Implementing Short-Format Podcasts for Preview on Mathematics Self-efficacy and Mathematical Achievement in Undergraduate Mathematics

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Abstract
The aims of this study were to examine the impact of the educational use of short-format podcasts before class and to investigate students' responses to the short-format podcasts regarding mathematics self-efficacy and mathematical achievement. Data was collected from 128 students in 6 sections of Intermediate and College Algebra for two semesters through pre- and post-tests, questionnaires including the Mathematics Self-Efficacy Scale, and semi-structured interviews. The data were analyzed by the two subgroups regarding students who do not watch the short-format podcast lectures (NSPL) before class and students who watch the short-format podcast lectures (SPL) before class, and intermediate- low and intermediate- high students. The results of this study showed that short-format podcasts before class were vital to enhancing intermediate students' mathematics self-efficacy and their achievement and an appropriate format on the preview section of the study cycle. In addition, this study contributed to the knowledge of student learning with technology and applications of short-format podcasts before class in mathematics education.

Keywords: Short-format Podcasts before class, Mathematics Self-Efficacy, Mathematical Achievement, Intermediate Students

1. Introduction

Mathematics instructors at colleges and universities have improved the pedagogical environment both inside and outside classrooms through technology. Using the technologies such as class websites and educational software, mathematics instructors have developed their resources in terms of how content is reinforced after their lectures. In addition, the rapid development of mobile devices and Internet speed increases the opportunities for students to access electronic educational materials on class websites or use education software everywhere by utilizing mobile devices, such as smart phones and tablets (Copley, 2007).

While podcasting has become a popular media on the Internet, researchers and instructors in higher education have been interested in the applications of podcasts as a potential pedagogical technology. In 2004, Duke University evaluated the effectiveness of mobile learning through iPods by analyzing teaching and learning data from more than 1600 students (Belanger, 2005). Belanger (2005) and Sutton-Brady, Scott, Taylor, Carabetta, and Clark (2009) reported that students' achievement improved in quality at the same time as the students' motivation and use of resources online increased. Several studies showed that streaming video significantly influenced students' achievement in higher education

(McGrann, 2006). In addition, instructors used podcasting in order to provide their dynamic resources as streaming videos and distribute them in order to help students learn materials (Laing, Wootton, & Irons, 2006; Sharples, 2000).

Research also noted several advantages for students' learning in terms of the use of podcasting in higher education. Students were able to revisit and study content through replaying podcast episodes on diverse devices (Laing, Wootton, & Irons, 2006; Shannon, 2006). In addition, students had opportunities to manage their time in order to learn content instead of only scheduled lecture times (Sharples, 2000). Other researchers studied supplementary podcasts, which are short podcasts including 5-minute summaries of presentations (Calder, 2006), interviews for past and upcoming lecture content, and announcements (Bell, Cockburn, Wingkvisit, & Green, 2007). Studies revealed that short-format podcast design would be a successful model in education (Sutton-Brady, Scott, Taylor, Carabetta, & Clark, 2009). Even though researchers raised concerns regarding applications of podcasting in education, there are still limited evidences to support relationships between the use of short-format podcasts for upcoming core-lecture content and student mathematical achievement and between the short-format podcasts for upcoming core-lecture content and student mathematical self-efficacy.

Each short-format podcast include upcoming core-content of a lecture, represent problem solving, and important announcements as a 5-minute preview video. The purposes of this study were to examine the impact of the educational use of short-format podcasts before class and to investigate students' responses of short-format podcasts for preview in mathematics at a university. There were three research questions with the following three sub-questions to the first question:

I. How do short-format podcasts before class affect student mathematics self-efficacy and student achievement in mathematics?
   - Are there significant differences in mathematics self-efficacy and mathematical achievement between the control and treatment groups?
   - Are there significant differences between intermediate-low (IL) and intermediate- high (IH) students each group based on incoming level of mathematics regarding mathematics self-efficacy and mathematical achievement?

II. What are students' perspectives on the short-format podcasts before class?

III. Do short-format podcasts before class fit the preview section in the study cycle?

For the first question, four hypotheses were tested in this study: 1) The mean of mathematics self-efficacy scores of students who watch the short-format podcast lectures (SPL) before class is significantly different from the mean of mathematics self-efficacy scores of students who do not watch the short-format podcast lectures (NSPL) before class. 2) The post-test mean of the students who watch the short-format podcast lectures (SPL) before class is significantly different from the post-test mean of the students who do not watch the short-format podcast lectures (NSPL). 3) Intermediate-low students' mathematics self-efficacy means and their post-test means in SPL are significantly different from intermediate-low students' mathematics self-efficacy means and their post-test means in NSPL. 4) Intermediate-high students' mathematics self-efficacy means and their post-test means in SPL are significantly different from intermediate-high students' mathematics self-efficacy means and their post-test means in NSPL.

2. Literature Review

2.1 Innovative Technology in Higher Education

The more students use technology, the more researchers and instructors have been interested in the application of technology in higher education because innovative technology is a potential tool to develop diverse pedagogical methods and learning environments. Instructors adopt technology as an education aid to improve students' conceptual understanding and motivation (Ruhven & Hennessy, 2002). Using technology in education helps students make connections and engage in activities and lead to student-centered instruction (Almeqdadi, 2000; Funkhouser, 2002; Hannafin, Burruss, & Little, 2001; Serhan, 2004). Furthermore, technology in education has changed few interactions between students and instructors, and interactions between students and students to close interactions between them because of instant feedback (Galbraith, 2006).

Researchers also revealed important factors to adopt technology in education. Galbraith (2006) pointed out that instructors' abilities to deal with technology and their roles were vital components to determine the impact of student learning and teaching. If students are the primary users instead of instructors, then the effect of using technology is further amplified (Drier, Harper, Timmerman, Garofalo, & Shockey, 2000). Therefore, the utilization of technology becomes a vital topic to improve student learning and teaching in higher education.

As one of innovative technology, podcasts are a series of multimedia files distributed through the Internet or downloaded through web syndication on computers or mobile devices. The word podcast is derived from "*broadcast"* and "*pod*" from iPod, Apple's mobile device. Podcasts have become a common mean to create and disseminate information, for example, lecture contents, interviews, and presentations (Richardson & Mancabelli, 2007).

Podcasts have significantly changed teaching and learning environments in higher education as the number of users of mobile technologies increased. With the advancements in mobile technologies, podcasts allow instructors and students to improve communication, interactions, exchange, and engagement anywhere (Reid-Martinez, Groom, & Bocarnea, 2009). In 2004, Duke University distributed more than 1600 iPods to freshmen to evaluate the effectiveness of iPods in education (Belanger, 2005). This project revealed that the number of students and faculty using iPods was increased, improved student engagement, and supported individual learning preferences (Belanger, 2005). In addition, Belanger (2005) reported that the use of multimedia developed students' motivation and their quality of work. Belanger (2005), Evans (2008), Fernandez, Simo, and Sallan (2009), Hew (2009), Vogt, Scaffner, Ribar, and Chavez (2010) pointed out the general benefits of using podcasts were the convenience and time management for students. Students were able to study content through replaying podcast episodes on various devices (Laing, Wootton, & Irons, 2006; Shannon, 2006). In addition, students had opportunities to manage their time in order to learn content instead of only scheduled lecture times (Sharples, 2000). These benefits provide flexible learning opportunities for students and increase students' responsibility for their own learning.

On the other hand, several researchers have been concerned of the utilization of podcasts in education. Because of the significant growth of mobile, Internet, and web technologies, the number of challenges regarding the utilization of podcasts' such as technical problems in terms of accessing, downloading, unfamiliarity, and limitations of the mobile devices have been decreased. However, there are still issues regarding pedagogical approaches using podcasts due to a lack of understanding the effects of mobile

technologies (Bell, Cockburn, Wingkvist, & Green, 2007; Belanger, 2005; Edirisingha & Salmon, 2007; Lane, 2006; Ogawa & Nickels, 2006; Tynan & Colbran, 2006). Ashley Deal (2007) reported that students were not interested in the supplementary materials through podcasts due to the length of the podcasts, which were approximately one hour long. Chan and Lee (2005) and Chan, Lee, and McLoughlin (2006) reported that students preferred short podcast episodes rather than an hour-long recorded lecture because of less time to download and consume. Other researchers have studied supplementary podcasts, which were short podcasts including 5-minute summaries of presentations, interviews for past and upcoming lecture contents, and announcements (Calder, 2006; Bell, Cockburn, Wingkvisit, & Green, 2007). Moreover, short-format podcast design would be a successful model in education (Sutton-Brady, Scott, Taylor, Carabetta, & Clark, 2009).

2.2 Mathematics Self-efficacy

Researchers have studied and used the concept of students' self-efficacy beliefs in capability because students' self-efficacy beliefs are one of the vital components to understanding and predicting students' behavioral choices, performance, and persistence (Bandura, 1977; Bandura, 1986; Pajares, 1996b; Schunk, 1991). Bandura (1977) defined students' self-efficacy beliefs in capability are essential to successfully performing a given task or behavior. Low self-efficacy expectations cause avoidance behavior. On the other hand, high self-efficacy expectations lead to increasing the frequency of approach behavior. Bandura (1977) categorized perceptions of self-efficacy beliefs into four sources of information: 1) performance accomplishments, for example, successful experience; 2) vicarious learning or modeling, recognizing students' own math abilities based on others' successful problem solving; 3) verbal persuasion; and 4) emotional arousal, for instance, anxiety. Even though there are common factors to influence academic outcomes such as self-concept beliefs, anxiety, and self-regulatory practice, several researchers suggested that self-efficacy is a significant element to predict mathematics performances (Pajares & Miller, 1995; Zimmerman, Bandura, & Martinez-pons, 1992). Collins (1982) reported that students who had high self-efficacy showed better outcomes and persistence than students who had low self-efficacy. In addition, Bandura (1977) and Patrick and Hicks (1997) indicated that self-efficacy was a mediator to affect academic outcomes, cognitive engagement, and performance.

3. Theoretical Framework

The theoretical rationale of this study was built from Mayer's (2001) cognitive theory of multimedia learning (CTML) and the study cycle (LSU Center for Academic Success, 2015) as constructivist views. Mayer and Johnson (2008) stated:

> Meaningful learning occurs when learners are able to pay attention to relevant portions of the words and graphics as they are registered in sensory memory, mentally organize them into coherent cognitive structures in working memory, and connect the verbal and pictorial representations with each other and with relevant knowledge retrieved from long-term memory. (p. 380)

The three assumptions of Mayer's CTML are 1) "Humans possess two separate channels for processing visual and auditory information"; 2) "Humans are limited in the amount of information that they can process in each channel at one time"; and 3) "Humans engage in active learning by attending to relevant incoming information, organizing selected information into coherent mental representations, and integrating mental representations with other knowledge" (Mayer, 2001, p. 44). With the three assumptions of the CTML, instructors help students improve their learning abilities in three areas: 1)

selecting relevant words and pictures during instruction; 2) organizing vital information into working memory; and 3) integrating new knowledge with prior knowledge (Mayer, 2001). In addition, essential processing and generative processing in Mayer's instructional design principles described that students learn better when multimedia presentations are divided into short bursts (5-7 minutes) as opposed to longer modules and students learn better from pictures and spoken words than from words alone (Mayer, 2009). The three assumptions of Mayer's CTML and essential processing and generative processing in Mayer's instructional design principles formed the length and the components of short-format podcast lectures before class.

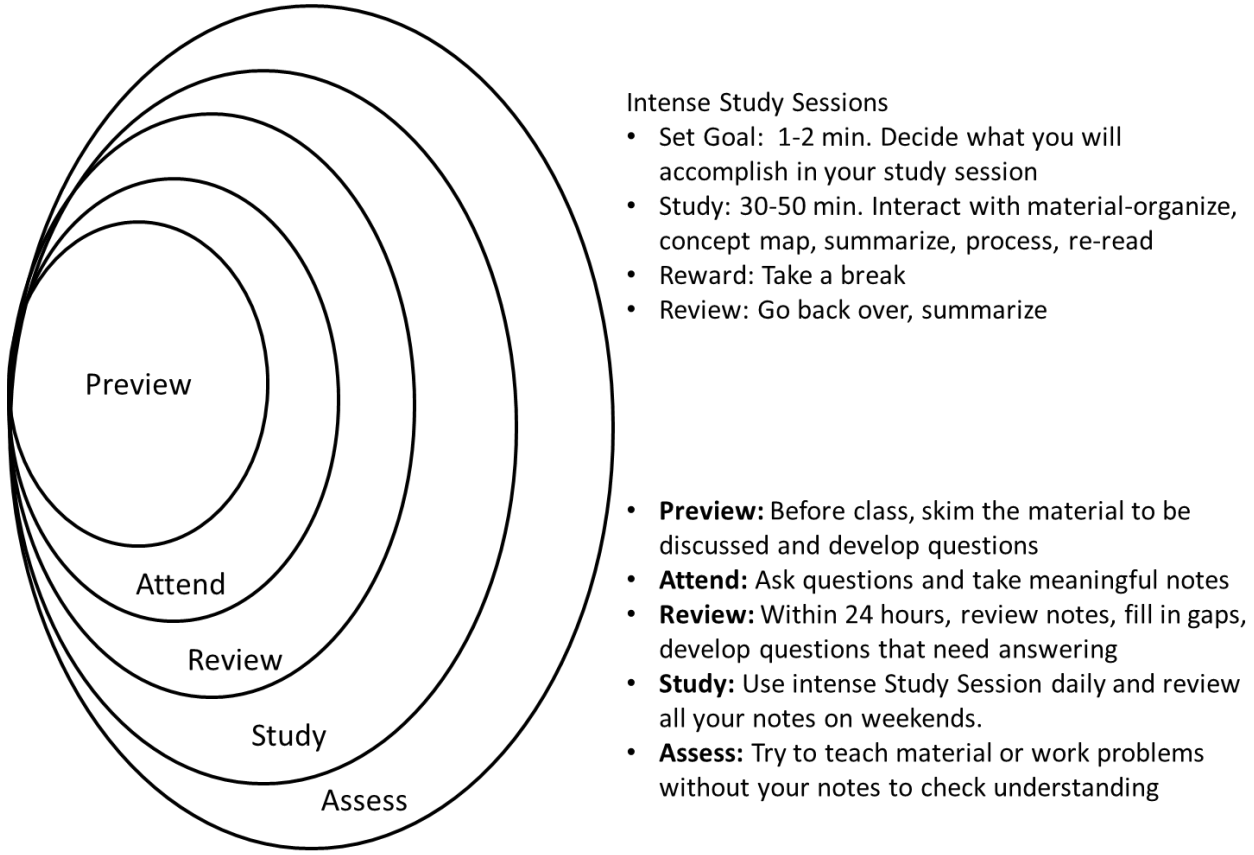

Figure 1 The Study Cycle

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The study cycle formed the basis for why the short-format podcasts lectures would be provided before class (see Figure 1). The preview section in the study cycle suggested to "look over bold and italicized print, headings, outlines, formulas, images and graphs. Read over the summary and other material offered at the end of the chapter" (LSU Center for Academic Success, 2015). Students can efficiently review the important contents before class through the short-format podcasts. Thus, the three assumptions of Mayer's CTML, the essential and the generative processing in Mayer's instructional design principles, and the study cycle supported this study as a theoretical roadmap.

4. Methods

As a mixed project, this study employed three different data sources: the pre- and post-tests, semi-structured interviews, and questionnaires including Mathematics Self-Efficacy Scale (Betz & Hackett, 1993). The pre- and post-tests were the same question formats with different numerical values

between the NSPL and SPL groups. The qualitative data explored the students' perspectives for the short-format podcasts before class and supported the findings of the quantitative data.

The participants were 128 students in 6 sections, 3 Intermediate Algebra and 3 College Algebra courses with the same instructor during two semesters at an educational public university with about 16,000 students in the Southeast (see Table 1). The participants enrolled in daytime classes to fit their schedule and other preferences. Sixty-four participants served as the control group and did not watch the short-format podcast lectures (NSPL) in a Fall semester. After a drop date, the number of the NSPL group was 59 from 64. The 59 participants consisted of 39 in 2 Intermediate Algebra courses and 20 in 1 College Algebra course. As treatment groups, sixty-nine participants watched the short-format podcast lectures before class (SPL) in a Spring semester. 69 out of 71 students in the SPL group participated in this study after a drop date. The 69 participants consisted of 19 in 1 Intermediate Algebra course and 50 in 2 College Algebra courses. In addition, the intermediate-low (IL) and high (IH) groups were divided by the median (73) of the all participants' pre-test scores.

Table 1. Participants

	N	Intermediate Algebra	College Algebra	Intermediate-Low	Intermediate-High
Control Groups (NSPL)	59	39	20	22	37
Treatment Groups (SPL)	69	19	50	38	31

The data was collected from the first exam as a pre-test and the final exam as a post-test each semester in order to measure the students' mathematical achievement. After the first exam, the participants completed the first questionnaire with a consent form. The first questionnaire consisted of background information and the Mathematics Self-Efficacy Scale (MSES_1). In addition, the second questionnaire included students' perspectives of the short-format podcasts and the Mathematics Self-Efficacy Scale (MSES_2) at the end of the semester. The Mathematics Self-Efficacy Scale (MSES), developed by Betz and Hackett (1993), consists of 18 items of mathematics tasks and problems subscales and 16 items of a mathematics course subscale with a 10-point scale. The mathematics task subscales assess students' confidence in their ability to perform mathematics problem solving. The mathematics course subscale is used to measure students' confidence in their ability to pass a college level course with a grade of "B" or better. The 10-point scale ranges from 0 (No confidence at all) to 9 (Complete confidence). Sixteen voluntary participants were interviewed in the treatment groups within 30 minutes to develop the findings of the quantitative data. The interviews were 7 open-ended questions about students' learning for the next class, engagement in class, and perspectives for the short-format podcast lectures. To improve the validity for this study, the interviewees checked their transcriptions and peer researchers reviewed the data and results, which were questionnaires, transcripts of interviews, critical themes, categories, and code books.

For the hypotheses of the research questions, two sample t-tests were conducted to compare the mathematical achievement and the mathematics self-efficacy between the control (NSPL) and treatment (SPL) groups, and between the IL students in NSPL and the IL students in SPL, and between the IH student in NSPL and the IH students in SPL, using Minitab, software for statistics. Similarly to Cohen (1988), a significance level of 0.05 was used for this study. The independent variables were class types: non-short-format podcast lectures (NSPL) and short-format podcast lectures (SPL); the pre-test score, in

order to measure incoming level of mathematics: intermediate- low (IL) and high (IH) groups. The dependent variables were mathematical achievement by the post-test and the mathematics self-efficacy. For the qualitative data, the transcripts were analyzed in order to find tentative codes based on the strategy of Miles and Huberman (1994). Through the derived codes, initial categories with the labels or codes were constructed. Refining the categories led to find critical themes.

5. Results

This section consists of two main categories, the results of the quantitative data and the results of the qualitative data. To find the research answers from the qualitative data, two sample t-tests were employed. The findings of the quantitative data were broken into two categories, the mathematics self-efficacy and mathematical achievement. From there, the mathematics self-efficacy findings were analyzed based on two parameters: students who did not watch the short-format podcast lectures (NSPL) and students who watched the podcast lectures before class (SPL) groups and incoming levels of mathematic abilities, intermediate- low (IL) and intermediate- high (IH) groups. In addition, student achievement was analyzed using the same categories. Semi- structured interviews and two questionnaires were analyzed for the qualitative data. The findings of the qualitative date supported the results of the quantitative data and explored the participants' perspectives of the short podcasts before class.

5.1 Mathematics Self-Efficacy

5.1.1 NSPL and SPL groups in Mathematics Self-Efficacy Scores

To find the answer for the first null hypothesis, the NSPL and SPL groups were compared by the means of the first and second mathematics self-efficacy scores (MSES) in the NSPL group to the means of the first and second MSES in the SPL group respectively. In addition, the paired t-tests were conducted to discover the change in the mathematics self-efficacy scores and mathematical achievement of each group. The two groups' first and second mathematics self-efficacy (MSES_1 and _2) means were not significantly different by the two-sample t-tests ($p_1 = 0.099$ and $p_2 = 0.364$ respectively) (see Table 2). Although each group's mean of MSES_1 and MSES_2 was not statistically different, Table 2 showed that the SPL's mean of MSES_2 slightly increased $(+0.12)$ whereas the NSPL's mean of MSES_2 decreased (-0.04).

Table 2. Mean Differences in MSES

Both Groups				Each Group			
	NSPL	SPL	p Value		MSES_1	MSES_2	p Value
MSES_1	5.79 (1.23)	5.40 (1.51)	0.099	NSPL	5.79 (1.23)	5.75(1.23)	0.771
MSES_2	5.75 (1.23)	5.52 (1.57)	0.364	SPL	5.40 (1.51)	5.52 (1.57)	0.278
IL students in Both Groups				IL students in Each Group			

	NSPL	SPL	p Value
MSES_1	5.55 (1.19)	5.38(1.28)	0.624
MSES_2	5.35 (1.01)	5.43 (1.45)	0.810

	MSES_1	MSES_2	p Value
NSPL	5.55 (1.19)	5.36 (1.01)	0.492
SPL	5.38 (1.28)	5.43 (1.45)	0.768

IH students in Both Groups			
	NSPL	SPL	p Value
MSES_1	5.95 (1.25)	5.41 (1.77)	0.162
MSES_2	5.98 (1.30)	5.64 (1.73)	0.360

IH students in Each Group			
	MSES_1	MSES_2	p Value
NSPL	5.95 (1.25)	5.98 (1.30)	0.876
SPL	5.41 (1.77)	5.64 (1.73)	0.194

IL and IH students in NSPL			
	IL	IH	p Value
MSES_1	5.55 (1.19)	5.95 (1.25)	0.221
MSES_2	5.35 (1.01)	5.98 (1.30)	0.043

IL and IH students in SPL			
	IL	IH	p Value
MSES_1	5.38 (1.28)	5.41 (1.77)	0.940
MSES_2	5.43 (1.45)	5.64 (1.73)	0.603

Standard deviations are in parentheses.

5.1.2 Intermediate-Low Students and Intermediate-High Students

Based on the median (73/100) of all participants' pre-tests, the data were divided by two subgroups, intermediate-low (IL) and intermediate-high (IH). The intermediate-low (IL) students' MSES_1 and _2 in NSPL and SPL were not significantly different ($p_{\text{MSES}_1\_\text{IL}} = .624$ and $p_{\text{MSES}_2\_\text{IL}} = .810$) (see Table 2). The IL students' MSES_2 in each group was no significantly different from the students' MSES_1 by the paired t-tests ($p_{\text{MSES\_IL(NSPL)}} = 0.490, p_{\text{MSES\_IL(SPL)}} = 0.768$). The IH students' MSES_1 and _2 means in NSPL and SPL were not statistically different ($p_{\text{MSES\_1}} = 0.162$ and $p_{\text{MSES\_2}} = 0.360$). In addition, the two groups' IH students' mathematics self-efficacy was not significantly different respectively by the paired t-tests ($p_{\text{MSES\_IH(NSPL)}} = 0.876$ and $p_{\text{MSES\_IH(SPL)}} = 0.194$). These results indicated that the IL and IH students' mathematics self-efficacy of each group was not changed during the semester.

To find the differences in the MSES_1 and _2 between the IL and IH students each group, the two sample t-tests were performed. Table 2 shows that the IL students' MSES_1 mean was not significantly different from the IH students' MSES_1 mean ($p_{\text{MSES\_1(NSPL)}} = 0.221$) in the NSPL group. However, the

IL students' MSES_2 mean was different from the IH students' MSES_2 mean in the NSPL group ($p_{\text{MSES\_IL(NSPL)}} = 0.043 < 0.05$). The IL NSPL students' mean (5.35) of the MSES_2 slightly decreased from the mean (5.55) of the IL NSPL students' MSES_1 whereas the IH NSPL students' means of the MSES_1 and _2 were not different ($p_{\text{MSES\_IH(NSPL)}} = 0.221$). In the SPL group, the IL students' MSES_1 and MSES_2 means were not significantly different from the IH students' MSES_1 and MSES_2 means ($p_{\text{MSES\_1(SPL)}} = 0.940$ & $p_{\text{MSES\_2(SPL)}} = 0.603$).

5.2 Mathematical Achievement

5.2.1 NSPL versus SPL groups

To discover the differences in student mathematical achievements between the NSPL and SPL groups, two-sample t-tests were used for the pre-test and post-test (see Table 3). The results indicated that the students in both the NSPL and SPL groups were similar performance. In addition, the students' incoming math abilities in both groups were not statistically different at the beginning of the semester and the students in the groups were similar in achievement at the end of the semester ($p_{\text{pre-test}} = 0.18$ and $p_{\text{post-test}} = .362$).

Table 3. Mean Differences in Mathematical Achievement

Both Groups				Each Group			
	NSPL	SPL	p Value		Pre-test	Post-test	p Value
Pre-test	72.7 (15.9)	68.7 (17.6)	0.180	NSPL	72.7 (15.9)	70.9 (22.2)	0.494
Post-test	70.9 (22.2)	67.8 (14.1)	0.362	SPL	68.7 (17.6)	67.8 (14.1)	0.689
IL students in Both Groups				IL students in Each Group			
	NSPL	SPL	p Value		Pre-test	Post-test	p Value
Pre-test	55.5 (10.3)	57.3 (14.7)	0.580	NSPL	55.5 (10.3)	58.4 (28.6)	0.633
Post-test	58.4 (28.6)	63.7 (14.6)	0.419	SPL	57.3 (14.7)	63.7 (14.6)	0.047
IH students in Both Groups				IH students in Each Group			
	NSPL	SPL	p Value		Pre-test	Post-test	p Value
Pre-test	83.0 (7.52)	82.8 (8.18)	0.907	NSPL	83.0 (7.52)	78.4 (12.7)	0.042
Post-test	78.4 (12.7)	72.9 (11.7)	0.068	SPL	82.8 (8.18)	72.9 (11.7)	0.000

Standard deviations are in parentheses.

5.2.2 Intermediate-Low and Intermediate-High Groups

The pre-test and post-tests were used to discover the difference in mathematical achievement between the IL students in NSPL and the IL students in SPL. The means of the pre-test and post-test between the IL students in NSPL and the IL students in SPL were not significantly different ($p_{\text{pre-test}} = 0.580$ and $p_{\text{post-test}} = 0.419$) (see Table 3). The comparison between the pre-test and post-test means of the IL students in the NSPL group was not changed ($p_{\text{IL\_(NSPL)}} = 0.633$). However, the post-test mean with *SD* 14.6 of the IL students in the SPL group increased from the pre-test mean with *SD* 28.6 of the IL students in the SPL group ($p_{\text{IL\_(SPL)}} = 0.047 < 0.05$). These results indicated that the short-format podcasts before class were one of the factors to enhance the IL students' achievements.

The pre-test and post-test means of the IH students in the NSPL and SPL groups were compared to find the differences in the IH student achievement between the two groups. The pre-test and post-test means of the IH students in NSPL was not significantly different from the pre-test and post-test means of the IH students in SPL ($p_{\text{pre-test}} = 0.907$ and $p_{\text{post-test}} = 0.068$). To find the improvement for the IH student achievement each group, the paired t-tests were used. The results revealed that the pre-test and post-test means of the IH students in both groups were significantly different ($p_{\text{NSPL}} = 0.042$ and $p_{\text{SPL}} = 0.001 < 0.05$). Unlike the increased post-tests' means of the IL students in both groups, the IH students' post-test means were less than the IH students' pre-test means in both groups.

5.3 Perspectives for Short-Format Podcasts for Preview

From the second questionnaire, the students in the SPL group believed that the short-format podcasts were an effective tool to learn materials because the mean of the effectiveness was 3.867 out of 5 with *SD* .5. Five themes emerged from the 22 semi structured-interviews. The five themes were classified as "Before Class" and "In Class" (see Table 4).

Table 4. Categories and Themes

	Categories	Themes
Before Class	1) Preparation	Preparation (Being better prepared for class and the material) A good overview An idea of the material A brief overview for the next class

	2) Reducing anxiety about new materials	Comfort in attending class Less overwhelming Familiarizing lecture material beforehand Class enjoyment Mental preparation for new material
	3) Increasing interest	Demanding more examples Practicing different examples
In Class	4) Improving students' understanding	Understanding of the material in class Learning better by practicing implementing the formulas and equations
	5) Improving student engagement in class	Reinforcing skills Asking better questions to understand Helping students to understand and engage in problem solving in class

5.3.1 Before Class

The short-format podcasts were used as an educational tool to develop students' readiness for new materials. First of all, the short-format podcasts helped the SPL students improve their preparations for the next class. According to the brief overview on what topics students would encounter in the next class, the students believed that they were better prepared for class and the new material:

> The short video lectures prepared me for the material covered in class. I like that they are short and straight to the point. That always satisfies students who are in a rush to learn things. The short video lectures were fine the way they are.

> It helps students get prepared so they are not as confused in class. So I didn't come into class not knowing what we were going to do. Once I figured out why it works or is that way instead of just memorizing formulas, I did much better.

The preparation of the up-coming material reduced the students' anxiety about new topics and activities in class because the students were familiar with the lectures beforehand through the short format lectures: "It helps me get ready and feel comfortable when I come to class. It mentally prepares me on what I am going to learn. Also, the next class was less overwhelming because of the short podcast lectures." In addition, the short-format podcasts increased the students' interest in problem-solving of the new materials and motivated them to solve more problems according to simple examples on the podcast video lectures. For examples, some students noted, "Give some problems for the students to practice on their own or provide those solutions at the end of the short video lectures" and "I needed to see more example." Since the length of the short-format podcasts is about 5 minutes, the short podcasts could not include more examples. However, the factor of the short length of the podcasts encouraged the students' desire to see and solve different examples. Therefore, a brief description and short problem solving of the up-coming materials before class through short-format podcasts reduced the students' anxiety about and increased their interests in the new materials (Categories 1, 2, & 3).

5.3.2 In Class

Previewing the new topics through the short-format podcasts encouraged the students to enhance learning new topics by repetition and to promote conceptual understanding of the new materials in class. The students believed that they had opportunities to understand new theorems and definitions, as well as to apply new formulas and properties in class, because they watched problem solving beforehand: "When you complete an example on the podcasts and then did it again in class, it really helped me to understand the material." In addition, the students often participated in problem solving because they saw similar problem solving from the short-format podcasts: "The podcast lectures give ideas of the material for the next class. Plus, if I didn't understand something, it was reinforced in class or I could ask better questions to understand." Thus, the students believed that the short podcasts helped their conceptual understanding and improved their engagement in class (Categories 4 & 5). In addition, the students actively engaged in problem solving in class because the short-format podcasts helped the students recall solutions of similar problems (Category 5).

To answer the third research question, the results from the quantitative and qualitative data were combined. The findings, category 1 (preparation), 2 (reducing anxiety), and 3 (increasing interest), indicated that short-format podcasts for preview promoted students' readiness for up-coming materials and the stages of vicarious experiences and emotional states. Finally, the short-format podcasts affected students' mathematics self-efficacy before class (Figure 2). These results from the qualitative data were consistent with the results, improving or keeping the IL students' mathematics self-efficacy. Therefore, short-format podcasts fit the preview step in the study cycle as a clear guide to learn new materials and enhance students' engagement.

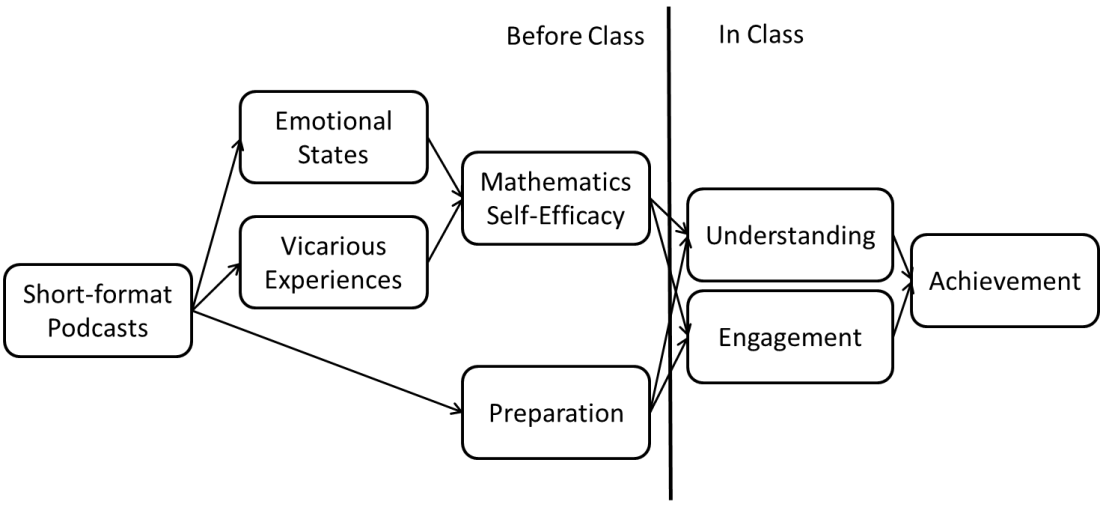

Figure 2. Influence of Short-format Podcasts on the Preview Step in the Study Cycle

5. Conclusion and Discussion

As a mixed methods research design, this study conducted comparisons between students who watched the short-format podcasts before class (SPL) and students who did not watch the podcasts (NSPL) in order to find the pedagogical impact of short-format podcasts for preview in student mathematics self-efficacy and mathematical achievement,

The findings from the quantitative and qualitative data answered three research questions. The results of comparisons in mathematics self-efficacy between two groups rejected the first null hypothesis. There

were no significant differences in the first and second means of the MSES between the NSPL and SPL groups. In addition, the mathematics self-efficacy of both groups was not changed. The data was classified into two middle-level topics to find the answer for the second null hypothesis "Are there significant differences between intermediate-low (IL) and intermediate-high (IH) students each group based on incoming level of mathematics regarding mathematics self-efficacy and mathematical achievement?" The IL and IH students in the SPL group were not significantly different in their mathematical self-efficacy score means between the beginning and the end of semester. In the NSPL group, the IL and IH students' MSES means were not statistically different at the beginning of semester. However, the IL and IH students' MSES means in the NSPL group were significantly different at the end of semester because the IL students' MSES_2 mean in NSPL was decreased from their MSES_1 mean. As a result, the MSES_2 mean of the IL students in the SPL group was higher than the MSES_2 mean of the IL students in the NSPL group, though the MSES_1 means of the IL students in both groups were not significantly different (see Table 2). This result of the IL students' mathematics self-efficacy in NSPL was consistent in researchers' findings that student mathematics self-efficacy was diminished at end of year or semester (Anderman & Maehr, 1994; Midgley, Feldlaufer, & Eccles, 1989; Pajares & Graham, 1999; Wigfield et al., 1991, 1996). However, the researchers' results did not apply to the IH students in both groups and IL students' mathematics self-efficacy in SPL because their MSES means were not dropped at the end of the semesters. Therefore, the short-format podcasts for preview had more influence on IL students than IH students in mathematics self-efficacy and helped the IL students keep or develop their mathematics self-efficacy.

The results in mathematical achievement indicated that the students in both the NSPL and SPL groups were not significantly different in mathematical achievement. For the IH students in both groups, the short-format podcasts did not affect their achievement. In particular, the means of the IH students' post-tests in both groups significantly decreased from the means of their pre-tests because the IH students' pre-test means were much higher than the IL students' pre-test means and the comprehensive post-tests might affect the IH students' post-test means. On the other hand, the IL students' post-test mean in SPL was significantly higher than their pre-test mean, although the IL students' pre-test and post-test means in NSPL were not statically different.

Although there are several components that affect students' achievement, the results of this study supported the fact that mathematics self-efficacy is a critical factor to improving students' achievement (Chen, 2003). In addition, the results showed the relationships between IL students' mathematics self-efficacy and their mathematical achievement through short-format podcasts. From the finding of this study, the mean of the IL students' MSES_2 in NSPL decreased from the mean of their MSES_1, and the means of the IL students' pre-test and post-test in NSPL was not different. On the contrary, the mean of the IL students' MSES_2 in SPL slightly improved from their MSES_1, and the mean of the IL students' post-test in SPL was significantly increased from the mean of their pre-test. The results were consistent with many researchers' reports that students who have high mathematics self-efficacy were better performers than students who have low mathematics self-efficacy (Bandura, 1986, 1997; Chen, 2003; Collins, 1982; Pajares & Graham, 1999; Pajares & Miller, 1994).

The findings from the qualitative data explained how the short-format podcasts affected the IL students' mathematics self-efficacy and their mathematical achievement in order to help the students increase their preparation for new topics before class and to improve their understanding and engagement in class.

Researchers reported that mathematics self-efficacy may be influenced by vicarious experiences, physical and emotional states, verbal persuasions, and past performance (Lent, Brown, Gover, & Nijjer, 1996; Lopez & Lent, 1992; Randhawa, Beamer, & Lundberg, 1993; Usher, 2009). The results of this study showed that the students could reduce their anxiety about and increase their preparation for the up-coming materials because of watching the short-format podcasts before class. Therefore, the short-format podcasts before class are a tool for the preview section of the study cycle to maintain or improve the IL students' mathematics self-efficacy as promoting the stages of vicarious experiences and emotional states for reducing students' anxiety, and finally, their developed mathematics self-efficacy enhanced their achievement.

There were limitations of this study in term of the number of participants and the periods of collecting data. Even though the total number of 126 participants was sufficient for valuable results, there was a lack in the number of IL students and IH students because of dividing the groups based on incoming level. There were potential differences between students in the Fall semester and students in the Spring semester, although there were not statistical differences in the mathematics self-efficacy and mathematics ability between the NSPL and SPL groups at the beginning of semesters. Even if there were limitations, this study showed the relationships among students' achievement, their mathematics self-efficacy, and short-format podcasts before class. In addition, the results of this study indicated that short-format podcasts before class are a vital tool in the preview section to enhance intermediate-low students' mathematics self-efficacy and their achievement. Therefore, this study will contribute to the knowledge and applications of short-format podcasts before class in mathematics education. Future research is needed to examine the impact of short-format podcasts before class in upper level mathematics courses and to explore the relationships between mathematics self-efficacy and short-format podcasts before class with a large number of participants.

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