

GREAT ACHIEVEMENT TOWARDS MATHEMATICS EXCELLENCE (GAME): THE USE OF CARD GAMES TO TEACH ADDITIONAL MATHEMATICS

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ABSTRACT

In most schools, the teaching of Additional Mathematics has always been the traditional approach where the teacher is the primary source of knowledge and the text is often the only source of information. In the wake of ‘Innovate & Enterprise’ (I&E) and ‘Teach Less Learn More’ (TLLM), GAME (Great Achievement towards Mathematics Excellence) is a new approach of using card games to teach Additional Mathematics that will change the classroom environment from passive to active learning. The current education system in Singapore has shifted from an instructive to constructive strategy which allows pupils to construct their own learning. Thus it is the team’s goal to create a classroom that engages, encourages and excite our Additional Mathematics pupils to persevere and value-add their learning. This study is to investigate the effectiveness of card games to allow our pupils to take charge of their own learning and make them teachers of their peers and to deepen their understanding of some abstract Additional Mathematics concepts. This paper reports the encouraging improvement in the pupils’ attitude towards the learning of Additional

Mathematics. Pre-tests and post-tests are also carried out to measure the cognitive domain of pupils' learning. The findings of this study will be useful towards the implementation of GAME as a learning tool in the Additional Mathematics classroom.

INTRODUCTION

The traditional method of teaching, learning or revising Additional Mathematics concepts would probably be chalk-and-talk and drill-and-practice for teachers and students respectively in most schools. Quite often, students lose interest and focus easily because of the lack of the element of fun. The students we are dealing with in present times are very different from the past. They are longer passive recipients of information and knowledge. As mentioned by Singapore's Senior Minister Goh Chok Tong (1997) in his speech at the opening of the 7th International Conference on Thinking,

We cannot assume that what has worked well in the past will work for the future. The old formulae for success are unlikely to prepare our young for the new circumstances and new problems they will face.

p.3

Students of the present days learn best when they are allowed opportunities to do discovery learning and to construct their own learning. In the wake of 'Innovate & Enterprise' (I&E) and 'Teach Less Learn More' (TLLM), the current education landscape in Singapore has shifted from instructive to constructive. We as teachers, are therefore at the frontline to make all this possible. Hence, in 2006, a team was formed to dialogue and brainstorm on how we could make the learning of abstract Additional Mathematics fun and yet meaningful.

A closer scan of our school current situation shows that in most Additional Mathematics classrooms, teacher-centred teaching using the chalk-and-talk method is the main teaching activity. This is especially true in the graduating classes, where most students will be doing drill-and-practice using questions from the textbook, ten year series or past year papers in preparation for their national examinations. Often, teachers will be seen going through answers either on the whiteboard or collecting assignments to be marked. In this scenario, the teacher is often the only one assessing students' performance and moreover, there is always a time-lag before the students receive feedback, if any.

Our team felt that this traditional method of learning can be greatly enhanced through the use of games. Yet, currently in the market, there is hardly any suitable game for this particular group of students. In addition, an exhaustive search of the educational literature also showed that very few researches have been conducted about the use of mathematics games in the teaching and learning of Additional Mathematics, or even Mathematics in the secondary schools.

As advocated by Cubix (2002), games create a positive learning atmosphere in the classroom leading to improved mental attitude towards mathematics in pupils. He added that games are able to integrate the cognitive, affective and social aspects of learning and they provide the chance for students to communicate mathematically, which reflects one of the aims of our Singapore mathematics education (Ministry of Education, 2006).

A novel approach of using specially designed card games was thus thought of to enhance the learning of Additional Mathematics. We wanted to transform the current classroom environment from one that is passive to one that actively engages, encourages and excite our

Additional Mathematics pupils to persevere and value-add their learning. We also wish to rekindle or instil the love for Additional Mathematics, an abstract subject, in our students through their natural, competitive nature while helping them to stay focused. We believe that the learning of Mathematics through card games is a good tool of assessment for learning as it offers the students a chance to assess themselves and at the same time, peer tutor their friends. By benchmarking their performance against their peers, it allows for immediate feedback and allows them to keep track of their progress. Naturally, many learning points like collaborative learning and communicating mathematically will come into play.

Furthermore, card games offer a physiological and psychological edge over traditional didactic methods, as unlike many test and worksheet assignments, they provide a more comfortable and interactive setting (Baker, R. N., 1999).

Our project was thus named GAME, short for Great Achievement towards Mathematics Excellence. In this paper, we seek to investigate the effectiveness of GAME in the learning of Additional Mathematics concepts, in both the affective and cognitive domains. We believe the implementation of card games as a learning tool will improve our students' attitude towards Mathematics leading to better academic performance, and teachers will make better progress in understanding and serving their learners needs.

IMPLEMENTATION PROCESS

Creation of Suitable Cards

Two important criteria were considered as we were in the process of designing and creating the cards.

First, questions used in the card games should be tuned towards the specific instructional objectives of our Additional Mathematics syllabus. Thus, ten year series and textbooks were used as guides where questions were either created or modified from. We created 9 sets of cards with 20 pairs of questions and answers on each of the following topics: sets, logarithms, matrices, indices and surds, functions, graphs of functions, trigonometric graphs, derivatives of trigonometric functions and derivatives of exponential and logarithmic functions. A pair of cards on the topic of logarithms is shown below in Figure 1.

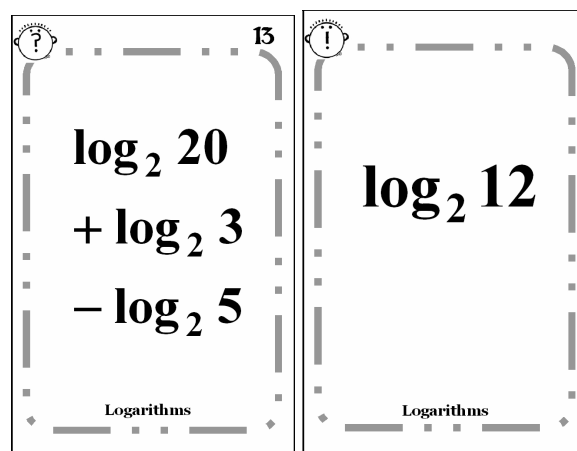


Figure 1

Secondly, the game rules should be easily grasped and understood by the students to ensure that the learning curve for the game is gentle and hence lesser resistance will be encountered when the game is introduced. Our cards were then designed such that they can accommodate the game rules of the following popular card games, like Donkey, Old Maid, SNAP and Heart Attack.

In mid-2006, we conducted pilot sessions on GAME to test the viability of our product and at the same time obtain feedback from the students. Two classes, 4E1 (average PSLE T-score: 215.3) and 5N1 (average PSLE T-score: 183.5) were chosen. The former was a full class of 36 Additional Mathematics students from the express stream, whereas the latter was a half

class of 20 Additional Mathematics students from the normal academic stream (A scene of GAME from 4E1 is shown in Figure 2).



Figure 2

These were some of the comments from the students.

“Fun and interesting, help me see whether I know the chapter well”, Chze Hao, 4E1.

“The questions were very challenging! It was a good change for the normal lessons that we have”, Jian Wen, 4E1.

“The game is a fun way to learn new things. It helps us to rebuild our foundation and with this, we can learn and help each other out“, Hasyimah, 5N1.

“I think the game is quite interesting. Perhaps can add prizes for winning so as to arouse the players’ interests”, Ying Ting, 5N1.

“An interesting way of learning/revising which makes students actively participating in the game. As long as it’s a game, students will love and enjoy it”, Sufi, 5N1.

Yet, one common response from the students was that some questions were too long and is too tedious for them to work out the solution without using paper and pen. The other feedback was that the cards that were used were not visually appealing to them (Figure 3).

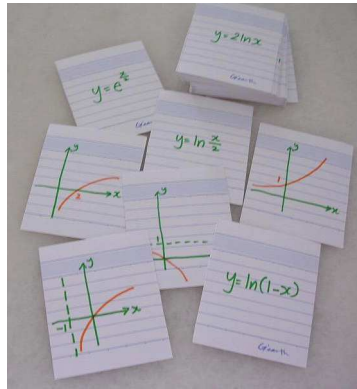


Figure 3

We then re-looked at the questions that we have selected for GAME and modified some of the questions so that it requires lesser workings and yet still test students on the important concepts. We also work on the visual appeal and manufacture cards that were of similar standards to the card games that are sold in the market (Figure 4).



Figure 4

Data Collection

In 2007, 3 Additional Mathematics teachers in the school conducted at least 2 sessions of GAME with their respective classes. A total of 65 students participated in this study; 22 students from 3N1, 30 students from 4E2 and 4E3 (combined class) and 13 students from 5N1.

To study the effects on the affective domain of students, in the usage of card games for the learning of Additional Mathematics, survey forms (Appendix A) were given to all the

students after the GAME sessions. Responses were also collated from the teachers who conducted the sessions to surface any issue or concern they have encountered or had in mind. To evaluate the effectiveness of GAME in the cognitive domain, pre-tests and post-tests were administered to each of the students participating in this study. The questions in the pre-tests and post-tests were similar to those found in the textbooks and cards, and the difficulty levels of both tests were pitched at the same level to ensure the validity of the study. Refer to Appendix B and C for a sample of a set of pre-test and post-test on the topic of derivatives of trigonometric functions.

Pre-tests were administered to all students the week before starting the GAME session. The test papers were then marked by the subject teacher and the test scores were recorded for comparison purposes later on. To avoid interfering the data for the post-tests, the marked pre-tests papers were not returned back to the students and no corrections were done either.

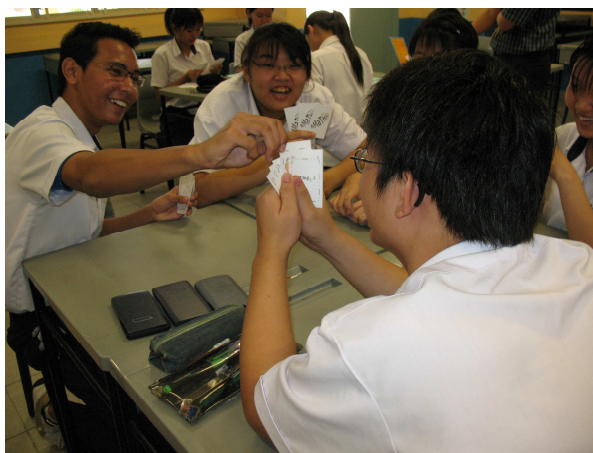


Figure 5

In the following week, students were given time to play the card game on that particular topic that they have completed. Each session of GAME lasted about an hour where students were randomly assigned into groups of 4 or 5 and each group was free to choose what game rules they wished to use. A video camera was also set up to record the lesson proceedings. A scene of GAME from 5N1 is shown in Figure 5.

In the week after the GAME session, a post-test on the same topic was administered and the results recorded. The students were thus expected to transfer what they have learnt during the game into the test situation.

RESULTS AND FINDINGS

Students' Survey Results

From the survey conducted with all the students from the 3 Additional Mathematics classes, all the students agreed that they enjoyed the GAME session, with 33.8% strongly agreeing to this notion. In addition, when asked if they hoped to have such activity for their future Additional Mathematics lessons, all were supportive with 30.7% strongly agreeing. Most agreed that the session has helped them understand the concepts better (89.2%) and were sure that their classmates had also enjoyed the GAME session (87.7%). However, quite a number of students felt that the questions were relatively difficult (15.4%). Yet, we must keep in mind that a certain level of difficulty is needed to sustain the level of interest and competitiveness in students.

Some of the good points mentioned by students were:

“It was very entertaining as the AMath lesson is normally very stressful.”

“The class was livelier.”

“Now I know the chapter better!”

“It helps me to discover my mistake.”

“It trains me to calculate faster mentally.”

“It makes AMath more interesting!”

“It is interesting and creative!”

From the feedback gathered and the videos, it was obvious that students welcomed the idea of playing games in the Additional Mathematics lessons and the classroom atmosphere was very energetic. More importantly, many felt that they have learnt better in such a setting and this has increased their confidence towards Additional Mathematics. One common area for improvement raised by the students was that some felt that more questions per set would be better such that each game could last longer.

Teacher's Observations and Remarks

All the teachers involved commented that their students had fun and enjoyed the game. Most were actively engaged, although some took a long time to pair up cards. Teachers also felt that the questions were relevant and helped to strengthen students' understanding.

Students' Pre-test and Post-test Results

From the comparison made from the results of the pre-tests and post-tests, a high percentage of students (ranging from 61% to 80%) either maintain their standards or did better in their post-tests. In fact, all 3 classes achieved higher mean scores (improvement ranging from 7% to 19%) in all the 6 GAME sessions conducted.

CONCLUSION

As mentioned by Prime Minister Lee Hsien Loong (2004) at the National Day Rally, our teachers need to “teach less, so that our students could learn more”. Teach less, learn more (TLLM) as noted in MOE's directive means “less dependence on rote learning, repetitive tests and a ‘one size fits all’ type of instruction, and more on experiential discovery, engaged learning, differentiated teaching, the learning of life-long skills, and the building of character through innovative and effective teaching approaches and strategies.” By this initiative, it

should be clear to teachers that there is a need “to remember why we teach, to reflect on what we teach and to reconsider how we teach”. Using game is one of the many strategies that we tried and which have proven to have a positive impact in students’ learning.

Our findings have revealed that the usage of cards games have created a positive learning environment that in turns improve the attitude towards mathematics in the pupils, leading to better academic achievement. Our success in GAME in the Additional Mathematics classroom goes to show that card games are powerful tools for the teaching of mathematics and their use in the mathematics classroom is definitely justifiable (Baker, R. N., 1999).

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APPENDIX A: Students' Survey Form

Woodgrove Secondary School
Mathematics Department

Name: _____ () Class: _____ Date: _____

SECTION A

Please shade the icon that best represents how you feel about the following comments.

	Strongly Agree	Agree	Disagree	Strongly Disagree
1. I enjoyed today's lesson.				
2. The lesson has helped me to understand the				
3. I hope to have such activity for future A. Maths				
4. I find the level of difficulty for the questions				
5. I am sure my classmates enjoyed the lesson too.				

SECTION B

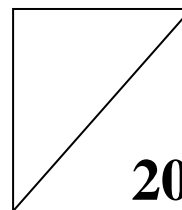
1. Give ONE good point about this lesson.

2. Give ONE area for improvement (AFI) about this lesson.

Thank You!

APPENDIX B

**Derivatives of Trigonometric Functions
Pre-Test**



Name : _____ ()

Marks :

Class : _____

Date : _____

Instructions to students:

1. The use of calculator is allowed.

1. $\frac{d}{dx} 2 \tan 5x =$ [2]	5. $\frac{d}{dx} \tan^2 x =$ [2]
2. $\frac{d}{dx} 3 \cos 5(x - 2) =$ [2]	6. $\frac{d}{dx} x \sin x =$ [2]
3. $\frac{d}{dx} \sin x^3 =$ [3]	7. $\frac{d}{dx} \sin \frac{2}{x} =$ [3]
4. $\frac{d}{dx} \frac{\cos x}{\sin x} =$ [3]	8. $\frac{d}{dx} \sqrt{\sin 2x} =$ [3]

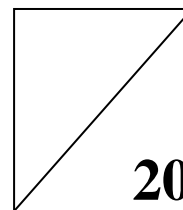
End of Paper

Please check your answer again.



APPENDIX C

**Derivatives of Trigonometric Functions
Post-Test**



Name : _____ ()

Marks :

Class : _____

Date : _____

Instructions to students:

1. The use of calculator is allowed.

1. $\frac{d}{dx} \frac{1}{2} \cos 3x =$ [2]	5. $\frac{d}{dx} \cos^2 x =$ [2]
2. $\frac{d}{dx} (2 \sin 4x - e) =$ [2]	6. $\frac{d}{dx} x^2 \sin 2x =$ [2]
3. $\frac{d}{dx} \sin \sqrt{x} =$ [3]	7. $\frac{d}{dx} \sec x =$ [3]
4. $\frac{d}{dx} (\sin x \sec x) =$ [3]	8. $\frac{d}{dx} (\cos 4x)^2 =$ [3]

End of Paper

Please check your answer again.

