbal learning styles affect learners' emotions and performance in the three considered multimedia materials including the static text and image-based multimedia material, video-based multimedia material, and animated interactive multimedia material. Their study confirmed that the video-based multimedia material generates the best learning performance and most positive emotion for verbalizers. Moreover, dynamic multimedia materials containing video and animation are more appropriate for visualizers than static multimedia materials containing text and image. That is, the ATI hypothesis that emphasizes visualizers learn best with visual instruction methods, whereas verbalizers learn best with verbal instruction methods, is partially supported by the finding of the study.

Moreover, to avoid students' cognitive overload and stress, Ocepek, Bosnić, Šerbec and Rugelj's study (2013) designed an adaptive learning system to provide an accurate and reliable model for recommending different multimedia types to different individuals by relating combinations of different learning styles to preferred types of multimedia materials. Homer, Plass, and Blake (2008) further found the presence of the instructor's face to induce differential effects on learners' cognitive load depending on their cognitive preference for visual or verbal information. In general, different types of video lectures show instructor's face by different presentation styles, such as that lecture capture type shows the whole body of lecturer, voice over presentation type shows the lecturer's face in a separated screen window, whereas picture-in-picture type shows the lecturer's face as spotlight style.

Although several previous studies (Massa & Mayer 2006; Chen & Sun, 2012) claim that there was not strong support for the attribute-treatment interaction (ATI) hypothesis that verbalizers and visualizers should be given different kinds of multimedia instruction to improve learning, it is worth to further confirm three video lecture types with different information presentation styles considered in the study on this hypothesis. Particularly, since the three considered video lecture types of the study contain various combinations of multimedia elements, whether or not these video lecture types are unfavourable to verbalizers in terms of learning performance, sustained attention, emotion, cognitive load needs to be further confirmed.

3. Research Methodology

3.1 The considered types of video lectures

3.1.1 The lecture capture type

Although e-learning has become a development trend in recent years, most of learning activities still take place in physical classrooms. Lecture capture means recording classroom-based activities by a video camera in a digital format that students can then watch over the web, on a computer or their mobile device. Lecture capture technology simultaneously records the lecturers' audio and video as well as the lecturers' instruction aids including writing on the whiteboard and PowerPoint lecture slides. Moreover, an important feature is that lecture capture preserves the interactivity of a classroom lesson – students' questions to the teacher or their reactions to the new information. Currently, the lecture capture used by most of the universities and online video-based learning platforms (e.g. Stanford, MIT Open Courseware, iTunes U) is the most commonly used type of video lecture. Figure 1 shows an example of lecture capture type.

Figure 1. An example of lecture capture type

3.1.2 The voice over presentation type

The main component of voice over presentation is usually a lecturer's PowerPoint presentation, supplemented with a voice over that explains the slides. Generally, the voice over presentation type simultaneously contains the elements of lecture's video, PowerPoint slides, and table of contents of the slides as well as presents the three elements as three separated screen windows. It lacks to capture learning context and visual information, such as classroom activities like the lecture capture type, and flash animation features like the picture-in-picture type. Figure 2 shows an example of the voice over presentation type. The upper left pane is the streamed video image displayed by the Windows Media Player to show lecturer's image. The lower left pane is the Table of Contents (ToC), a list of links that correspond to each slide in the lecture; each link also contains a synchronized anchor point in the video stream. Thus, viewers can easily skip around in the web lecture simply by clicking on the ToC entries. The right pane is the current PowerPoint slide.

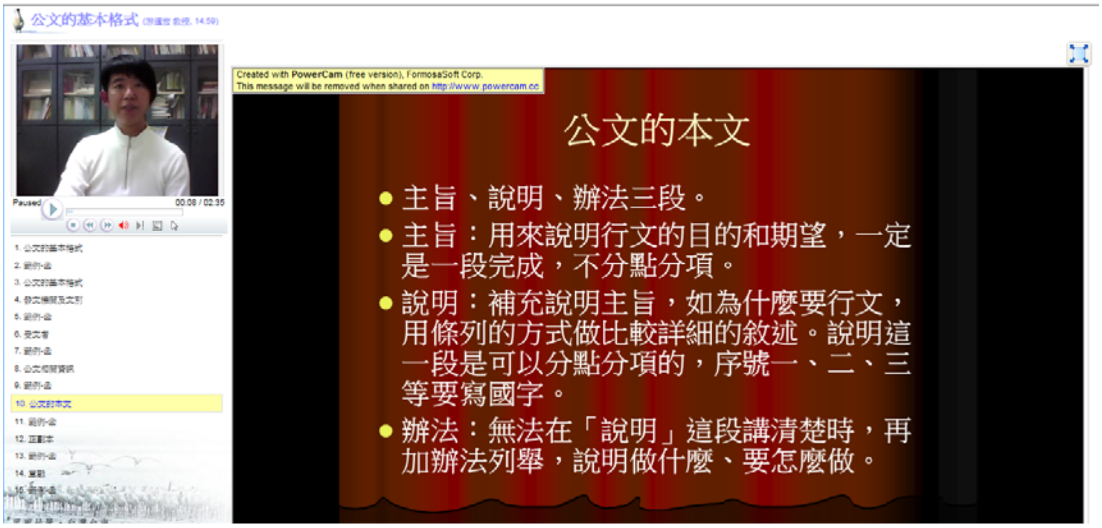

Figure 2. An example of the voice over presentation type

3.1.3 The picture-in-picture type

The picture-in-picture type, which is designed with the overlay of an instructor's video over lecture slides, is one of the most complex lecture video types. Generally, it includes instructor's video and audio, PowerPoint slides, subtitle, and other flash animation feature. Thus, it provides usable cuts between the instructor's video feed and the slides, but it requires elaborate post-production. In other words, the picture-in-picture type is a powerful combination of rich media presentation and informative video lesson. Currently, the picture-in-picture type is widely used in massive open online courses (MOOCs), such as Coursera. Figure 3 shows an example of the picture-in-picture type.

Figure 3. An example of the picture-in-picture type

Table 1 shows a summary comparison of three video lectures with different information presentation types considered in the study from the perspectives of cost, production technology, conveyed learning context, multimedia elements, and media richness. The results show that the picture-in-picture type has the highest cost, production technology, and media richness, followed by the lecture capture type, and then the voice over presentation type. The lecture capture type can convey the learning contexts of physical classroom instruction such that learners can experience instruction activities of physical classroom; the voice over PowerPoint presentation can be viewed as one kind of speech-based lectures; the picture-in-picture with elaborate media post-production belongs to multimedia interaction instruction. Developing a video lecture aims to facilitate learners' learning experiences so that learners' learning performance and satisfaction are maximized, while keeping down production costs.

Table 1. Comparison of three considered video lectures with different information presentation types

Comparison Item	**Lecture Video Type**		
	Lecture Capture	**Voice Over Presentation**	**Picture-in-picture**
Cost	Moderate	Low	High
Production Technology	Moderate	Low	High
Conveyed Learning Context	Physical classroom instruction	Online speech-based instruction	Multimedia interaction instruction
Multimedia Elements	1. Lecture slides 2. Lecturer's audio and video 3. Writing on the whiteboard 4. Interaction between lecturer and students	1. Lecture slides 2. Lecturer's audio and video 3. Table of contents of slides	1. Lecture slides 2. Lecturer's audio and video 3. Flash animation materials 4. Subtitle of slides
Media Richness	Moderate	Low	High

3.2 Experimental design

This work considered three frequently used video lectures with different information presentation types (*i.e.*, lecture capture type, voice over presentation type, and picture-in-picture type) to assess their effects on sustained attention, emotion, cognitive load, and learning performance. The learning contents of the three considered video lecture types were selected from three different units of an online course “Document Writing”. The online course was taught by the same lecturer and presented with three considered video lecture types. Based on the pilot study results that recruited 118 undergraduate students of non-participants from the Department of Chinese Literature at National Chengchi University, Taiwan to assess the difficulties of the corresponding test sheets of the three considered video lecture types, this work confirmed that the learning units of the three considered video lecture types have the same difficulty. Furthermore, based on brainwave detector, emWave stress detector, cognitive load scale, and learning performance test sheet, this work designed an online learning experiment with a two-factor experimental design to assess the effects of verbalizers and visualizers presented with the three considered video lecture types in sitting posture on sustained attention, emotion, cognitive load, and learning performance. This work enrolled 37 undergraduate students from the Department of Chinese Literature at National Chengchi University, Taiwan to participant in the formal experiment. To avoid that the learning performance was affected by the learning order of three considered video lecture types, each participant followed a random order to perform the learning activities of the three considered video lecture types by a notebook computer in an observation room.

3.3 Experimental procedures

The entire experimental procedures were planned as three stages. In the first stage, each participant received a 10-minute preparing session in understanding the entire experimental procedures, learning how to operate the three considered video lecture types on a notebook computer, and conducting a pretest to know prior knowledge of participants on the learning unit of the selected video lecture type. In the second stage, the learning activities were then performed in the sitting posture. To identify sustained attention and emotion based on human brainwave signals and heart rate variability (HRV) patterns, all participants who simultaneously wore the MindSet headset developed by Neurosky and emWave stress detector developed by the Institute of HeartMath during performing learning activities (Figure 4). Each participant learned three considered video lecture types, which were respectively presented on a notebook computer in an observation room. Based on the pilot study results, this work confirmed that the learning units of the three considered video lecture types have the same difficulty for undergraduate students in the department of Chinese literature at National Chengchi University, Taiwan. Proponents of active learning suggest that instructors should lecture for no longer than 15 to 20 minutes, and at that time use a strategy that causes students to engage with the information just presented (Osborn, 2010). Therefore, the learning time for the learning unit of each video lecture type was about 15 minutes. In the third stage, after each participant finished the learning unit of a considered video lecture type, she/he was asked to immediately take a posttest for assessing the learning performance, and fill out a cognitive load scale to identify the degree of cognitive load. Finally, several research participants were interviewed.

Figure 4. The experimental scene of a learner who simultaneously wore a Mindset earphone and an emWave stress detector to assess sustained attention and emotion while performing an autonomous online learning by video lecture

3.4 Research participants

This work enrolled 37 undergraduate students from the Department of Chinese Literature at National Chengchi University, Taipei City, Taiwan. Written informed consent was obtained from all participants following a full explanation of the experiment. Among 37 participants, 9 (24%) were male and 28 (76%) were female. Participants were aged 20–21. All participants had experiences on e-learning by computer devices.

3.5 Research instruments

This section introduces four research instruments, which were used to assess sustained attention, emotion, cognitive load, and learning performance.

3.5.1 Brainwave detection system to identify learner sustained attention

NeuroSky's MindSet headset records raw electroencephalography (EEG) data through a single contact sensor on a learner's forehead, and can output two custom measures including "attention" and "mediation" based on EEG data in real time. The "attention" values, which were in the range of 0–100, indicated a learner's level of mental focus. Our previous study (Chen & Huang, 2013) has confirmed that NeuroSky's MindSet headset has sufficient validity and reliability based on examining correlation between Birdwatching scores, which is a visual attention-based cognitive training program developed by Lumosity (Hardy, Drescher, Sarkar, Kellett & Scanlon, 2011), and attention meter values sensed by NeuroSky's MindSet headset. The result shows that Birdwatching scores were strongly and positively correlated with meter values (correlation coefficient is as high as 0.73). Moreover, Rebolledo-Mendez *et al*. (2009) also assessed NeuroSky's ability to demonstrate that a positive correlation existed between attention meter values measured by NeuroSky's MindSet headset and self-reported attention levels in a Second-Life assessment exercise. These analytical results demonstrate that the attention meter value measured by NeuroSky's MindSet headset has satisfactory validity and reliability for identifying learner attention level in learning activity.

3.5.2 Emotion assessment by the emWave system

The emWave system, which is a stress detector for emotional states developed by the Institute of HeartMath, uses an ear sensor to determine heart rate variability (HRV) based on heart rate power spectral density analysis for identifying human emotion (McCraty, Atkinson, Tiller, Rein & Watkins, 1995). The emWave system provides an easy-to-use software program with a heart rhythm monitor and a HRV-based emotion recognition algorithm for identifying emotional states. Several previous studies have revealed that HRV patterns are directly responsive to changes in emotional states (McCraty, Atkinson, Tiller, Rein & Watkins, 1995; Tiller, McCraty & Atkinson, 1996; Latham, 2006). Latham's review (2006) indicated that there are two major theoretical frameworks including Polyvagal theory and Neurovisceral Integration theory that articulate the role of HRV in emotional responding. There have been several our previous studies associated with multimedia learning and mobile learning to assess learners' emotion states by the emWave system (Chen, & Sun, 2012; Chen & Wang, 2011; Chen & Lin). This study also adopted the emWave system to measure changes in learner emotional states when presented with different types of video lectures in order to identify how different types of video lectures affect individual learning emotion.

3.5.3 Cognitive load scale for identifying learner cognitive load

To identify how the three video lecture types influence cognitive load, this study applied the cognitive load scale proposed by Sweller *et al*. (1998) to identify learner cognitive load. This scale, which consists of one subscale for mental load and one subscale for mental effort, contains four items with responses on a seven-point Likert scale. Two items were for mental load (intrinsic load) and two items were for mental effort (extraneous and germane load); the total score for each subscale was 14. Cronbach's α value for the cognitive load scale was 0.92. For mental effort and mental load, the Cronbach's α values were 0.86 and 0.85, respectively. These analytical results demonstrate the high reliability of the measurement scale.

3.5.4 Test sheet for assessing learning performance

To evaluate learning performance, this work designed three test sheets based on the learning contents in the three considered types of video lectures. Each test sheet was composed of ten items to assess memory, comprehension, and application. The memory items identified whether learners memorized facts conveyed in a video lecture; comprehension items assessed whether learners understood facts conveyed in a video lecture, and organized or interpreted facts correctly; and application items assessed whether learners solved problems via understanding. Each correct answer in the test sheet will get 1 point. That is, the full mark of the test sheet for assessing learning performance is 10 points. Also, the estimation of item difficulty and discrimination by using classic testing theory shows that the average difficulty of the test items in each test sheet is moderate, and the discrimination of each test item in three test sheets is quite good. The results imply that the three test sheets for assessing learning performance has high reliability.

4 Experimental Results

4.1 Effects of verbalizers and visulaizers presented with three considered video lecture types on sustained attention

Table 2 shows descriptive statistical results of sustained attention of verbalizers and verbalizers presented with three considered video lecture types. The analysis of two-way ANOVA shows that no significant interaction effect exist between the cognitive styles and video lecture types ($F=1.40$, $p=.249>.05$) (Table 3). The results of main effect analysis reveal that the effect of video lecture types on sustained attention was significant ($F=3.35$, $p=.039<.05$), and that the effect of cognitive styles on sustained attention was significant ($F=12.50$, $p=.001<.05$). The Scheffe's multiple comparison shows that sustained attention in the voice over presentation type was significantly higher than the picture-in-picture type. Moreover, sustained attention of verbalizers was significantly higher than visualizers while learning by three considered video lecture types. Further, compared with lecture capture and picture-in-picture types, voice over presentation type not only generates the highest mean sustained attention (mean=49.92), but also generates the highest standard deviation of sustained attention (Std.=8.11). It seems that split-attention effect occurs to some degree in voice over presentation type.

Table 2. Descriptive statistics of sustained attention of verbalizers and verbalizers presented with three considered video lecture types

Video Lecture Type	Cognitive Style	Mean	Std.
Lecture Capture	Verbalizers	48.36	8.26
	Visualizers	45.39	5.07
	Total	47.00	7.05
Voice Over Presentation	Verbalizers	53.29	6.68
	Visualizers	45.90	8.02
	Total	49.92	8.11
Picture-in-picture	Verbalizers	47.25	5.97
	Visualizers	44.39	3.33
	Total	45.93	5.08
Total	Verbalizers	49.63	7.40
	Visualizers	45.25	5.72
	Total	47.62	7.01

Table 3. A comparison of sustained attention of verbalizers and verbalizers presented with three considered video lecture types by two-way ANOVA with the Scheffe test

Item	Sum of Squares	Degree of Freedom	Sum of Mean Squares	F	Sig.	Result of Scheffe Test
Video Lecture Styles	283.73	2	141.86	3.35*	.039	Voice Over Presentation > Picture-in-picture
Cognitive Style	529.22	1	529.22	12.50*	.001	Verbalizer>Visualizer
Video Lecture Styles * Cognitive Style	119.08	2	59.54	1.40	.249	-
Error	4443.16	105	42.31			-
Total	257150.05	111				-

4.2 Effects of verbalizers and visulaizers presented with three considered video lecture types on emotion

Next, this work examined the effects of verbalizers and verbalizers presented with three considered video lecture types on positive emotion and negative emotion based on the emWave stress detector, respectively.

4.2.1 Negative emotion

Table 4 shows descriptive statistical results of negative emotion of verbalizers and verbalizers presented with three considered video lecture types. The analysis of two-way ANOVA shows that no significant interaction effect exist between the cognitive styles and video lecture types (F=0.09, p=.905>.05) (Table 5). The results of main effect analysis reveal that the effect of video lecture types on negative emotion attention was not significant (F=0.92, p=.399>.05), and that the effect of cognitive styles on negative emotion was also not significant (F=0.65, p=.419>.05).

Table 4. Descriptive statistics of negative emotion of verbalizers and verbalizers presented with three considered video lecture types

Video Lecture Type	Cognitive Style	Mean	Std.
Lecture Capture	Verbalizers	72.67	23.73
	Visualizers	67.23	23.73
	Total	70.17	21.47
Voice Over Presentation	Verbalizers	75.52	22.3
	Visualizers	74.40	17.08
	Total	75.00	19.81
Picture-in-picture	Verbalizers	70.27	23.20
	Visualizers	67.1	17.07
	Total	68.85	20.40
Total	Verbalizers	72.82	22.79
	Visualizers	69.61	17.63
	Total	71.34	20.56

Table 5. A comparison of negative emotion of verbalizers and verbalizers presented with three considered video lecture types by two-way ANOVA with the Scheffe test

Item	Sum of Squares	Degree of Freedom	Sum of Mean Squares	F	Sig.	Result of Scheffe Test
Video Lecture Type	801.03	2	400.51	0.92	.399	-
Cognitive Style	284.14	1	284.14	0.65	.419	-
Video Lecture Type * Cognitive Style	85.90	2	42.95	0.09	.905	-
Error	45353.93	105	431.94			-
Total	611529.88	111				-

4.2.2 Negative emotion

Table 6 shows descriptive statistical results of positive emotion of verbalizers and verbalizers presented with three considered video lecture types. The analysis of two-way ANOVA shows that no significant interaction effect exist between the cognitive styles and video lecture types (F=0.07, p=.931>.05) (Table 7). The results of main effect analysis reveal that the effect of video lecture types on positive emotion attention was not significant (F=0.78, p=.458>.05), and that the effect of cognitive styles on positive emotion was also not significant (F=0.48, p=.488>.05).

Table 6. Descriptive statistics of positive emotion of verbalizers and verbalizers presented with three considered video lecture types

Video Lecture Type	Cognitive Style	Mean	Std.
Lecture Capture	Verbalizers	18.24	22.37
	Visualizers	22.53	15.38
	Total	20.21	19.3
Voice Over Presentation	Verbalizers	15.26	18.45
	Visualizers	16.58	14.77
	Total	15.87	16.64
Picture-in-picture	Verbalizers	19.87	20.95
	Visualizers	21.55	14.95
	Total	20.64	18.21
Total	Verbalizers	17.79	20.39
	Visualizers	20.22	14.96
	Total	18.91	18.06

Table 7. A comparison of positive emotion of verbalizers and verbalizers s presented with three considered video lecture types by two-way ANOVA with the Scheffe test

Item	Sum of Squares	Degree of Freedom	Sum of Mean Squares	F	Sig.	Result of Scheffe Test
Video Lecture Type	526.61	2	263.30	0.78	.458	-
Cognitive Style	162.35	1	162.35	0.48	.488	-
Video Lecture Type * Cognitive Style	48.18	2	24.09	0.07	.931	-
Error	35183.82	105	335.08			-
Total	75604.46	111				-

4.3 Effects of verbalizers and visulaizers presented with three considered video lecture types on cognitive load

Table 8 presents descriptive statistics of cognitive load of verbalizers and verbalizers presented with three considered video lecture types. Based on analysis of two-way ANOVA show that a significant interaction effect existed between video lecture types and cognitive styles for cognitive load (F=3.98, p=.021<.05). The results of simple main effect analysis show that cognitive load was not significantly affected when verbalizers were presented with three considered video lecture types (F=2.99, p=.058 >.05); cognitive load was significantly affected when visualizers were presented with three considered video lecture types (F=9.86, p=.000<.05). Scheffe’s test results show that cognitive load of visualizers presented with the voice over presentation type was significantly higher than that with the lecture capture type and picture-in-picture type (Table 9). Moreover, the results of simple main effect analysis show that cognitive load was not significantly affected when verbalizers and visualizers were presented with the video capture type (F=0.98, p=.327>.05); cognitive load was significantly affected when verbalizers and visualizers were presented with the voice over presentation type (F=7.62, p=.009<.05); cognitive load was not significantly affected when verbalizers and visualizers were presented with the picture-in-picture type (F=1.56, p=.219>.05). Scheffe's test results show that cognitive load of visualizers presented with the voice over presentation type was significantly higher than verbalizers presented with the voice over presentation type (Table 10).

Table 8. Descriptive statistics of cognitive load of verbalizers and verbalizers presented with three considered video lecture types

Video Lecture Type	Cognitive Style	Mean	Std.
Lecture Capture	Verbalizers	13.70	4.96
	Visualizers	12.23	3.80
	Total	13.02	4.46
Voice Over Presentation	Verbalizers	13.55	5.04
	Visualizers	18.00	4.69
	Total	15.59	5.31
Picture-in-picture	Verbalizers	10.55	3.63
	Visualizers	12.23	4.56
	Total	11.32	4.11
Total	Verbalizers	12.60	4.74
	Visualizers	14.15	5.08
	Total	13.31	4.94

Table 9.The one-way ANOVA results of cognitive load of visualizers presented with three considered video lecture types

	Sum of Squares	Degree of Freedom	Sum of Mean Squares	F	Sig.	Result of Scheffe Test
Cognitive Load	376.62	2	188.31	9.86***	.000	Voice Over Presentation > Lecture Capture; Voice Over Presentation > Picture-in-picture

Table 10.The one-way ANOVA results of cognitive load of verbalizers and visualizers presented with the voice over presentation type

	Sum of Squares	Degree of Freedom	Sum of Mean Squares	F	Sig.	Result of Scheffe Test
Cognitive Load	181.96	1	181.96	7.62**	.009	Visualizer > Verbalizer

4.4 Effects of verbalizers and visulaizers presented with three considered video lecture types on learning performance

This study used paired-sample *t*-test to determine whether learning performance by three considered video lecture types was significantly promoted based on pretest and posttest scores. Table 11 shows the results. Analytical results revealed that three considered video lecture types all have significant learning performance. Table 12 shows descriptive statistical results of learning performance of verbalizers and visulaizers presented with three considered video lecture types. The analysis of two-way ANOVA shows that no significant interaction effect exist between the cognitive styles and video lecture types ($F=0.57$, $p=.565>.05$) (Table 13). The results of main effect analysis reveal that the effect of video lecture types on learning performance was significant ($F=35.77$, $p=.000<.05$). Further, the Scheffe's multiple comparison shows that learning performance in the lecture capture and picture-in-picture types was significantly higher than the voice over presentation type. Also, the effect of cognitive styles on learning performance was not significant ($F=3.52$, $p=.063>.05$). That is, the learning performance of verbalizers and visulaizers presented with three considered video lecture types has no significant difference.

Table 11. Paired-sample *t*-test of learning performance of the both groups presented with three considered video lecture types

Video Lecture Type	Learning Performance	Number of students	Mean	Std.	*t*	Sig.
Lecture Capture	Pretest	37	2.35	1.33	21.69***	.000
	Posttest	37	8.62	1.13		
Voice Over Presentation	Pretest	37	2.51	1.40	11.53***	.000
	Posttest	37	6.40	1.60		
Picture-in-picture	Pretest	37	2.94	1.02	22.39***	.000
	Posttest	37	8.75	1.32		

Table 12. Descriptive statistics of learning performance of verbalizers and visualizers presented with three considered video lecture types

Video Lecture Type	Cognitive Style	Mean	Std.
Lecture Capture	Verbalizers	8.80	1.05
	Visualizers	8.41	1.17
	Total	8.62	1.11
Voice Over Presentation	Verbalizers	6.80	1.60
	Visualizers	5.94	1.51
	Total	6.40	1.60
Picture-in-picture	Verbalizers	8.85	1.49
	Visualizers	8.64	1.11
	Total	8.75	1.32
Total	Verbalizers	8.15	1.68
	Visualizers	7.66	1.76
	Total	7.92	1.73

Table 13. A comparison of learning performance of verbalizers and visualizers presented with three considered video lecture types by two-way ANOVA with the Scheffe test

Item	Sum of Squares	Degree of Freedom	Sum of Mean Squares	F	Sig.	Result of Scheffe Test
Video Lecture Type	130.75	2	65.37	35.77***	.000	Lecture Capture > Voice Over Presentation; Picture-in-picture > Voice Over Presentation
Cognitive Style	6.44	1	6.44	3.52	.063	-
Video Lecture Type * Cognitive Style	2.10	2	1.05	0.57	.565	-
Error	191.89	105	1.82			-
Total	7306.00	111				-

In conclusion, Table 14 shows the summary of the effects of different cognitive style learners presented with three considered video lecture types on sustained attention, emotion, cognitive load, and learning performance.

Table 14. The summary of the effects of verbalizer and visualizer presented with three considered video lecture types on sustained attention, emotion, cognitive load, and learning performance

Sustained Attention	Video Lecture Type		Voice Over Presentation＞Picture-in-picture
	Cognitive Style		Verbalizer > Visualizer
Positive Emotion	Video Lecture Type		---
	Cognitive Style		---
Negative Emotion	Video Lecture Type		---
	Cognitive Style		---
Cognitive Load	Video Lecture Type	Lecture Capture	---
		Voice Over Presentation	Visualizer > Verbalizer
		Picture-in-picture	---
	Cognitive Style	Verbalizer	---
		Visualizer	Voice Over Presentation > Lecture Capture; Voice Over Presentation > Picture-in-picture
Learning Performance	Video Lecture Type		Lecture Capture > Voice Over Presentation; Picture-in-picture > Voice Over Presentation
	Cognitive Style		---

5. Discussion

This work aims to examine the effects of the verbalizers and visualizers presented with the three common used video lectures on sustained attention, emotion, cognitive load, and learning performance in an autonomous online learning scenario. The lecture capture simultaneously records the lecturer’s audio, video, lecturer’s instruction aids including writing on the whiteboard and PowerPoint slides, and preserves the interactivity of a classroom lesson between teacher and students. The picture-in picture type includes instructor’s video and audio, PowerPoint slides, subtitle, and other flash animation features and it is the only one video lecture type that provides subtitles to correspond lecturer’s narration in the three considered video lecture types. Mayer (2001) indicated that computer-based multimedia learning environments support the idea that people learn better and more deeply when appropriate pictures (i.e., animations, video, static graphics) are added to text or narration. That is, the picture-in-picture type is a powerful combination of rich media presentation and informative video lesson through providing usable cuts between the instructor’s video feed and the slides. In contrast, the voice over presentation type simultaneously contains the elements of lecture’s video, PowerPoint slides, and table of contents of the slides as well as presents the three elements as three separated windows in a computer screen. It lacks to capture learning context and visual information (i.e. non-verbal information), such as classroom activities like the lecture capture type, and flash animation features like the picture-in-picture type. Analytical results confirmed that the three considered video lecture types all significantly promote learning performance as well as the learning performance in the lecture capture and picture-in-picture types was significantly superior to the voice over presentation type. This analytical result is consistent with several previous studies (Ilioudi, Giannakos, & Chorianopoulos, 2013; Griffin, Mitchell, & Thompson, 2009), in which confirmed that the lecture capture type is more effective than the Khan Style video lecture and asynchronously presenting PowerPoint and audio files. This work inferred that adopting inappropriate information presentation layout in a computer screen and having less visual information integrated with learning material lead to that the voice over presentation type has the poorest learning performance among the three considered video lecture types. In short, this work concluded that the lecture capture and picture-in-picture types have higher degree of media richness, integrate verbal and non-verbal (i.e. visual) elements more appropriate and have better visual presentation layout for presenting multiple multimedia elements than the voice over presentation type, thus having better learning performance.

Furthermore, the ATI hypothesis asserts that visualizers will perform best on tests of learning when they receive visual rather than verbal methods of instruction, whereas verbalizers will perform best on tests of learning when they receive verbal rather than visual methods of instruction (Massa & Mayer, 2006). Smith and Woody (2000) claimed that multimedia material benefits students who prefer visual representations. However, this work confirmed that the three considered video lecture types have equivalent learning performance for verbalizers and visualizers. Restated, this analytical result does not support the ATI hypothesis, which supposes that visualizers may learn better by the picture-in-picture type with high media richness than the lecture capture type with moderate media richness and voice over presentation type with low media richness. In other words, well-designed video lectures will provide the equivalent benefits in promoting learning performance for verbalizers and visualizers even though most of video lecture types contain rich and multiple multimedia elements. The results of the study are consistent with several previous studies (Chen & Sun, 2012; Kollöffel, 2012; Karakaya, Ainscough, & Chopoorian, 2001), in which examine the effects of cognitive styles on learning performance for multimedia learning. Chen and Sun’s study (2012) confirmed that the video-based multimedia material generates the best learning performance and most positive emotion for verbalizers among the static text and image-based multimedia material, video-based multimedia material, and animated interactive multimedia material as well as video-based multimedia material and animated interactive multimedia material are more appropriate for visualizers than static text and image-based multimedia material. Their study has not fully supported the ATI hypothesis. Moreover, Kollöffel (2012) examined the relationships between cognitive style (i.e., visualizers and verbalizers), cognitive abilities (spatial and verbal abilities), and learning performance while learning multimedia materials. Analytical results showed that the visualizer and verbalizer cognitive styles and learning outcomes were unrelated, concluding that learning results are influenced by cognitive ability (particularly spatial visualization) and the extent to which a format allows cognitive processing, rather than a match between the preferred format and the format administered. Also, Karakaya, Ainscough and Chopoorian (2001) also examined the impact of student learning style (convergers, divergers, assimilators, and accommodators) on student learning performance in a multimedia lecture presentation setting as well as confirmed there was no significant difference in learning performance between students with different learning styles.

Moreover, this work found that the voice over presentation type generates the highest sustained attention and cognitive load among the three considered video lecture types. This work found that the effect of high sustained attention possibly derive from learners' high mental load or stress while learning by the voice over presentation type, thus leading to increasing cognitive load. According to cognitive load theory, learners' learning might be inhibited by the voice over presentation type when learners must split or distribute their attention to mentally integrate three separated windows that respectively contain the lecturer's video, PowerPoint slides, and table of content of slides because the integration process might overburden limited working memory capacity (Kalyuga, Chandler, & Sweller, 1999). This viewpoint was supported by the interview results. Several interviewees expressed that their visual attentions are split by three separated windows that respectively display the lecturer's video, PowerPoint slides, and table of content of slides while learning by the voice over presentation type. They also expressed that learning by the voice over presentation type has to switch frequently between the lecturer's video and the slides to compare the lecturer's narration to what is illustrated or written on the slides, thus increasing their mental load. Additionally, several interviewees expressed that respectively displaying the lecturer's video, PowerPoint slides, and table of content of slides as three separated windows in a computer screen leads to over small texts and images in PowerPoint slides, thus increasing visual burden. Moreover, Multimedia Richness Theory indicated that if a communication medium is rich, there will be less uncertainty and equivocality associated with the task and hence there will be less effort required to use it (Lee et al., 2007; Sun & Cheng, 2007). The picture-in picture type has the highest media richness, followed by the lecture capture type, and then the voice over presentation type. This viewpoint supports why the cognitive load in the lecture capture and picture-in picture types is lower than the voice over presentation type.

Further, this work found that the voice over presentation type not only generates the highest mean sustained attention, but also has the highest standard deviation of sustained attention among three considered video lecture types. It seems that the voice over presentation type generates split-attention effect to some degree because learners have to switch their visual attentions among three separated windows that respectively contain the lecture's video, PowerPoint slides, and table of contents of slides. The results are consistent with several previous studies (Mayer & Moreno, 1998; Mousavi, Low, & Sweller, 1995; Kalyuga, Chandler, & Sweller, 1999), in which indicate that presentations typically involve audio and video of a lecturer, along with a visual presentation of the slides is not ideal for learning because it divides visual attention between the video of the lecturer and the visual of the slides, thus creating a split-attention effect. That is, the lecturer's video in the voice over presentation type possibly overloads the visual channel so that the split-attention effect is involved, but does not add instructional value. In contrast, several previous studies (Gunawardena, 1995; Church, Ayman-Nolley, & Mahootian, 2004; Valenzeno, Alibali, & Klatzky, 2003) claimed that the lecturer's video may be having other effects that enhance learning. Gunawardena's study (1995) claimed that the lecturer's video may give learners a sense of interacting with a ''real'' person while watching the video lecture. In other words, the lecturer's video may help create a sense of social presence. Social-cue hypothesis asserts that the outcome of most communications would be more effective if they contained more natural social cues (Rutter, 1984). In video lecture presentations, social cues are sometimes provided by a pedagogical agent, such as an animated cartoon character or a video image of the actual physics instructor. Church, Ayman-Nolley and Mahootian's study (2004) also demonstrated that gestures and other nonverbal communication—visible in the lecturer's video—enhance learning (Church, Ayman-Nolley, & Mahootian, 2004; Valenzeno, Alibali, & Klatzky, 2003). Moreno, Mayer, Spires and Lester's study (2001) also indicated that the presence of an on-screen agent did not produce a split-attention effect. However, the analytical results of the study for the voce over presentation type have not supported the social-cue hypothesis. This work inferred logically that displaying lecture's video by a separated window is the main reason that leads to decreasing the effects of natural social cues from actual physics instructor.

Also, this work confirmed that verbalizers and visualizers presented with the three considered video lecture types have equivalent emotion responses in positive and negative emotions. The results are inconsistent with Chen and Wang's study (2011), in which demonstrated that the video-based multimedia material generates the most positive emotion among the static text and image-based multimedia materials, video-based multimedia materials, and animated interaction-based multimedia materials assessed in the study. This work inferred that the main reason is that multimedia elements containing in the three considered video lecture types are similar, thus generating similar emotion responses.

Finally, some study limitations merit consideration. First, the study evaluated only three most common used video lecture types, the other video lecture types, such as Khan Style video lecture (Chorianopoulos& Giannakos, 2013), which captures an interactive drawing board with voice over, have not been considered in the study. Moreover, the study was conducted in a highly controlled environment, which might have induced demand characteristics that affected participants' performance. Specifically, participants were told they would be tested on the material in the lecture video, which may have led to increased apprehension and desire to be a 'good participant'. Moreover, in our study, the video lecture was shown without the opportunity to pause, rewind, or take notes, which might have induced higher levels of cognitive load than would have been experienced without such constraints. Also, pedagogical strategies generally used in video lectures include receptive viewing, problem solving, and created video podcasts (Kay, 2012), the pedagogical strategy used in the three considered video lecture types is receptive viewing aiming at the delivery of information. The others pedagogical strategies have not considered in the study.

6. Conclusions and Future Work

The study investigates whether the three considered video lecture types with different information presentation styles lead to significant differences on sustained attention, emotion, cognitive load, and learning performance for verbalizers and visualizers based on a two-factor experimental design. Analytical results confirmed that three considered video lecture types all provide remarkable promotion in learning performance, but the learning performance in the lecture capture and picture-in-picture types was significantly higher than the voice over presentation type. Importantly, verbalizers and visualizers have equivalent learning performance among three considered video lecture types used to support online learning. Also, this work confirmed that the voice over presentation type generated the highest sustained attention as well as the sustained attention of verbalizers was significantly higher than visualizers while learning three considered video lecture types. However, visualizers presented with the voice over presentation type generated the highest cognitive load among the three considered video lecture types. Further, cognitive load of visualizers was significantly higher than verbalizers while learning the voice over presentation type. Furthermore, the learners' positive and negative emotion induced by the three considered video lecture types do not appear significantly differences as well as the verbalizers and visualizers' positive and negative emotion also do not appear significantly differences while learning three considered video lecture types. In conclusion, compared to the voice over presentation type with relatively low cost and production technology, both the lecture capture and picture-in-picture types may be worth to be developed for online learning from the viewpoints of facilitating learning performance and reducing cognitive load even though the both video lecture types need to take the extra expense and production effort.

Moreover, additional studies are warranted. Firstly, with rapid development of mobile learning in recent years, the effects of different video lecture types on sustained attention, emotion, cognitive load, and learning performance for mobile devices with small screen are worth to be further studied. Secondly, this work enrolled 37 undergraduate students from the Department of Chinese Literature at National Chengchi University, Taiwan to take part in the study. Further study should confirm whether research subjects with different academic levels lead to different results with the study. Moreover, Mayer (2001) noted that the redundancy effect may not apply to lecture-style presentations where notes or outlines (like those provided with PPT text) could aid learner processing. Further study should investigate whether or not the redundancy or modality effect happens in the three considered video lecture types because they all contain multiple multimedia elements. Finally, future study should confirm whether or not split attention effect occurs in the voice over presentation type, which shows multimedia instruction elements by three separated windows based on eye-tracking technology. Actually, applying eye movement measures to explore learners' visual attention on the determined area of interest (AOI) in video lecture will also be very helpful in understanding how information presentation types of video lectures affect learners' sustained attention, cognitive load, and learning performance.

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科技部補助計畫衍生研發成果推廣資料表

日期:2014/09/05

科技部補助計畫	計畫名稱: 基於學習情緒感知之多媒體網路適性化學習系統發展與學習成效評估研究
	計畫主持人: 陳志銘
	計畫編號: 100-2511-S-004-001-MY3　　學門領域: 資訊教育

無研發成果推廣資料

100 年度專題研究計畫研究成果彙整表

計畫主持人：陳志銘			計畫編號：100-2511-S-004-001-MY3				
計畫名稱：基於學習情緒感知之多媒體網路適性化學習系統發展與學習成效評估研究							
成果項目			量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
			實際已達成數（被接受或已發表）	預期總達成數(含實際已達成數)	本計畫實際貢獻百分比		
國內	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%		
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	1	1	100%	篇	1. Chih-Ming Chen*, and Chung-Hsin Wu "Effects of Different Video Lecture Types on Sustained Attention, Emotion, Cognitive Load, and Learning Performance," Computers & Education, vol. 80, 108-121, 2014. [SSCI, SCI, EI 收錄]
		研究報告/技術報告	1	1	100%		1. 陳志銘，基於學習情緒感知之多媒體網路適性化學習系統發展與學習成效評估研究(3/3)，科技部結案報告，計畫編號 NSC 100-2511-S-004-001-MY3。
		研討會論文	2	2	100%		1. Jhih-Kun Yang ; Chih-Ming Chen, * ; Mi Lin, 2014.06, 'Facilitating English Language Learners' Oral Reading Fluency with Digital Pen Technology,' Proceedings

							of the International Mobile Learning Festival, Consultants International for Human Capital Development, pp.17-19.(*為通訊作者) 2.Yung-Ting Chen ; Chih-Ming Chen*, 2014.06, 'Effects of Different Text Display Types on Reading Comprehension, Sustained Attention and Cognitive Load in Mobile Reading Contexts,' Proceedings of the International Mobile Learning Festival, Consultants International for Human Capital Development, pp.1-16.(*為通訊作者)
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	2	2	100%	人次	李庭慧、楊智琨
		博士生	1	1	100%		陳勇汀
		博士後研究員	0	0	100%		
		專任助理	1	0	100%		郭于嫙

其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)	1. 榮獲國立政治大學 102 年度研究優良獎。 2. 榮獲科技部 102 年度獎勵特殊優秀人才獎勵。 3. 榮獲國立政治大學特聘教授。

	成果項目	量化	名稱或內容性質簡述
科教處計畫	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材		錄製現場教學錄播、配音簡報與子母畫面

加填項目			等不同方式呈現之多媒體影音教材各一個單元
	舉辦之活動/競賽	0	
	研討會/工作坊	1	接受 CSCL & CSPL SIG 邀請於 8 月 20 日 13:00~17:00 在國立成功大學成功校區資訊大樓（計網中心）電腦教室舉行「社會網路工作坊」，並擔任主要講者，計有 43 位老師及學生參加。
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	36	國立政治大學文學院中國文學系公文寫作知線上多媒體影音課程學習活動

科技部補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■達成目標

□未達成目標（請說明，以 100 字為限）

□實驗失敗

□因故實驗中斷

□其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文：■已發表 □未發表之文稿 □撰寫中 □無

專利：□已獲得 □申請中 ■無

技轉：□已技轉 □洽談中 ■無

其他：（以 100 字為限）

本計畫之研究成果已經發表於以下之國際期刊:

Chih-Ming Chen*, and Chung-Hsin Wu "Effects of Different Video Lecture Types on Sustained Attention, Emotion, Cognitive Load, and Learning Performance," Computers & Education, vol.80, 108-121, 2014. [SSCI, SCI, EI 收錄]

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以 500 字為限）

隨著電腦技術及網際網路的蓬勃發展，數位學習儼然已成為當今教與學的發展趨勢，以網路學習為基礎的數位學習模式應該重視個別差異，以滿足個人化(Personalization)學習之需求。因此，近年來有許多研究者著手於發展網路適性化學習系統(Adaptive Learning System)，以達因材施教、提升學習效率、降低學習負擔、避免學習迷失以及提升學習成效之目的。目前大部份的網路適性化學習系統以考量學習者的興趣、喜好及瀏覽行為為主，也有以考量學習者能力、知識背景提供個人化學習路徑規劃的研究被提出。近幾年由於情境感知技術(Context-aware Technology)的快速發展，使得適性化學習的研究邁入了一個嶄新的境界，許多適性化學習系統開始將學習者個人所處的學習情境考量進去，因此許多考量學習者所在位置及環境狀態等情境因素的適性學習機制被相繼提出，但目前仍少有以考量個人學習特質以及學習情緒發展適性化學習的研究被提出。許多認知與心理學領域的研究已經證實學習情緒與學習成效具有高度的關聯，學習情緒的好壞可能加速或干擾學習，負面情緒會損害認知活動的效能，相對的，正面的情緒則有助於提升認知活動效能。因此若能結合情緒感知技術於目前發展的網路適性化學習系統，將可以發展出更符合個別學習需求之網路適性化學習環境。

學習情緒的即時偵測具有極高的難度與挑戰性，然而近幾年已有基於聲音、外顯行為、臉部表情及人體生理訊號發展出來的情緒感知技術被相繼提出，使得動態即時偵測學習情緒成為可能，其中以人體生理訊號偵測情緒的研究尤受矚目。此外，有鑑於多媒體教材已經成為數位學習教材設計發展的主要趨勢，不同型態多媒體教材是否影響學習情緒進而影響學習成效，值得進一步探究。因此本計畫於計畫執行的三年內探討不同多媒體型態及不同類型多媒體影音教材對於文字型及圖像型學習者的影響，也探究不同型態多媒體教材與學習風格、學習情緒與學習成效之關聯性基礎研究。本計畫之研究成果有助於多媒體影音教材的設計，也可作為線上學習多媒體體影音教材的選擇參考。