Maintaining Students' Involvement in a Math Lecture Using Countdown Timers

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Abstract - *Involving students in a lecture is an important but not an easy task that every lecturer must encourage. This task becomes even greater in a math class that is composed of eighty to a hundred sixty students. In 2007, the University of the Philippines Los Baños (UPLB) started offering some of its basic math courses in lecture-recitation set-up. This shift and many other factors drove most math instructors of UPLB to widely use presentation software, such as the PowerPoint (PPT), to deliver their lectures. The non-stop use of these softwares, however, seems to have negative effects on the students when it comes to maintaining their involvement in a lecture discussion for they tend to be more passive spectators. On the other hand, adding countdown timers strategically on some parts of the discussion seems to lessen such negative effects.*

This study determined the effectiveness of using countdown timers in maintaining students' involvement in a lecture of MATH 27 (Analytic Geometry and Calculus II), a course in UPLB commonly taken by sophomore students. Results show that the effectiveness of countdown timers, as perceived by the students, is independent to students' genders and degree programs, but is dependent to the colleges where the students belong to. Also, some effects of countdown timers are significantly correlated to various data from students' profiles. It was concluded in the study that the use of countdown timers is effective in maintaining student's involvement in MATH 27 lectures and might also be useful in other math lecture classes.

Keywords: *countdown timer, involvement, lecture*

INTRODUCTION

In most math classes, there are parts where the teacher guides the students to solve a seatwork problem, and there are also parts where the students are allowed to solve on their own. The latter teaching strategy, however, does not guarantee successful learning since students were found to be on task less during independent seatwork than during teacher-directed parts of the lesson [1]. The situation does not improve during an ungraded seatwork. This students' behavior challenges some of the math courses the University of the Philippines Los Baños (UPLB) offers in lecture-recitation format.

In a lecture-recitation format, a class is composed of a lecture class and a recitation class. The lecturer meets the whole class twice a week, at least one hour every meeting (depending on the number of units credited for the course), to discuss the definitions, theorems and examples needed to develop the course. The class is divided into smaller recitation classes where each is composed of around 32 students. The recitation classis conducted once or twice a week.

UPLB started offering some of its courses in lecture-recitation set-up in 2007 to improve the university's efficiency among other reasons. In 2009, most of the basic math courses in UPLB are already in this kind of set-up. This shift drove most UPLB's math lecturers to widely use presentation software, particularly PowerPoint (PPT), to deliver their lectures. PPT, an MS Office Application made by Microsoft Corporation, is commonly chosen for its appropriateness in this set-up and many other reasons like its availability and easy-to-use features. Aside from these, PPT also has a potential to increase and maintain student's interest and attention in a lecture discussion [2].

The continuous use of PPT, on the other hand, seems to have negative effects on the students when it

comes to maintaining their involvement in a lecture for they tend to be more passive spectators [2]. For instance, during a lecture class, when a seatwork problem appears on a PPT presentation, it is observable that many students tend to just wait for the solution to appear next and thus spend their time off-task until then. This behavior could be explained by the fact that in a lecture class, students are not pressured to do seatwork for the lecturer would not be able to catch them doing nothing due to the large number of students. To reduce this attitude of disregard, countdown timers could be incorporated in the PPT whenever a seatwork is presented hoping to provide stronger urge for the students to do the seatwork.

Despite the perceived importance, only few empirical studies had been conducted to explore the effects of timers on students in a math class especially in the tertiary level. One particular study was done by Wright. He observed that incorporating timers in PPT presentations can encourage punctuality, positive student behavior and active academic engagement [3]. It can also speed up transitions in class, help students monitor their work time, and increase student work fluency [3]. In another study, Chappa found that displaying a board timer during timed addition and subtraction enhances student speed and achievement [4].

This study investigated the effects of timers on students' involvement in a math lecture class. The National Council of Teachers of Mathematics defined involvement as the process in which students are actively participating in the learning of a new educational material [5],[6]. Based on the papers reviewed for this study, it seems that involvement is a well studied subject in education research.

Reed and Schallert, in their study, asked college students to rate their involvement in activities such as reading and writing. Results revealed two major components of involvement. First, students reported to have experienced deep concentration during the task. It was characterized by focused attention, moderate task difficulty, and importance of the task to the student. The second component of involvement was an increased understanding of the task and the students' goals for the task [6], [7].

On another study, Csikszentmihalyi pointed out that the balance between challenges and skills is the best key factor of involvement. According to his theory, when people exercised challenges and skills that were both balanced and above average, they would feel most positive about the experience because they were functioning at their fullest capacity [6],[8].

Various ratios of challenges and skills are predicted to lead to different qualities of experience. If challenges and skills are both high, one feels involved. If both challenges and skills are low, one feels indifferent. If challenges exceed skills, then one feels anxiety, whereas if skills exceed challenges, then boredom is experienced [6], [8].

In a study by Clare et al., involvement includes student behaviors such as eye contact with the teacher, working quietly, and appropriately orienting to a task. Increase in students' involvement was found to be inversely related to disruptive behavior [9]. Students diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) are more likely to display disruptive off-task behaviors. However, other students may display them as well for various reasons. If students do not understand a classwork or find it difficult, they may become disengaged and more likely to display off-task behavior. There may be other students whose behaviors are distracting or other factors in the environment that causes a student to display such behaviors. Off-task behaviors are also a common occurrence during waiting times, as students are unsure of what to do next [10].

In a study by Godwin et al., there are six mutually exclusive categories of off-task behavior: (1) *Self-distraction,* (2) *Peer distraction,* (3) *Environmental distraction,* (4) *Supplies,* (5) *Walking,* and (6) *Others. Self-distraction* entailed engagement with something on the child's own body, such as an article of clothing or an appendage, as well as episodes in which the child closes their eyes. *Peer distraction* involves interaction with or looking at another student when not directed to do so. *Environmental distractions* include interacting with or looking at any object in the classroom that is not related to the task at hand, while *Supplies* consists of inappropriately using any object that is part of the assigned task (e.g., playing with a writing utensil). *Walking* is the behavior of the student who is physically walking around the classroom when it is not considered appropriate for the task. *Other distractions* included student behavior that is off-task but did not clearly align with the five aforementioned categories [11].

Among these categories of off-task behavior, *Peer distraction* had the highest percentage of students (45%) of whom the behavior was observed. It was

followed by *Self-distraction* (18%), *Environmental distraction* (16%), *Supply distractions* (11%), *Other distractions* (8%), and lastly, *Walking* (3%). It was also found in the study that student's gender and grade level make only a marginal contribution to off-task behavior [11].

One way to increase student learning and avoid off-task behavior is to use a timer. Wright recommended timers to be used as a monitoring cue for students. Self-monitoring helps a student to be involved in the class and to decrease behaviors such as calling out, leaving one's seat and requesting teacher's assistance [12]. He also advised that teachers can boost student motivation by posting time remaining for the lesson. He saw that students are motivated to engage academically because they can see on the timer that the lesson will only last a finite (and manageable) amount of time [3]. Furthermore, displaying a board timer can helpsome students increase their speed and their achievement and accuracy in successfully mastering timed math-fact tests. However, it also serves as a distraction for some students [4].

Prior research on performance effects has demonstrated that time pressure – defined as either subjectively perceived time pressure or the imposition of a deadline – increases the rate of individual and group performance [13].

OBJECTIVES OF THE STUDY

This study determined the effectiveness of using countdown timers in maintaining students' involvement in a math lecture class. It also determined the portion of students who recommends countdown timers to be used in their other math courses. Finally, this study determined some effects of using countdown timers and analyzed their correlations to some data from the students' profiles.

METHODS

To meet the objective of determining the effectiveness of countdown timers, both quantitative and qualitative approaches of social research were used in this study.

Respondents

This study took the students of MATH 27 (Analytic Geometry and Calculus II) enrolled during the first semester of academic year 2014-2015, as respondents. MATH 27 is the second of the series of calculus courses that is taken by many sophomore students of UPLB and is being offered in a lecture-recitation set-up. It covers various topics such as differentiation and integration techniquesand the derivatives and integrals of some transcendental functions. It also includes some applications of derivatives and integrals. MATH 27 is regularly offered by the Institute of Mathematical Sciences and Physics (IMSP) under the College of Arts and Sciences (CAS), UPLB. It was chosen for this study for they are known to incorporate countdown timers in the lectures.

Table 1. Frequency distribution of students' profile

Criterion	Category	Frequency
age (in years)	16	2
	17	78
	18	88
	19	25
	20	13
	21	2
	22	4
	23	1
gender	Female	103
	Male	110
degree program	BSABE	30
	BSABT	2
	BSAC	9
	BSB	2
	BSC	34
	BSCS	109
	BSFT	15
	BSMST	7
	None	5
college	CA	18
	CA-CAS	9
	CAS	155
	CEAT	30
	None	1
batch	2008	1
	2009	4
	2010	7
	2011	13
	2012	28
	2013	152
	None	8

When the study was conducted, there were 213 students, 89 of which were from lecture section A while the remaining 124 students were from section W. The two lecture sections were handled by two lecturers who have been handling different math courses in IMSP since 2008.

The students' ages range from 16 to 23 years old. The oldest student is from batch 2008 while the youngest is from batch 2013. Most of them are first time to take MATH 27 but there are few who have the course for the third time, that is, they are not passing the course yet. They belonged to eight different degree programs, namely: BS Agricultural Biosystems Engineering (BSABE), BS Agricultural Biotechnology (BSABT), BS Agricultural Chemistry (BSAC), BS Biology (BSB), BS Chemistry (BSC), BS Computer Science (BSCS), BS Food Technology (BSFT), and BS Mathematics and Science Teaching (BSMST). These degree programs are under four colleges, namely: College of Agriculture (CA), College of Agriculture – College of Arts and Sciences (CA-CAS), College of Arts and Sciences (CAS), and College of Engineering and Agro-industrial Technology (CEAT).The frequency distribution of students' profile can be seen in Table 1.

Research Instrument

The main data gathering instrument was a self-made questionnaire which was developed through a lot of study and evaluation by the researchers. Four professors from different UPLB units (Institute of Mathematical Sciences and Physics, Department of Social Sciences and Institute for Governance and Rural Development) were requested to evaluate the questionnaire. These professors have been handling lecture classes and are familiar with the problem context. Moreover, they are experienced researchers in both qualitative and quantitative research. The questionnaire was then revised and improved accordingly.

Statistical Tools Used

The gathered data were tallied, tabulated, encoded, and analyzed using the following statistical tools.

Frequency distribution and *percentage* was used to describe the socio-demographic profile of the students. This includes student's age, gender, degree program, college, batch, the number of times MATH 27 was taken and the number of classes where the countdown timers were encountered.

Mean was used to determine the average ranks given by thestudents on some variables that are in Likert- scales.

Chi-square was used to determine the independence between two variables that are on a nominal scale.

Spearman rank correlation was used to determine the magnitude and association between two variables that are not normally distributed, and are on an ordinal, interval or ratio scale.

Table 2. Assigned values for Likert scales used in the study.

Options	Range	Verbal Interpretation (VI)	
		Involvement	Perception on the Effects of Countdown Timer
4	3.50 – 4.00	Always (A)	Strongly Agree (SA)
3	2.50 – 3.49	Sometimes (SO)	Agree (A)
2	1.50 – 2.49	Seldom (SE)	Disagree (DA)
1	1.00 – 1.49	Never (N)	Strongly Disagree (SDA)

Countdown Timers

In this study, countdown timers were used as components of PPT presentations. A countdown timer appears as the PPT slide containing a seatwork appears. The lecturer clicks the countdown timer and waits until it ends. The lecturer does not do anything and say nothing while the timer is running. The idea is that the student should start answering the seatwork as soon as the timer starts. The end of the timer signals the lecturer to show the solution to the seatwork. The countdown timers usually run from 30 seconds to 4 minutes depending on the difficulty of the seatwork as determined by the lecturer.

RESULTS AND DISCUSSION

After all the data were obtained and analyzed, results show that countdown timers helped maintain students' involvement in MATH 27 lectures.

Effectiveness as perceived by the students

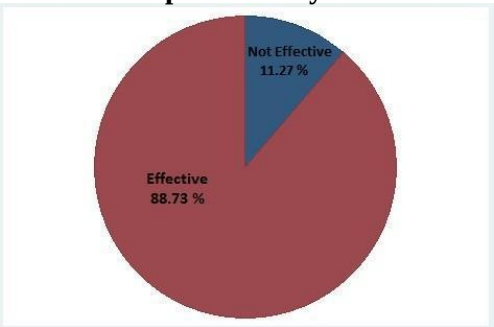

Figure 1.*Perceived effectiveness of countdown timers in maintaining students' involvement in MATH 27 lecture.*

It can be seen in Figure 1 that a large proportion

(88.73 % or 189 out of 213) of the students considered the use of countdown timers effective in keeping the students involved in MATH 27 lecture while the remaining 11.27 % (or 24 students) did not. Motivation is the reason cited by most students why they found countdown timers to be effective. This finding can be further explained by Steel and König's Temporal Motivation Theory (TMT) which emphasizes time as a critical and motivational factor.

TMT theory asserts that the perceived utility of a given activity increases exponentially as the deadline nears. A classic example could be a student who is given one month to accomplish a project. The student is given two options—working on the project and socializing. The student enjoys socializing but needs to achieve a good grade. Because the positive component of socializing is continuously in the present, it maintains a uniformly high utility. The reward of accomplishing the project is initially temporarily distant, decreasing its utility. Only toward the deadline does motivation to work on the project surpasses the motivation to socialize. In a classroom activity, if students do not realize the immediate need of their action, the greater the possibility for them to procrastinate or be off-task [15].

With a countdown timer being present, students seem to be motivated to do the seatwork because they saw through the countdown timer an imminent deadline. The countdown timer lessened the amount of time to realization hence increasing motivation [15].

On the other hand, those students who did not find countdown timer effective mentioned that it caused panic and pressure for them.

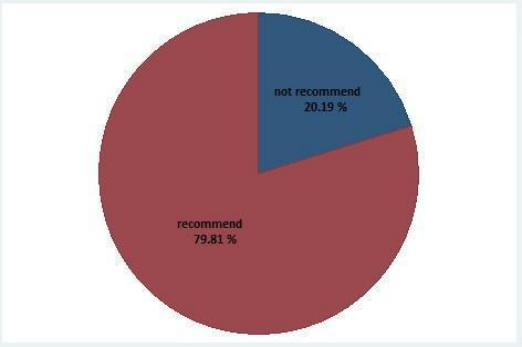

Figure 2.*Students' opinion on whether they recommend countdown timers to be used in other Math subjects.*

Figure 2 shows that majority (79.81 % or 170 out of 213) of the students recommended the countdown timers to be used in other math courses while the remaining 20.19 % (or 43 students) did not. Most of the students who recommended the use of countdown timers reasoned that it motivates them to answer the given seatwork so it may also motivate students in other math courses. Those who did not recommend claimed that the effectiveness of countdown timers depends upon the lecturer's teaching styles and the topic being considered.

In addition, majority of those who considered countdown timers effective and those who recommended its use are from the students with the following profile: 18 years old; male; BSCS; belong to batch 2013; first-taker of MATH 27; and first time to encounter countdown timers being used in a college course.

The independence between the students' perceived effectiveness of countdown timers in maintaining involvement in MATH 27 lecture and the information from their profiles was determined using the chi-square test of independence.

Table 3. Independence between perceived effectiveness of countdown timers and students' profile

Criterion	Chi-squared Value	p-value	Decision
gender	1.2766	0.259	fail to reject
degree program	12.5541	0.128	fail to reject
college	10.8342	0.028	
recommend the use of countdown timers	66.9355	0	reject

The hypothesis that students' perceived effectiveness of countdown timers was independent to each criterion of their profile was tested at 0.05 significance level. Since the p-values for gender and degree program were greater than the significance level, we do not reject the null hypothesis that students' perceived effectiveness of countdown timers is independent to gender and degree program. However, since the p-values for college and for the criterion to recommend the use countdown timers were less than the significance level, the students' perceived effectiveness of countdown timers is significantly dependent to college, and their opinion to recommend the use of countdown timers in other math

subjects.

In UPLB, just like in other universities, related degree programs are housed in the same college. Hence, mathematically-inclined students are more likely to belong to the same college that offers degree programs that are more related to math. For example, the College of Engineering and Agro-Industrial Technology (CEAT) is more likely to have students who are used to solving math problems devotedly. These students could feel challenged rather than anxious because of the pressure brought by the timer compared to students from other colleges. This explains the dependence of students' perceived effectiveness of countdown timers to college.

On the other hand, it is likely for the respondents to recommend countdown timers to be used in other math subjects after they perceived it as effective in MATH 27. It is like people recommending the use of a certain commercial product to their friends because it worked for them.

Table 4. Different behaviors exhibited by the students during the span of a countdown timer

	Behavior	Mean	VI	Rank
1.	try to solve the problem presented	3.68	A	1
2.	doodle/write things not related to the problem	1.77	SE	6.5
3.	discuss with my seatmate about things not related to the problem	1.55	SE	9
4.	look into my notes about how to solve the problem	2.61	SO	3
5.	read about things not related to the problem	1.50	SE	10.5
6.	play with things around me (ball pen, handkerchief, etc.)	2.10	SE	5
7.	discuss with my seatmate about how to solve the problem	2.33	SE	4
8.	do nothing	1.71	SE	8
9.	daydream	1.77	SE	6.5
10.	consult the lecturer	1.50	SE	10.5
11.	go somewhere else (comfort room, etc.)	1.19	N	15
12.	use my gadget/s	1.45	N	12
13.	think about the problem	3.58	A	2
14.	eat or drink	1.32	N	13
15.	sleep	1.30	N	14
	Composite Mean	1.96	SE	

It can be seen in Table 4 the different behaviors exhibited by the students during the span of a countdown timer. The students were asked to rate themselves according to how intense they manifest a given behavior. The composite mean obtained is 1.96 which is verbally interpreted as seldom. This figure means that the students seldom behave negatively during the span of a countdown timer as there are more negative behaviors included in the list.

Furthermore, the students always try to solve the seatwork problem presented since this is the behavior that obtained the highest mean. On the other hand, having the lowest mean, the students never go somewhere else during the span of a countdown timer. This could be explained by the TMT theory of Steel and König, that is, the motivation to go somewhere else was exceeded by the motivation to do the task at hand in the presence of a countdown timer which emphasizes the urgency of the task.

It is also important to notice that even though the students always try to solve the problem presented, they seldom discuss with their seatmate about how to solve the problem. They also seldom consult the lecturer. This only means that the students were independently trying to solve the problem during the span of a countdown timer.

Independence in trying to solve the problem can be beneficial to the students in a way that they become more aware of their limitations and their ability to manage them. They can also monitor their performance through the timer. Moreover, independence allows them to exercise their cognitive skills in constructing informal rules for solving so as to solve the problem more quickly. It also nurtures their affective skills since there is "delay of gratification". Having solved the problem independently within a specific amount of time (especially within a short period time) boosts the confidence of the students about the lesson and their motivation to be involved [15].

Table 5. *Some effects of a countdown timer*

	A countdown timer…	Mean	VI	Rank
1.	disturbs my concentration in answering the problem.	2.34	DA	4
2.	improves my concentration in answering the problem.	2.81	A	3
3.	is not needed in the lecture.	2.00	DA	5
4.	is needed in the lecture.	2.95	A	2
5.	discourages me in answering the problem.	1.86	DA	6
6.	motivates me in answering the problem.	3.13	A	1
	Composite Mean	2.51	A	

Included in Table 5 are some effects that could be

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brought by a countdown timer to the students. The students were asked to rate their level of agreement in each of the said effects.

Having the highest mean, the students agreed that a countdown timer motivates them in answering a problem. They also agreed that a countdown timer is needed in the lecture and it improves their concentration in answering a problem. In contrast, having the lowest mean, most of the students disagreed that a countdown timer discourages them in answering the problem. Most of them also disagreed that the countdown timer disturbs their concentration in answering the problem and that it is not needed in a lecture. Hence, the students agreed that countdown timers have positive rather than negative effects on them.

The correlation among the students' profile and the effects listed above were obtained using the Spearman rank correlation since the data obtained are not normally distributed and are at least on the ordinal level.

Table 6. Relationship between students' profile and some effects of countdown timers.

Profile	rho-value	p-value	Decision
age	0.1793	0.0087	reject
batch	0.1595	0.0198	reject
number of times MATH 27 was taken	-0.1930	0.0047	reject
number of courses where the use of countdown timers was encountered	0.0791	0.2506	fail to reject
involvement	0.1584	0.0207	reject

From Table 6, it can be seen that the p-values for age, batch, the number of times MATH 27 was taken and involvement (based on the behaviors listed in Table 4) was less than 0.05. This implies that the hypothesis that there is no significant relationship between each of these variables and the said effects of countdown timers is rejected.

With low rho-values, age, batch, the number of courses where use of countdown timers was encountered and involvement had low positive correlation with the said effects of countdown timers. Whereas, the number of times MATH 27 was taken had low negative correlation with the said effects.

The idea that age and batch are marginally correlated to the effects of countdown timer could be due to one's level of maturity and span of stay as a student in the university. Older students seem to be more complaisant of what was happening in the class while the students who are more involved in the class are the ones more affected by the countdown timer for they tend to be more active and attentive.

The negative correlation of the number of times MATH 27 was taken can be explained as students who took MATH 27 for the first time treated everything in the subject as new and exciting experience compared to those who have taken it before. The manner the countdown timers were used before may have decreased its effect especially since it was used in the same subject with the same lessons as they already had.

SUMMARY AND CONCLUSION

Based on the results, most of the students considered the use of countdown timers effective in keeping their involvement in MATH 27 lecture primarily because it motivates them to answer a given seatwork. Most of the students also recommended countdown timers to be used in other math courses for the same reason.

Most of the subjects in which the students encountered the use of countdown timers were Computer Science subjects. This means that countdown timers might have been widely used already in the Institute of Computer Science.

It was also found out that on the average, the students always try to solve the problem presented and never go somewhere else during the span of a countdown timer. This means that the students are involved in the lecture during the use of countdown timers.

Also, even though the students always try to solve the problem presented, they seldom discuss with their seatmate about how to solve the problem and seldom consult the lecturer. Hence, on the average, the students independently try to solve the problem during the span of a countdown timer.

Moreover, on the average, the students agreed that the countdown timer motivates them in answering the problem, is needed in the lecture, and improves their concentration in answering the problem. This means that the students recognize that countdown timers bring positive effects on them.

With a confidence level of 95 %, there are sufficient evidences, based on the results, to claim the following conclusions. The students' perceived effectiveness of countdown timers is independent to

gender and of degree program, but is significantly dependent to college. Their opinion to recommend countdown timers to be used in other math courses is significantly dependent to the perceived effectiveness of these countdown timers. Moreover, the effects (listed in Table 4) of countdown timers are significantly correlated to age, batch, level of involvement, and the number of times MATH 27 was taken while they are not correlated to the number of courses in which the use of countdown timers was encountered.

It can be generalized that the use of countdown timers was effective in maintaining students' involvement in MATH 27 lectures.

RECOMMENDATION

For future studies, it is recommended to consider the topic and the duration of countdown timers in testing its effectiveness. Some of the students in this study reasoned out that its effectiveness depends on the topic and the duration of the timer. It may also be aimed to determine certain topics and the appropriate durations of countdown timers to maximize its full potential to involve the students in the lecture.

Moreover, to better understand the effectiveness of countdown timers a comparative study of lecture classes with and without countdown timers can be conducted. It is also interesting to know how the use of countdown timers affected students' academic performance.

The conclusions drawn from this study reflect only for MATH 27 and UPLB, not considering other subjects, universities, and levels—elementary and high school. Also, the conclusions are generalized for all MATH 27 lecture sections at the time of the study, even though the use of countdown timers (type, duration, frequency, and problems accompanied by) was different for each section. However, since majority of the students, in this study, recommended countdown timers to be used in other math courses, math lecturers from other universities are also challenged to see for themselves the effects of incorporating countdown timers in their lectures.

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