By Hook or by Crook

Designing Physics Video Hooks with a Modified ADDIE Framework

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This paper delineates the specific design strategy used in the creation of physics video hooks over the course of an eight-week project. A hook is an instructional technique which stimulates student attention (Hunter, 1994; Lemov, 2010), interest (Jewett Jr., 2013) and engagement (McCrory, 2011; Riendeau, 2013). The hook videos are aimed at post primary/middle school students (11–15 years old) with relevant topics being selected from the Irish science curriculum. The project employed a modified Analysis, Design, Development, Implementation and Evaluation (ADDIE) design framework that allowed videos to be developed in an efficient and practical manner. Pertaining to design considerations, the videos are aligned with the cognitive theory of multimedia learning. Furthermore, specific design elements are embedded into the videos, which include relevance, questioning, discrepancy, and novelty. Finally, the key findings and challenges encountered during the hook design process are examined.

Introduction

Coffman (2003) asks "[w]ouldn't it be great if our students came to class prepared–not just having read the assignment, but mentally prepared as well–alert and ready to debate, challenge, interact, and contribute?" (p. 2). Coffman advocates that students should anticipate a teaching strategy that provokes these attributes and enthuses them into an active state of learning from lesson introduction. "Hooks" are any form of pedagogical strategy that catch attention and serve as an enticement for learning (McHugh & McCauley, 2016). They are different from other teaching strategies in that their primary aim is to foster interest (Jewett Jr., 2013; Marinchech, 2013), reinforce attention (Hunter, 1994; Lemov, 2010; McCauley et al., 2015), and encourage engagement among learners (McCrory, 2011; Riendeau, 2013).

The purpose of this study is to design and construct an instructional resource that acts as an effective hook when applied to science classrooms with post primary/middle school students (11–15 years old). This project stems from a collaborative design project with pre-service science teachers and educators at the National University of Ireland, Galway (McCauley et al., 2015). As part of this project, six pre-service science teachers were recruited to work with a science and technology educator. Working in separate pairs, the goal was to design a suite of physics, chemistry, and biology video hooks. This paper delineates the specific design strategy used in the creation of the physics video hooks over the course of the eight-week project. To develop the hooks, a modification to the Analysis, Design, Development, Implementation and Evaluation (ADDIE) instructional design framework was employed. This modification involved the removal of the "implementation" phase and the instigation of an enhanced evaluation step to compensate, a process that is described in detail below. In what follows, the creation of the physics video hooks is articulated through the lens of each phase of the instructional model.

Instructional Design Framework

The creation of the physics video hooks employs an instructional design framework, which according to Martin et al. (2013) refers to the detailed design and evaluation of instructional materials, necessary to facilitate successful learning and performance. Other scholars concur with this depiction, describing instructional design as a systematic and iterative approach to developing educational materials and programs (Smith & Ragan, 1999), the goal being to follow a process that can make instruction more effective (Gustafson & Branch, 2002). Additionally, Merrill (2002) reports on the value of using instructional design for the generation of learning products; thus the framework was embraced for the design of the video hooks, as a learning product for the science classroom.

Modified Addie Framework

The instructional design framework initially utilized during this project was the 'Analysis, Design, Development, Implementation and Evaluation' ADDIE model (Gustafson & Branch, 2002). The ADDIE model provides dynamic and flexible guidelines for the construction of teaching and learning tools (Moradmand et al., 2014). It is a common approach used in the development of instructional programs and training courses. The process is iterative and sequential (Molenda, 2003), yet functions as a generic model in which any type of instructional material can be created (Martin et al., 2013).

The hooks' project worked through each phase of the ADDIE model. However, it was not within the scope of the project to complete the implementation stage. Implementation of the videos involves school testing by science teachers with associated feedback, the scale of which demands a separate and substantial research project. Moreover, hook design and creation was constrained within an eight-week project, held during the summer months, making it infeasible. Therefore, the exact instructional design model used was a four-stage model instead of five (Figure 1) changing 'ADDIE' to '*ADDE'. To compensate, an enhanced evaluation stage was employed.

It should be noted that the *ADDE model followed is not linear. For convenience, steps may be presented in an undeviating manner; however, designers transition in and out of phases as needed. This allows for a "self-corrective" strategy in which mistakes can be identified and corrected at almost any stage of the design (Gustafson & Branch, 2002).

Figure 1

Summary of Phases enacted during the ADDIE Model of Instructional Design

Summary of Phases During the ADDIE Model of Instructional Design
Analysis
Analysis of teacher needs and requirements
Analysis of student needs and requirements
Identification of instructional techniques and elements used to augment attention, interest, and engagement
Select digital video as hook medium
Design
Establish specific goals and objectives to be completed
Align design with the principles of Cognitive Load Theory
Align design with multimedia principles
Select curriculum relevant topics to base video content
Delineate design elements to be tested during "development" phase
Development
Refine and test the hook video content and specific design elements
Collaborate with camera operator through storyboarding process
Direct and record physics video hooks
Evaluation
Formative weekly evaluation based upon group meetings with corrections/modifications
Subjective expert evaluation by teachers/designers
Edits and revisions conducted

Analysis

The motivation behind the study arose from both a lack of curriculum specific multimedia resources for the Irish post primary/middle school science curriculum, and the declining number of students choosing to study physics (Drudy, 2011; Kennedy, 2014). Moreover, today's students, often defined as 'digital residents' (Connaway et al., 2011; White & Le Cornu, 2011) and are totally attune with multimedia and digital content, thus echoing the consideration of a digital based platform. However, following an examination of the ever-expanding web, the dearth of technology-based resources that are pedagogically designed for teachers and students was realised. To address such issues, a detailed analysis of the following areas took place: instructional techniques used to augment attention, interest, and engagement among students; student needs and characteristics; and teacher needs and characteristics. Analysis of these various components resulted in a comprehensive literature review, a brief snapshot of which follows.

Instructional Techniques Used to Augment Attention, Interest, and Engagement

Educators have long espoused the imperative role of attention, interest, and engagement in stimulating student learning (Dewey, 1913; Johnston & Roberts, 2011; Schraw et al., 2001). Hence the analysis phase revealed a theoretical and practical need for resources that specifically explore how the aforementioned constructs affect learning among the student body. Anderman et al. (2004) postulates that "[s]tudents often are not motivated to engage in academic tasks that are boring" (p. 1). Implicit within any theories of academic achievement, learning, and motivation is the assumption that the student will pay attention. Motivation, interest, and engagement theories are redundant if the student were to ignore instruction. Thus, attention is a necessary precursor of cognitive processing. Motivational theories, such as the expectancy-value theory (Wigfield, 1994) and goal orientation theory (Nicholls, 1984) are widely advocated among educators; however, these theories do not explain how instruction and tasks initially grab a learner's attention (Anderman et al., 2004).

A further difficulty in the analysis phase revealed that the constructs ‘attention’, ‘interest’ and ‘engagement’ are often used colloquially by educators as a way of referring to students being actively involved in a lesson, both cognitively and physically, and thus the credibility around their reference within the literature may be challenged. Furthermore, according to Renninger and Bachrach (2015) within modern educational literature; attention, interest, and engagement are seen as separate constructs with overlapping aspects. In appreciation of the complexity of the literature, and to narrow down the field search, the following search was conducted: an examination of instances where authors discuss instructional strategies used to augment attention, interest or engagement relative to hook-like teaching strategies.

The first record of which came about in the 1960s with a method known as “set induction.” Developed by Schuck (1969, 1970, 1981) and further developed by Perrott (2014), set inductions catch attention through the use of analogies that are relevant to the student. The goal of set induction is to demonstrate real world application of learning to students with the aim of increasing attention. Hunter (1994) expands on set induction and writes about “anticipatory sets” (p. 37). These are short activities used at the start of a lesson with the aim to capture student attention. They can take the form of a demonstration, statement, or question but should orientate students toward learning goals.

Several years later, McCrory (2011) formally introduces the term “hook” (pg. 97) into the scholarly conversation. McCrory argues that ‘engagement’ should be used to foster a positive learning environment, lending credence to demonstrations as an instructional technique to create anticipation, surprise, and curiosity. Complementing this finding, Zehr (2011) articulates the use of students’ personal interests as potential hooks. The pop culture icon “Batman” is given as an example that can be linked to many aspects of science and social sciences. From an educational technology perspective, Zavalani and Spahiu (2012) discuss the use of Virtual Reality (VR) as a hook. Using the novelty of new technology, they discuss how to promote student engagement by encouraging curious behaviour in class. Jewett Jr. (2013) adds to this growing body of literature and specifically discusses hooks in terms of promoting interest. Like previous scholars, Jewett Jr. promotes relevance-based pedagogies. He links physics to topics such as cooking, driving, and climate change. In addition to this, Jewett Jr, advocates for discrepant and novel based instructional techniques, termed “mysteries” or “magic” (p. 422), as ways to spark interest. Jewett Jr. notes “startling demonstrations can be used to raise student interest before moving onto the material” (p. 422).

Although the above literature is limited, it does provide a grounding for the “analysis” phase and the emergent design process for the video hook project. Key instructional techniques such as relevance, novelty, questioning and discrepancy have the potential to excel as hooks within the post primary/middle school classroom (students aged 11–15 years old). As potential ‘design elements,’ each strategy must be tested with regard to how they can be visually represented through the medium of video. Moreover, when using ‘relevant’ or ‘novel’ materials in education, an instructional designer must take note of any signal characteristics of their target student audience. In this regard, the design took account of its audience as “digital residents”, a concept which is detailed in the following section.

Digital Residents

Analysing modern student needs in the science classroom lead to the consideration of learning drivers. Duffy (2008) asks “how can we as educators engage the YouTube, Google-eyed generation?” (p. 119). Our target audience are often referred to as ‘digital residents’ (Connaway et al., 2011; White & Le Cornu, 2011) or millennials (Steffes & Duverger, 2012). Education today must compete with contemporary and instantaneous technology in grabbing student attention and maintaining their interest (Clifton & Mann, 2011). Such students command a wide range of digital resources to manage their social lives (Prensky, 2012). According to Clifton and Mann (2011), it is imperative that science education finds new ways of engaging such students. As such, technology was chosen as a transmission medium to provide a novel hook delivery method. Furthermore, as digital video becomes the dominant form of student learning (Ni et al., 2020) either formally in class, or informally beyond the classroom; digital video was selected as the platform.

Digital Video

As noted previously, the main consideration during the analysis phase is the target audience. In our case this refers to teachers and students within science (Peterson, 2003). From a teacher perspective, digital video was chosen due to its ease of use and dissemination. According to Andrews (2012) video can be ‘pulled’ by learners and ‘pushed’ by teachers.

This means that learners can access the video at any time and teachers can present the content in a suitable pedagogical manner. Learners have increased control over their learning pace (Andrews, 2012) and teachers, through stopping and starting the video can achieve a 'bite size' delivery suitable to their needs (Fill & Ottewill, 2006).

From a student user perspective, the demographic of YouTube users aligns with the current demographic of students. Therefore, they are more likely to identify with the content (Steffes & Duverger, 2012). According to Jones and Cuthrell (2011) students make positive gains in learning outcomes from the inclusion of video technology in the classroom. Furthermore, video can also display hard to capture phenomena that are common in physics. It has the ability to present both static and moving material with additional animation to further highlight focus points (Harwood & McMahon, 1997). Video provides an information rich and realistic context, referred to by Kumar (2010) as "macro-contexts" (p. 14). This allows educators to teach about the processes and nature of science (Vaughan, 2004). Adding to this, Gilbert (2005) states that "[c]onveying process in static diagrams is not straightforward" (p. 37). Processes normally involve fluid movement and changes in structure. Students who find mental visualisation difficult are at a disadvantage in a science curriculum based on static diagrams. Therefore, physics video hooks have the potential to bring to life a number of moving processes grounded in a realistic context to benefit learners and teachers alike.

Although one of the notable criticisms of using video as the hook delivery method is that many science videos can be found online especially on YouTube; the abundance of such resources can be burdensome, in narrowing down to the appropriate selection. Often video quality is lacking and videos are not entirely fitting or correct for teaching and learning environments (Trier, 2007). Furthermore, Michalovich & Hershkovitz (2020) found that perceived scientific credibility is linked to the perceived video quality. They also note the users' history, and note that working with, and watching video on the platform can influence their perception of content. Another problem is commercials within video and suggested videos on the website that may not be appropriate for the classroom (Trier, 2007). Additionally, the structure of a YouTube video for example, may not be suitable for instructional use, as many videos are lengthy, contain inapt language or are confusing and distracting (Berk, 2009). In consideration of these numerous issues around digital resource development (e.g. the need for clear language, short video bites, curricular alignment etc.) the hook videos are specifically built for the science classroom, underpinned with the Irish science syllabus. The content is wholly relevant to science teaching. Furthermore, teachers do not have to search for the videos as the entire suite is available at the following website: www.sciencehooks.scoilnet.ie/physics.

Design

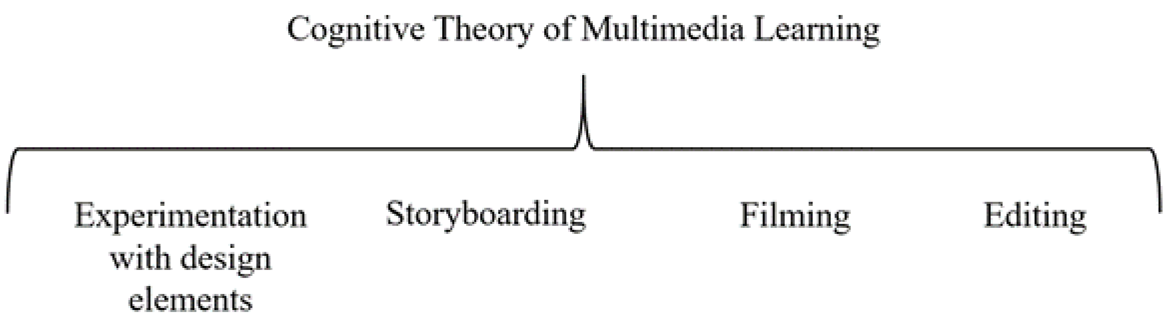
The analysis phase provides an informed context for the design phase, in this instance, of the physics video hooks. The design phase includes the identification of objectives to be completed and elements to be built into the videos (Peterson, 2003). During the design phase, objectives are defined that would embed a theoretical framework into the videos based upon the principles of a) cognitive load theory and b) multimedia design. Such principles are integral to the design and creation of the physics hook videos, as moving images present new pedagogical hurdles to be overcome (Gilbert, 2005). Moving images are a natural way of presenting processes and this is one of the reasons for student enthusiasm. However, they are often far too fast and complex to be adequately perceived (Kozma, 1986; Spanjers et al., 2011). There are sometimes too many moving parts occurring at various times. The mind and the eye are working together to figure out the process, but often cannot keep up. Some students find it hard to identify what to focus upon (Gilbert, 2005). Given the above, cognitive theories of multimedia learning acted as key design considerations that framed the video hooks all the way from storyboarding to editing. These design considerations are elaborated upon directly.

Cognitive Theory of Multimedia Learning

The following sections delineate the design framework and design elements that are essential to all elements of hook videos. All of this work is conducted through the lens of cognitive theories pertaining to multimedia learning (Mayer, 2005). A model demonstrating the approach in this study is displayed in Figure 2 below. It should be noted that the steps Storyboarding, Filming and Editing do not occur in a linear fashion and are activated and adapted intermittently throughout the process when required. They are thus discussed periodically in the sections that follow.

Figure 2

Model Showing How Cognitive Theory of Multimedia Learning (Mayer, 2005) Influenced All Other Facets of the Design Process for Video Hooks



Essentially, items presented in a video format should be made as simple and as legible as possible, to aid cognitive processing and the various techniques described. Cognitive load is concerned with the difficulty level of the material to be learned (Ayoob et al., 2020). To reduce load, information needs to be structured in a manner that reduces difficulty (Sweller, 1994). Cognitive load theory posits that the capacity of working memory is limited. Hence, pedagogy needs to be cognizant of potentially overloading working memory and restricting learning (De Jong, 2010). As such, the design of instruction should be optimized to avoid cognitive overload (De Jong, 2010; Smith & Ragan, 1999), a design goal of the physics video hooks. As explained by Mayer and Moreno (2003), cognitive overload is an issue when processing demands exceed the learner's cognitive capacity. This is described as a "central challenge for instructors (including instructional designers) . . . " (p. 45). The following strategies (Redundancy Principle: Signalling and Weeding; and two strategies that promote deep learning through multimedia design: Multiple Representation Principle and Split Attention Principle), are set out in the design phase to reduce cognitive load on students. These principles are detailed forthwith.

To impactfully reduce cognitive load, instructional designers are advised to streamline content by following the 'Redundancy Principle'. Videos should be streamlined, involving the removal of any extraneous material that may inappropriately distract student attention. Student attention should be directed toward essential information (Berk, 2009; Mayer & Moreno, 2003). The two main streamlining methods include signaling and weeding. Signaling limits words and narratives, however, it highlights certain sections of interest or application (Spanjers et al., 2011). Signaling involves the highlighting of objects to focus attention. Such cues orientate the student through a video and facilitate the extraction of essential information. This also reduces extra cognitive load as the learner does not have to try to locate the most vital aspects intended for comprehension (Mayer & Moreno, 2003). Signaling is enacted by placing words on screen at pivotal times. The example in Figure 3 is asking the viewer to explain the phenomena being observed by placing the word 'Explain?' on the screen.

Figure 3

Screenshot from the Sink or Float Physics Video Hook Exhibiting the Signaling Principle

The second process is weeding where irrelevant information is removed from a multimedia project. This principle applies to sounds, words and visuals. Irrelevant information diverts attention away from the intended focus (Mayer & Moreno, 2003). Given this, the physics video hooks are kept as simple as possible.

The former strategies of signaling and weeding reduce the cognitive requirements of the learner when interacting with multimedia content. However, certain strategies can be used to augment deeper learning, and this is especially important for video. In terms of multimedia design, deeper learning occurs when words and images are used over words alone (Ayoob et al., 2020; Mayer, 2002, 2003; Paivio, 1969, 1990). The promise of multimedia is that students can learn more effectively from well-designed multimedia applications combining both visual and word-based platforms rather than traditional forms of instruction. Words are a single medium presentation format and the dominant vehicle for instruction (Mayer & Moreno, 2003). However, humans are adapted to interact with moving visual images, similar to those we encounter on a daily basis. Winkler (2005) states that “80–90% of all neurons in the human brain are estimated to be involved in visual perception” (p. 5). Humans naturally gravitate toward visual stimulation and this is potentially why Vaughan (2004) posits that multimedia can ‘electrify’ the action centres of peoples’ brains. Pertaining to multimedia design, there are two principles that are instrumental in the physics video hooks.

The first is the multiple representation principle that suggests that it is better to present information in word and pictures rather than one alone. Two modes of representation are better than one. An example of this is highlighted in Figure 4. This is known as the multimedia effect (Mayer & Moreno, 1998). This principle suggests that multiple formats provide multiple platforms on which retrieving information is possible (Kalyuga et al., 1999).

The second is the split attention principle of multimedia, which states that words should be delivered in an auditory manner rather than visually. Narration and visual information are processed differentially (Mayer & Moreno, 1998). The human eye can only observe a certain amount of concurrent information and this is where narration can help (Mayer & Moreno, 2003; Koć-Januchta et al., 2019). That is, it can be challenging to read excessive on-screen text while simultaneously focusing on the intended image. Hence, narration is used when one or two words on screen are not sufficient to explain the phenomena being demonstrated and the multiple representation principle is not appropriate. As recommended by Berk (2009) and Mayer (2005) the narrative is written in everyday and non-scientific language. Thus, narration formed an integral part of the video hook design.

Figure 4

Screenshot of the Energy Conversions Physics Hook Video Displaying the Use of the Multimedia Principle with Words and Corresponding Image

Experimentation with Design Elements

As noted previously, the analysis phase examines instructional techniques that can act as potential hooks. The specific list of instructional techniques includes: a) Relevance, b) Questioning, c) Discrepancy and d) Novelty. These techniques are positioned as the design elements of the video hooks. A scientific laboratory provided the facility to test out the visual appeal of experiments that were linked to curriculum relevant topics. The designers assess experiments by examining ways in which they could be storyboarded with cognisant consideration of their ease of transition to a film format. This is one of the most pivotal steps in the *ADDE process as it develops and tests the core video content. Many experiments were trailed and not used. An example of which is the 'solar oven'. In this experiment, sunlight is reflected into a box and used to cook food or melt marshmallows. Based on the discrepancy design element, the idea was rejected as the experiment is reliant on a sufficient amount of sunshine. Moreover, aspects of the experiment such as sun rays and heat are completely invisible to the viewer. In addition, not being able to show the method of action in the video meant that the solar oven was not legible to a novice audience and therefore did not align with the cognitive theory of multimedia learning that framed all parts of the design phase.

To further illuminate this process, the following sections explore the four design elements. Starting with relevance, successful examples that made it through experimentation, storyboarding and editing are demarcated.

Design Element 1: Relevance

Numerous authors note the importance of relevance in education for creating interest in a topic (Osborne et al., 2003; Pikaar, 2013; Roe, 2011; Rotgans & Schmidt, 2011). The relevance strategy is twofold. Firstly, relevance is constructed throughout the videos by using items students would find and see in everyday life. This ranges from foodstuffs such as maple syrup and honey to hardware such as hammers and simple aluminium cans (Figure 5). This approach enables the viewer to observe how interesting and engaging scientific experiments and phenomena can be constructed with objects students encounter on a daily basis.

The second relevance strategy is to align with curricular relevant content. The omission of extraneous content strengthens the relevance both for both teacher and student. Further to this, cross-curricular links are also integrated within the videos. Links to art, music and in particular mathematics are emphasised to broaden the scope and appeal of the videos and to show the various connections between science and other subjects.

Figure 5

Displaying Everyday and Relevant Materials Used in the Density Hook

Design Element 2: Questioning

The basic premise of the questioning strategy is that questioning facilitates attention (Bergin, 1999), one of the primary constructs of a lesson hook. The physics hook videos use two types of questions, lower order and higher order. This is heavily dependent on the content of the video and when opportunities for questions within footage presented themselves. The following are examples of generic questions either presented on screen or asked by the narrator of the videos.

a. “Can you explain this?”
b. “What is happening here?”

The questions are very simple and direct students thinking toward the discrepant phenomena within the video. They are employed to focus and direct the viewer’s attention.

The second type of question is a higher order more complex question. For example, during the pressure video in which a balloon is pressed against a bed of nails and then against one nail, the narrator asks –

a. “Why was the balloon safe on this bed of nails, but popped on this one nail?”

The second strategy is employed at the end of the videos so that students are left pondering about the science behind what they observed. After these questions are asked, the video ends. This open nature of the videos is key to their design as a classroom resource that is used to ‘set up’ teachers and their bespoke learning environment.

Design Element 3: Discrepancy

The presentation of discrepant events in class has a strong potential to stimulate attention and interest among students (Bergin, 1999; Cakir, 2008; Edelson, 2002; Thornton & Sokoloff, 1998). Discrepancy is a method in which an educator presents a phenomena that does not make sense or has associated misconceptions (Broughton et al., 2010). When designing the physics video hooks, efforts were made to create effects or visuals that look impossible or implausible, similar to magic tricks. Such a technique presents a student with a gap in their knowledge that has the potential to spark interest (Bergin, 1999; Edelson & Joseph, 2004; Rotgans & Schmidt, 2011). An example of which is illustrated in Figure 6. A screenshot from the centre of gravity video hook is displayed, in which a meter stick and sledgehammer are balanced off a table with string. It is not intuitive to explain why the items are balanced and therefore attempts to create a discrepancy within the video for students to notice.

Figure 6

An Example of a Discrepant Event in the Centre of Gravity Physics Video Hook (McHugh & McCauley, 2017)

Design Element 4: Novelty

The final design step involves the design team's deliberate consideration of ideas that make the videos novel. In this regard, it should be noted that the aforementioned discrepancy strategy also works on the basis of novelty. The two are heavily interlinked. According to Silvia (2008), novelty may result in greater attention, interest, recall and behavioural intentions. Novel events act as a form of surprise (Itti & Baldi, 2009) which rely on the uncertainty of prior beliefs. This unpredictability impacts on all stages of neural processing indicating that novelty within a hook may augment attention, interest and engagement. Thus both novel and discrepant events were considered as strategies to draw and hold students in the learning moment.

Development

The development phase, drawing upon the results of the former phases, involves the construction of a product (Peterson, 2003). The physics hook videos display numerous scientific phenomena which required verification in the laboratory to establish their ease of use and appropriateness for a visual medium before filming. Once testing was complete, a list of ten physics-based topics with ten storyboards were developed. These included: atmospheric pressure, centre of gravity, conservation of energy, convection, density, energy conversions, friction, pressure, sink or float and sound. A storyboarding process was used to document exact shots and transitions. Storyboarding provides a particular type of diagram for efficient communication between design members (Shi et al., 2020). The diagram attempts to convey in static pictures the flow and shots of a finished video or film (Goldman et al., 2006). A professional cameraperson was hired to film the video hooks. Videos were directed by the teacher designers in close collaboration with the cameraperson. This took place in a laboratory setting over the course of two days. A 7D Canon camera was used for filming with the Adobe Premiere Pro CC.4. software suite used for editing.

Enhanced Evaluation

The enhanced evaluation phase in this project involved both formative and summative evaluation. In terms of formative evaluation, weekly meetings were organised throughout the eight weeks to critique and assess the work that had been conducted by the three pairs of teacher designers. This was a collaborative effort chaired by the project lead. Each teacher design team presented on embryonic and developed ideas which were challenged by fellow design teams. The fact that opposing teams were out of field teachers further challenged designers to explain the science simply. Changes were identified and modifications made to improve the end product. This evaluative step provided formative feedback that interlaced each step of the *ADDE model. A similar formative evaluation process is conducted by Moradmand et al. (2014) in which evaluation is present during every phase of instructional design. An additional summative evaluation is built into the project enhancing the overall evaluation process, to compensate for not being able to conduct a full-scale implementation phase. Although conducted near the end of the project, the summative evaluation was timed to allow changes to be made to the video hooks. Briggs et al. (1991) state that products should be tried out on members of the targeted population. The target population is both teachers and students. Hence, for the enhanced evaluation, it was decided to invite members of the other design teams (pre-service science teachers) to critique the videos from a science teacher perspective and to welcome critical subjective expert opinions. Teacher evaluation is an appropriate strategy as teachers are the gatekeepers to their own classrooms. If a resource does not fit their teaching criteria, then it will not be implemented within the classroom and will not reach the second user group of students. Thus, the enhanced evaluation allowed the videos to be revised upon the user needs.

The two separate pairs of teachers who worked as designers on biology and chemistry hooks critiqued the physics hook videos, highlighting their user needs as teachers. They also evaluated the instructional products based upon the following criteria:

a. The characteristics of target teachers
b. The characteristics of target learners
c. The characteristics of intended learning environments

This provided two sets of user feedback based upon a needs assessment from four teachers in total. This is what Briggs et al. (1991) denote as subjective expert opinion in which an expert is asked to render an opinion in relation to a product, procedure or programme. Although in many instances, the opinions generated from these scenarios can often be personal, and thus limited in this regard; “experts can usually provide insights for decision makers that are absent from more objective methodologies” which in the case of this research was a full scale implementation (p. 228). Edits and revisions were conducted based upon the user generated feedback.

Project Considerations and Limitations

Project limitations are detailed here relative to framework selection, design elements and consideration of a collaborative stance.

Framework Selection

Before the initiation of the project, one of the challenges faced was to find an instructional design framework that ‘fit’ the project. The ADDIE framework was employed and modified. Other frameworks including the ‘Pebble in the Pond' design (Merrill, 2002) and the ‘Spiral Model’ as described by Goodyear (2013) were considered, however their emphasis was dependent on in-classroom teaching strategies. Although the ADDIE framework also considered an implementation phase, the adapted *ADDE framework provides a comprehensive model that demands a robust design, testing and evaluation phase as sought. Originally, the ADDIE model was used because of its simple layout and approach to design. The application to the resource design described here was found to be particularly useful for novice designers. An implementation phase would have been desirable; however, it would have been wholly impractical within the remit, time and funding restrictions of the project. When discussing the process of instructional design, Jonassen (2008) notes that “[d]ecisions are driven less by accepting principles than they are by constraint satisfaction and beliefs, some of which are culturally accepted and others are context specific” (p. 21). In the design process described in this paper, decisions were made based upon content specific constraints to enable the completion of the project. Additionally, Jonassen raises the problem of adhering too closely to instructional design models, when they can be a limiting factor to some projects. This was initially problematic, yet design in itself is a problem-solving process and *ADDE was the most efficient route to follow, providing a solution to our context specific problem. Jonassen continues and characterises successful design as one that “must address the constraints imposed by the context” (p 26). As such, constraints must be addressed by decisions, in this instance, the decision was taken to modify the design process to accommodate our constraints and goals.

Design Elements

One of the biggest quandaries that arose during the design and development phases of the project was how to build the specific design elements of relevance, questioning, discrepancy and novelty into the videos. The video suite includes physics topics that are more suitable to the incorporation of some design elements over others. Every design element was not used in the creation of every video hook. An example of which is the use of a tuning fork in the sound video. This item does not abide by the relevance strategy as it is not be an everyday object for a lot of students; however, some students may find it novel.

Indeed, the design element of novelty proved to be the most difficult to build into the videos. The challenge being: How can you judge novelty? What is novel to one student may be mundane to another. Videos are aimed at digital residents, however one questions if the videos are novel enough to stimulate the attention, interest and engagement of a potential cohort of students who are competent with YouTube and Web 2.0 applications? Our novelty strategy is to use everyday items in unusual ways and testing this with students would have demonstrated its potential. This is where the *ADDE instructional design framework is lacking most, and an implementation phase would have been beneficial.

Collaborative Development

Gilbert (2005) postulates that visualisations in science require excellent design input from both an educational and scientific perspective. In achieving this, discourse is advised between scientists, teachers and technologists. Collaboration leads to more effective interventions. However, it could be argued that it would have been beneficial if teachers perform every part of the development phase so that a clear and concise vision can be achieved. None of the designers had any experience with cameras or filming. The cameraperson had limited knowledge of science. Therefore, this created a knowledge gap that could not be bridged fully. Making the link between the teacher and the cameraperson meant that certain aspects of the videos do not capture phenomena in the way originally intended due to camera and angle restrictions. This is a problem if there is limited filming time for every video. The storyboarding process noted earlier did not ameliorate this negative effect. In future, this could be combated by the teachers/designers filming the phenomena using tablets or phones to acquire a rough idea of what will look good on camera and this mock video then to be shared with the camera operator to further inform planning. Other options include teachers and designers gaining camera experience to film the videos themselves or the cameraman forming part of the design team throughout every phase of the project.

Conclusion

This article describes the design process involved in the creation of physics video hooks. It is argued that the adapted instructional model in the form of *ADDE is highly suitable for the creation of video content for the science classroom. The videos are aligned with cognitive theories of multimedia learning which proved to be an effective alignment for the creation of the videos. Some specific design elements worked better than others. The main constraint was not being in a position to assess the videos from a student perspective. This is where the implementation phase of the ADDIE framework would have been beneficial. However, a formalised intervention process is currently being undertaken in schools.

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