Development and evaluation of physics podcasts as instructional materials for grade 9 High school students

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ABSTRACT

Several educational researches identify factors that can account to the poor performance of Filipino students in understanding concepts in physics. Some of these factors include the teacher's quality, student's attitude towards physics and the lack of instructional materials in teaching physics. The provision of effective and appropriate instructional materials can help address these setbacks, and thus, improve the quality of academic performance among the students. As an innovative instructional material, podcasting captures the attention of many educators. It is an alternative means of delivering content using audio files. This study involved the development of "The Physics Station", a collection of 13 podcast episodes about different physics topics and their application to everyday life. It followed the 4 stages of podcast development, namely: (1) Planning and organization, (2) File production, (3) Web subscription and publication, and (4) Delivery and playback. With this intervention, they were utilized as instructional materials given to Grade 9 high school students of a laboratory school in Paciano Rizal, Bay, Laguna. After which, students evaluated all podcast episodes by answering an instrument entitled, Instructional Materials Motivation Survey (IMMS). Results showed that among the ACRS model, the Relevance sub-component had the highest mean score. Further, this implies that for any instructional materials or teaching approaches to be implemented inside the classroom, its relevance and meaningful connections should be considered to engage the students more and thus, promote lifelong learning.

Keywords:
Podcast production
Physics education
Instructional material development
Luzon, Philippines

Introduction

Instructional materials play an essential role in the overall teaching and learning process. They facilitate the transmission of knowledge, stimulate active thinking, concretize conceptual understanding, and develop student's skills and abilities (Effiong, 2015; Stephen, 2015). As early as 1980s, Ellington (1987) reviewed and enumerated seven different types of instructional materials, namely: (1) printed and duplicated materials; (2) non-projected display materials: (3) still projected display materials; (4) audio materials; (5) linked audio and still visual materials; (6) cine and video materials; and (7) computer aided materials. However, despite these various means of content delivery, there is still a pressing gap between pedagogy and the learning styles of the students nowadays. Millenials as they are called, today's students are multi-taskers, technologically-stimulated and highly achievers (Monaco & Martin, 2007). Their levels of exposure and engagement in the internet do not necessarily translate to lifelong learning. Thus, it is very crucial to develop updated and appropriate instructional materials to engage, equip, and empower the 21st century learners.

As a type of technology-based instructional material, podcasts remain a resource yet to be tapped to better facilitate learning among students (Scutter, Stupans, Sawyer, & King, 2010). A podcast is a digital media file that plays audio and/or video components that can be downloaded and/or streamed online (Salmon, Mobbs, Edirisingha, & Dennet,

2008). Its purpose is primarily for entertainment and for mass distribution of various audio files. Studies have reported positive feedback on the use of podcasting in education because it encouraged active learning inside the classroom. Studies have indicated increased in the conceptual understanding and enhanced motivation among the learners (Edirisingha, Rizzi, Nie, & Rothwell, 2007a; Edirisingha, Salmon & Fothergill, 2007b; Morris, 2010; Ng'ambi &Lombe, 2012; Scutter et al., 2010).

Clearly, such technology tools can be utilized to improve the overall quality of education. Realizing this potential, the researcher developed a collection of 13 podcast episodes entitled, "*The Physics Station*". Each episode featured the conversations of Nick and Chloe discussing about different physics topics. With its development, they were utilized as instructional materials integrated to the conventionalphysics lecture classes of Grade 9 high school students.

Podcasting as an ICT Tool in Education

As a new trend in technology, podcasting is becoming more popular as an educational tool as it deviates from its original purposes in entertainment and journalism. In fact, in 2005, the New Oxford American Dictionary has declared the term "podcast" word of the year. By definition, podcast is a digital media file that plays audio and/or video. It can be downloaded from a website and be played on any portable players that are designed to play sound (Salmon et al., 2008). Cebeci and Tekdal (2006) expressed these features in a formula as follows:

> *Podcasting = Web syndication (RSS, Atom) + Audio content (talk shows, music, news and certain learning resources…) + Mobile devices (MP3 players, PDAs, cell phones…)* (p.48).

According to Bennett (2007), podcasts can be categorized into three, namely: (1) audio, (2) video, and (3) enhanced podcast. Audio podcast is the simplest among the three since it contains sounds only. It is relatively easy to make, requires a small storage space and thus, involves faster file transmission. The second type is the video podcast that contains both sound and imagery, such as moving and still pictures. Often, it is called vodcast because it can be played on devices with larger displays. It is more complicated, time-consuming and a little more extensive since they require good video editing skills (Bennett, 2007; Salmon et al., 2008). Lastly, the enhanced podcast is the extended version of audio podcasts capable of displaying additional information like chapter markers, web links, and other still images. The most common educational form is a slide presentation (PowerPoint, Keynote, etc.) with an audio track. Its main advantages include its small file size compared with a video podcast and its chapter markers. These markers aid the listeners in their navigation by allowing them to jump from one chapter to another (Hurst &Waizenegger, 2006; Salmon et al., 2008).

Currently, the practice of podcasting are evidently applied in K to 12 curriculum and higher education settings. Rossell-Aguilar (2007) illustrated a taxonomy to classify these practices. The process can be divided into two main groups (Figure 1), namely: (1) creating own materials, and (2) using available existing podcast resources. Creating one's own podcasts can be further classified into (a) podcasts developed by teachers, and (b) podcasts developed by students as projects. There may also be a collaborative project between the teachers and students.

Teacher-created podcasts can be divided into lecture podcasts and supplementary learning materials. Lecture podcasts refer to audio recordings of lectures (Copley, 2007); while supplementary podcasts refer to audio recordings that aid student learning and provide support in relation to the core learning materials (McLoughlin, Lee, & Chan, 2006). Existing podcast resources are usually embedded and/or linked to a webpage. Podcasts can also be compiled and distributed by various agencies through CDs/DVDs and USB drives.

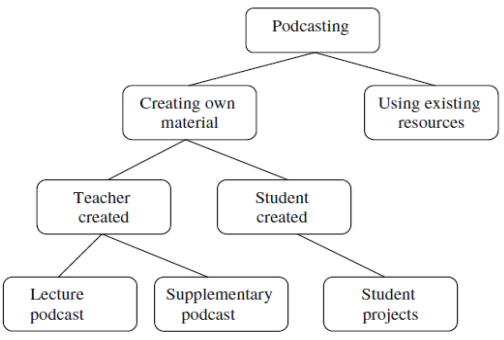

Figure 1. Taxonomy of Practices used in Podcasting by Rossell-Aguilar (2007), p. 337.

Many research findings have reported that integrating podcasts in pedagogy resulted to increased, positive, and enhanced learning among students (Edirisingha et al., 2007a; O'Bannon, Lubke, Beard,& Britt, 2011; Parson, Reddy, Wood & Senior, 2009; Taylor & Clark, 2010). As it is tightly coupledon lecture discussions, podcasting is a powerful tool to complement traditional resources on a course. Theycan serve as supplementary tools to enrich content previously presented in class. Since the students already had an initial encounter with the contents of the subject, there is an increase the level of understanding among them. In effect, it allowed them to have valuable learning experience in the subject matter (McLoughlinet al., 2006). In other researches, the benefit of podcasting is evident on the students behavior prior the classroom discussions. Results showed that the podcasting method was an ideal medium for addressing preconceptions and alleviating student's anxiety about a subject and its content (Chan & Lee, 2005).

Consequently, this new and emerging technology makes mobile learning possible for learning is no longer tied to a particular location. Ng'ambi and Lombe (2012) also pointed out that podcasting offers flexibility and self-control to the learners. As the students explore this new learning tool, they also develop greater confidence and a sense of autonomy in building their own knowledge. Clearly, the use of podcasts promotes an "*anytime, anyplace education*" (Chan & Lee, 2005).

Methodology

Research Design

As illustrated in Figure 2, the study involves the development of 13 podcast episodes, collectively called as *"The Physics Station"*. They were implemented as instructional materials integrated to the conventional physics lecture classes of Grade 9 high school students from a laboratory school in Laguna, Philippines. After the 8-week intervention, students evaluated the podcast episodes by answering an adapted 5-point Likert scale instrument entitled, Instructional Materials Motivation Survey (IMMS).

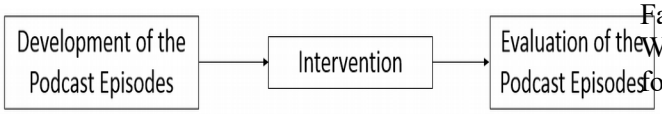

Figure 2. Research design of the study.

Sample

Two intact sections of Grade 9 high school students of a laboratory school at Paciano Rizal in Bay, Laguna served as the participants in the study. They were composed of 80 students, with age ranges from 14-16 years old. Overall, there were 35 male students and 45 female students.

The Instrument

After the intervention, an instrument entitled, Instructional Materials Motivation Survey (IMMS) was adapted and administered to the students. Originally, it was created by John Keller in 1987, then modified by Bollinger, Supanakorn, and Boggs (2010) to specifically measure student's motivational responses in utilizing podcasts as instructional materials in online learning environment. It is composed of 36 questions with a 5-point Likert scale items. Each question on the IMMS corresponds to one of the sub-components of ARCS model, namely: Attention, Relevance, Confidence, and Satisfaction. It is a valid instrument and has documented to have a reliability coefficient of .96 (Bollingeret al., 2010).

Intervention

For eight weeks, students were exposed to podcasts as instructional materials to complement their conventional lecture classes. An online group in Edmodo was created where they could access such materials. They were instructed to listen to the podcast episodes prior every classroom discussion. After the intervention, a survey was administered to them to measure student's level of engagement in using podcasts.

Results and Discussion

Development of the Physics Podcasts

The "*Physics Station*" is a collection of 13 podcast episodes, which was developed by the researcher. Each episode lasted for 15-20 minutes that featured the conversations of its two hosts, Nick and Chloe about the following physics topics: (1) Introduction to Physics, (2) Famous Physicists and their contributions, (3) Work, (4) Power, (5) Energy and its many forms, (6) Conservation of Mechanical Energy,

(7) Center of gravity, (8) Torque, (9) Uniform Circular Motion, (10) Law of Planetary Motion, (11) Universal Law of Gravitation, and (13) Heat and Temperature. The researcher followed the four stages of podcast development as identified by Aristizabal (2009), as shown in Figure 3.

Stage 1: Planning and Organization

The first stage of podcast development involved the planning and organization of content. The researcher designed the storylines and script for the podcast episodes. Scripts were then drafted with great considerations on the content and depth of discussion, maintaining a simple conversational approach in explaining physics concepts, and the retaining interest level of the students. Experts from the Institute of Mathematical Sciences and Physics in UP Los Baños and physics teachers from other schools in Laguna reviewed the script. The researcher revised the scripts based on the experts' recommendations. The scripts were finalized with the inclusion of segment breaks and sound effects ready for recording.

Stage 2: File Production

After the finalization of the scripts, the recording of each podcast episode commenced. The researcher hired two voice actors who were knowledgeable in the technical aspects of podcast production. The voice actors helped the researcher in recording, editing, and producing all podcast episodes.

Nick was the male host of the podcast. In the episodes, he was characterized as the person who knew many different concepts in physics and how they can be applied to everyday life. On the other hand, Chloe was the female host with an inquisitive character who wanted to learn more about physics. A conversational type of program was the main approach of the podcast series.

Simple recording equipment, such as a microphone and laptop were used to record and edit all the podcast episodes. Each episode contained 8 different segments, which were not necessarily be in order for every episode: (1) objectives of the podcast, (2) opening segment, (3) conversation of the hosts, (4) discussion of the physics concepts, (5) segment break, (6) thinking time, (7) recall, and (8) closing segment.

Table 1 shows the different segments of the program for each podcast episode. The segment description and an excerpt from different podcast episodes were also presented to correspond to a specific part of the program.

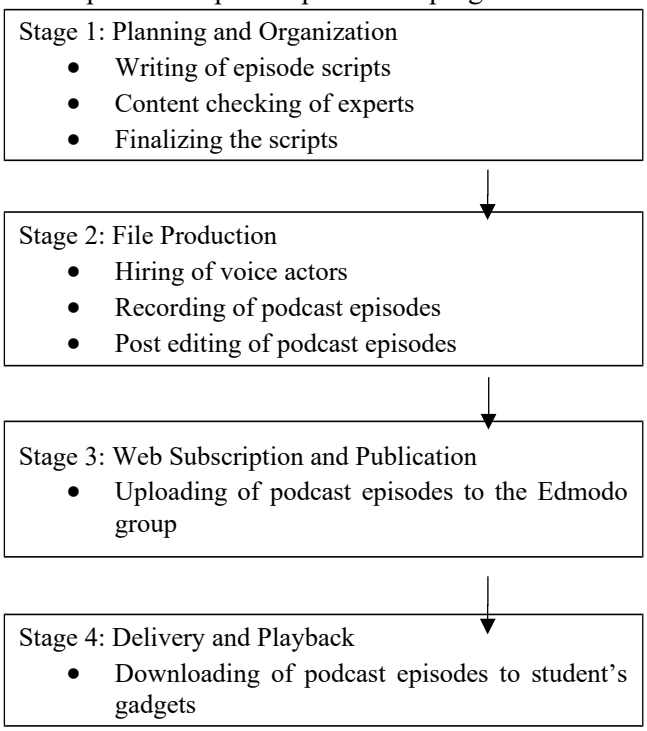

Figure 3. Stages of the Development of the Physics Podcast Episodes.

Table 1. Segments of the Program and Excerpts from the Different Podcast Episodes

Flow of Program	Segment Description	Podcast Episode Title and Time	Excerpt
1. Objectives of the podcast	This segment includes the objectives that should be achieved by the students after listening to the podcast.	Episode 1: Introduction to Physics (00:00 to 00:15 minutes)	Nick: *After listening to this episode, you must be able to:* *a. define Physics;* *b. enumerate various sub-branches of Physics;* *c. describe different concepts covered in Physics; and* *d. cite applications of Physics to everyday life.*
2. Opening segment	This includes the introduction of the hosts and what the podcast was all about.	Episode 2: Famous Physicists and their Contributions (00:24 to 00:45 minutes)	Nick: *Hello there Ruralites! You are now listening to the Physics Station, a podcast that talks about everything and anything about Physics. I'm your host, Nick.* Chloe: *Well, yes! This is not your ordinary podcast! The Physics Station is especially designed for you to learn more about the amazing works of Physics in our everyday life. I'm Chloe! And I'm your co-host for today.*
3. Conversation of the hosts	This pertains to the storyline in which the whole episode revolved, with relation to the physics concept to be discussed.	Episode 11: Laws of Planetary Motion (01:09 to 01:40 minutes)	Nick: *Whooh! What's up with those eyebags?* Chloe <SLEEPY>: *Haay! You're right! Look at them, they are so big!* Nick: *What happened? How's your sleep last night? Or should I say, have you slept last night? Hahaha! Just kidding!* Chloe: *Oh you! Just stop it! I really had the weirdest dream last night! And I felt so awake. I felt like I was not dreaming at all. It'ssoooreaaal!* Nick: *What's your dream about?*
4. Discussion of the physics concepts	This segment provides the explanation and content deepening of the physics concept discussed in the podcast episode.	Episode 5: Power (06:54 to 07:30 minutes)	Chloe: *So if work done is held constant, the only factor that will affect the difference in our power rating is… time!* Nick: *Yes! Time! And what do you think is the relationship of the amount of time to the power rating?* Chloe: *Hmmm... let me see, if power is work over time… time is found in the denominator of the ratio. Hmmm… That goes to say that, time is inversely proportional to power!* Nick: *Absolutely! The shorter time it takes to finish a certain amount of work, the greater will be the power rating. Inversely proportional!* Chloe: *That's right!*

5. Segment break	This segment incorporates additional information about the physics topic, which may be a trivia or historical background related to it.	Episode 8: Center of Gravity (14:10 to 14:38 minutes)	<INSERT SEGMENT BREAK> Voice Over: …*Human proportions have been important in art, measurement, and medicine. Although the human body has complicated features, the location of the center of gravity could be a good indicator of body proportions. In the anatomical position, the center of gravity lies approximately anterior to the second sacral vertebra. However, since human beings do not remain fixed in the anatomical position, its precise location changes constantly with every new position of the body and limbs….*
6. Thinking time	This portion gives students time to reflect and answer the questions posed by the hosts.	Episode 3: Work (11:40 to 12:25 minutes)	Chloe: *Hmmm... What if the father pushes the grocery cart twice as much as he pushes it? What do you think will happen to the work done on the cart?* <SOUND EFFECTS: REFLECTION TIME> Chloe: *The work done will also be doubled because the force applied in pushing the cart is also increased twice as much. The magnitude of the force applied and the work done on the object is directly proportional.* Nick: *You are so bright! Haha! Now, it is your time to shine! Can you think of another example of work done. Are you ready? Thinking time starts now.* <SOUND EFFECTS: REFLECTION TIME>
7. Recall	This includes the summary or generalization of the physics concepts discussed in the podcast episode.	Episode 13: Heat and Temperature (13:17 to 13:51 minutes)	Chloe: *Whooh! I have learned so much about Thermodynamics, including the concepts of temperature and heat.* <INSERT PROGRAM MUSIC> Nick: *So let's recall again, temperature is the measure of the degree of hotness or coldness of a body. It is proportional to the average kinetic energy of the object.* Chloe: *Yes! And we can measure temperature by simply touching. However, even if it is the most practical way of measuring temperature, it is less accurate.* Nick: *How then can we measure temperature with more accuracy?*
8. Closing segment	This includes the final regard of the hosts and teaser for the next episode.	Episode 9: Torque (13:13 to 13:38 minutes)	Chloe: *Tune in again next time for another episode of the Physics Station. My name is Chloe!* Nick: *Study your lessons for the next quiz! And my name is Nick! Signing off.* <INSERT PROGRAM MUSIC> Voice Over: *Did you enjoy today's episode? Wait for the next one! And it's all about UCM! U-C-M? Haha! Find out why!*

During the recording of the podcast episodes, four aspects were taken into consideration, namely the (1) pacing, (2) tone, (3) background music, and (4) length of the podcasts. The voice actors were reminded not to speak too fast because students may not understand or have difficulty following what they were saying. On the other hand, a reminder not to speak too slowly was also emphasized because other students may consider the podcast unattractive and boring. Moreover, the voice actors were advised to sound friendly and maintain a more conversational tone. In this way, students were engaged in listening to the podcast. Emphases for important key points were demonstrated by consistently repeating such topics all throughout the podcast.

Another consideration was a good choice of background music. A catchy program music and appropriate sound effects were chosen to enhance student's listening experience. They were also used for transition between segments and cue for the next segment. Finally, the length of each podcast episode was limited to 15-20 minutes only. Beyond this time limit, students tend to be distracted and may no longer be attentive to the discussion of the physics concepts.

Post editing and content mixing of the recordings were done using audio-editing software called Audacity. The recordings were arranged to have a smooth transition between different segments. Program music and sound effects were also

incorporated in the process. The experts then assessed the finished episode for a second round of evaluation.

Stage 3: Web Subscription and Publication

While using a website with RSS (Really Simple Syndication) was recommended to feed the podcasts on the internet, the researcher opted to upload the podcast collection to the Edmodo group of the students. This online group was created for the students to access and download the episodes. The home page of the Edmodo website was shown in Figure 4.

Stage 4: Delivery and Playback

Once the podcast episode was uploaded, the students accessed the podcasts online through their mobile phones, laptops, and/or tablets. When they clicked the icon, the podcast played automatically, as shown in Figure 4.

Overall, almost four months were spent for the development of 13 physics podcasts. Table 2 shows the complete collection with the corresponding title, podcast duration, and synopsis or storyline for each episode.

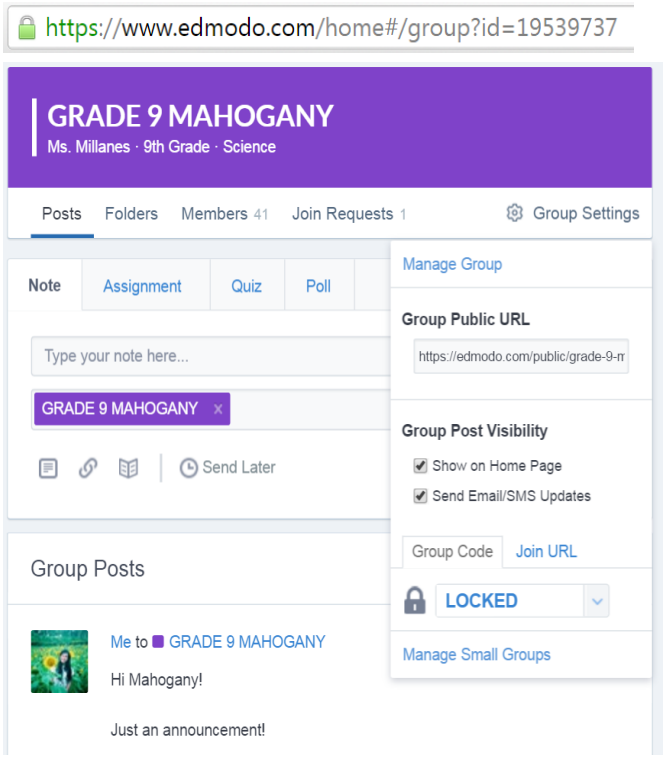

Figure 4. Home Page of the Edmodo, online p

Episode	Physics Topic	Podcast Duration (minutes)	Storyline
7	Conservation of Mechanical Energy	00:15:28	Nick and Chloe invited a special guest for an interview. Engr. William Smith, a rollercoaster engineer shared his expertise in constructing roller coasters and the physics behind them.
8	Center of Gravity	00:16:29	Nick and Chloe talked about an interesting act by Edwin Morales, a tightrope walker in Pilipinas Got Talent. They related the concept of center of gravity and stability in his balancing acts.
9	Torque	00:13:39	Chloe asked Nick why do doorknobs positioned that way. Nick discussed the concept of torque and its applications on doorknobs, seesaws and wrenches.
10	Uniform Circular Motion	00:11:43	Nick shared the story of David and Goliath to Chloe. She was amazed that the slingshot weapon was an example of objects exhibiting UCM.
11	Law of Planetary Motion	00:26:11	In a dream, Chloe was abducted by GYK, an alien who is looking for four persons on earth – Copernicus, Ptolemy, Brahe and Kepler. She was surprised that they had great contributions in the development of the law of planetary motion.
12	Law of Universal Gravitation	00:16:16	Nick and Chloe discussed about gravity and the corresponding factors between two objects.
13	Heat and Temperature	00:16:46	Chloe was holding an iced coffee on one hand, and a hot coffee on the other hand. Nick related her experience to the topics of temperature and heat transfer.

Table 2. List of the Podcast Episodes and their Corresponding Storylines

Episode	Physics Topic	Podcast Duration (minutes)	Storyline
1	Introduction to Physics	00:13:44	Nick gave Chloe some insights on what topics were usually covered in physics. Chloe realized that everything around her was governed by different concepts in physics.
2	Famous Physicists and their Contributions	00:18:34	Nick enumerated famous physicists and their contributions in the foundation of classical physics. He was shocked to know that Chloe knew some other physicists and their contributions to the development of modern physics.
3	Work	00:14:32	Chloe was working out in preparation for school's Intramurals. Nick explained to her that the term "work" can be described differently in physics than in common usage.
4	Work	00:12:11	This was a continuation of Episode 3. Angle theta, the angle between force and the displacement was emphasized in this episode.
5	Power	00:17:14	The elevator in Nick and Chloe's office was broken…again! They had to use the stairs to get to their office in time for the recording. They related the concept of power as a function of work and time.
6	Energy and its many Forms	00:22:50	Chloe seemed to be weak during the recording because she did not eat her breakfast. Nick related the concept of energy as the ability to do work. Different forms of energy were also enumerated.

B. Evaluation of the Physics Podcasts

With the Likert scale ranges from 1 to 5, the minimum and maximum scores on the instrument are 36 and 180 points, respectively. With the students responses after the intervention, the total scores attained ranged from 73 to 179 points (M = 129.80, SD = 21.871). These results indicate that students were highly motivated in using podcasts as instructional learning materials.

Table 3 shows the descriptive statistics for the individual sub-components of IMMS. The Relevance component (M = 3.77, SD = .924) scored the highest mean, followed by the Satisfaction component (M = 3.72, SD = 1.058), Confidence component (M = 3.60, SD = .944), while the Attention component (M = 3.41, SD = 1.063) attained the lowest mean scores. This confirms that among the ARCS model, the relevance or meaningful connections of topics discussed highly motivate the students in learning. Relevance pertains to how well the instruction targets the learner's personal needs and goals, and connects to their prior experiences (Bollinger et al., 2010).

Table 3. Descriptive statistics of all sub-components.

Sub-components	Mean (M)	Standard Deviation (SD)
Attention	3.41	1.063
Relevance	3.77	.924
Confidence	3.60	.944
Satisfaction	3.72	1.058
Over-all	129.80	21.871

In a study conducted by Rehman and Haider (2013) among secondary students and teachers in Pakistan, they concluded that for students to understand their lessons, teachers should make teaching effectively by using different modern methods and relating daily life examples. Clearly, this was observed on the only statement under the Relevance component that had a mean score greater than 4.0 (Statement 2: *There were stories or examples in the podcasts that showed me how this material could be important to some people.*). Real-life stories and examples which students can easily relate to are best motivators to engage them in performing well. They need to establish a personal connection to any instructional material for concepts to sink in to their understanding.

Moreover, as millenials, students are now motivated by "*What's in it for me*" phenomenon, wherein they associate their personal relevance to the things that they are doing (Strang, 2014). In this study, podcasting targeted both the potential use of technology and learning preference of the students as digital natives. These characteristics of podcast made it an effective instructional material in teaching physics.

Summary and Conclusion

This study established the following conclusions:

"*The Physics Station*", a collection of 13 podcast episodes about different topics in physics was developed following the 4 stages of podcast production, namely: (1) Planning and organization, (2) File production, (3) Web

subscription and publication, and (4) Delivery and playback.

An instrument entitled, Instructional Materials Motivation Survey (IMMS) was adapted and administered to the students in order to assess their level of motivation in using the podcasts. Results showed that among the ACRS model, the Relevance component had the highest mean score. Thus, to promote lifelong learning among students, relevant and meaningful connections should be incorporated to any teaching approaches.

The use of podcasts as instructional materials is found effective in teaching physics since it maximizes the potential use of technology, increases high level of motivation among students, and promotes lifelong learning.

Recommendations

The following recommendations were suggested in order to further improve this study:

Since most of the students are visual-learners, it is highly recommended to incorporate videos, *PowerPoint* presentations and animations to the podcasts, making them vodcasts or enhanced podcasts. Especially for subjects such as physics, mathematics, and other sciences, students learn best when they can perceive the lessons visually and even do hands-on activities (Scutter et al., 2010).

Comprehensive statistical analysis should be performed to further assess relationships among the sub-components of motivation.

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