

A CASE STUDY ON APPLYING GAMIFICATION TOOLS IN BUSINESS MATHEMATICS FOR HIGHER EDUCATION STUDENTS

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Abstract: Empirical research was conducted on applying Gamification in Higher Education using the dynamics and mechanics of gaming in a non-game context of the subject Business Mathematics for undergraduate students. A case study was used as a method to collect data using questionnaires, observations, and interviews. Online feedback was conducted as part of the semester completion for the subject Business Mathematics to test the usage of Gamification tools (Kahoot!, Socrative, Quizlet, Quizizz and Showbie) in learning. It was found that Gamification tools enhanced students' motivation in learning and understanding mathematical concepts, and that it has boosted their engagement in gamification activities, increased critical thinking and problem-solving skills.

Keywords: Gamification tools, Business Mathematics, Higher Education, Online Learning

Resumo: Foi realizada investigação empírica sobre a aplicação da Gamificação no Ensino Superior utilizando a dinâmica e a mecânica do jogo num contexto extra-jogo da disciplina de Matemática Empresarial para estudantes de licenciatura. Foi utilizado um estudo de caso como método de recolha de dados utilizando questionários, observação e entrevistas. Foi realizado um feedback online como parte da conclusão do semestre para a disciplina de Matemática Empresarial para testar a utilização de ferramentas de Gamificação (Kahoot!, Socrative, Quizlet, Quizizz e Showbie) na aprendizagem. Verificou-se que as ferramentas de Gamificação melhoraram a motivação dos estudantes na aprendizagem e compreensão dos conceitos matemáticos, aumentaram o seu envolvimento em actividades de Gamificação, melhoraram o pensamento crítico e as capacidades de resolução de problemas.

Palavras-chave: Ferramentas de gamificação, matemática de negócios, ensino superior, aprendizagem online



This research was part of my Ph.D. program for the project of Gamification in Higher Education to motivate learners and develop creative thinking. Sometimes the conventional education method fails to foster and develop the stunt potentials that lie within the students.

But it proves that the study based on gamification can develop the hidden innate potentials of the students. The Grace International Academy of Punalur in Kerala, India, enabled to teach the module Business Mathematics for the undergraduate students of the Bachelor of Commerce

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program. A case study was used as a method to collect data using questionnaires, observations, and interviews. Based on the analysis performed on the data we decided to implement Gamification tools in learning and teaching the module Business Mathematics in Grace International Academy.

On 13th January 2020, research questionnaire one was conducted with Likert scale measures (Strongly Agree, Agree, Neither Agree Nor Disagree (NANDA), Disagree, Strongly Disagree) that were used to identify the category for each question. Feedback responses were added to find the cumulative response, using the cumulating data, the median was calculated with the formula $(n+1)/2$ where n = number of students, that is $(17+1)/2 = 9$. This was used to find the category, which falls in cumulative responses as shown below with categories.

- | | |
|--|------------------|
| 1) To confirm the module is designed interestingly to learn. | - Agree |
| 2) To check skill development by learning the module. | - Agree |
| 3) To test the module is intellectually challenging. | - Agree |
| 4) To examine the class participation. | - Strongly Agree |
| 5) To analyze self-initiative and self-creative in learning. | - NANDA |
| 6) To investigate the module that supports innovative ideas. | - NANDA |
| 7) To assess the students' engagement in the class. | - NANDA |
| 8) To test active participation in learning. | - Agree |
| 9) To check guidance from lecturer. | - Agree |
| 10) To ensure the usage of multimedia tools in learning. | - Agree |

The above questionnaire questions were observed in the classroom, especially the research objective, self-initiative, and self-creativity in learning. Students did not show a willingness to take initiative to solve the mathematical problems written on the whiteboard and they were busy interacting with their friends. It was a real challenge to make them engage in classroom activities. Considering the above factors in the objectives and the classroom observations a plan was executed, to design and implement Gamification tools for the Business Mathematics module.

At the end of the semester, questionnaire two was applied with research objectives to identify the effectiveness of Gamification tools in learning and to check the amelioration of critical thinking and problem-solving skills of students.

METHODOLOGY

In this research, the case study was used as a method and it was carried throughout the semester with a duration of six months. On 16th December 2019, I was assigned the subject Business Mathematics for the undergraduate Bachelor of Commerce (B.Com) with a class of 17 students. The subject Business Mathematics consists of chapters 1) Number Sense, 2) Matrix, 3) Basic Algebra, 4) Mathematical Application in Business and 5) Mathematics for Financial Analysis.

Several studies (AlexandruTopîrceanu, 2017; Majumdar; 2017, 2014) show in various contexts that gamification can be an effective approach to increase motivation and engage users or participants in each activity. Gamification's impact on student motivation and performance is an

important theme, as there has been an increased interest in gamification (Hanus& Fox, 2015) in Higher Education. Denn y's (2013) students were evaluated individually and reported increased participation of those who experienced strong preferences and joy towards the badge system as a game mechanism in the class. Gamification involves motivational information, and the goal of gamification is commonly used to affect the behavior of users.

On 16th January 2020, the gamification tool Kahoot! was introduced for students of Grace International Academy. Two activities were conducted in the form of Classic and Team mode. In classic mode students were able to participate individually and in team mode five teams were created in Kahoot!, and students were divided into five teams and participated in the activity.

Students were given feedback after the classic (individual) activity and the Team activity.

Classic activity

How fun was the activity? -> 4.14 out of 5 in a scale of fun were measured.
Did you learn something? -> 100% students stated yes
Do you recommend Kahoot? -> 100% students recommend Kahoot!
How do you feel? 85.71% gave positive and 14.29% neutral response.

Team activity

How fun was the activity? -> 4.40 out of 5 in a scale of fun were measured.
Did you learn something? -> 100% students stated yes
Do you recommend Kahoot? -> 100% students recommend Kahoot!
How do you feel? 80% gave positive and 20% neutral response.

On 28th January 2020, Socrative (Gamification tool) was introduced to students, it was an effective tool to gauge students' understanding in real-time. Conducted Quiz and Space Race activity of Socrative in students' paced mode. It provides immediate feedback and delivers fun for students. This enabled them to understand the interface and to participate well in the activity.

Gamification tools (Kahoot and Socrative) were used more often in different classroom activities, students performed well in all activities, especially in team events they worked together, and it allowed them to participate willingly. They were able to interact among themselves to get the correct answers.

A class test was conducted on 4th February 2020 to test problem-solving skills and creative thinking of student's knowledge in particular chapters (Number Sense, Matrices, and Determinants) in Business Mathematics with maximum marks of 25. The test was designed as a diagnostic test, to know students' proficiency on skills and misconceptions in mathematical concepts.

The results of the class test were not up to the expectations, as 82% of students scored below 45% of marks. Answer scripts reflected students required extra care in specific areas in Number Sense like rational numbers, rule of signs, the hierarchy of arithmetic operations using BODMAS, fractions (improper, mixed, and decimal), calculating and converting percentages and rules for constructing bar charts. Students get confused with matrix operations like addition, subtraction, multiplication, and properties of determinants. Their answer scripts and the classroom observations reflected that these students do not have a basic understanding of mathematical concepts; regarding class attendance, two students only had 57% attendance, one had genuine medical reasons as to her absence, another one always entered the classroom in the middle of the session. I reminded him many times about his late comings, and this was informed to higher officials and discussed with colleagues too, which conveys that the student was not having an intrinsic interest in learning the course.

The midterm examination was scheduled for 13th February 2020, having only a week's time preparation for students. Considering students' knowledge and their grasping power, I decided and conducted revision using the traditional method (chalk and talk, face to face interaction). This allowed clearing their doubts of mathematical concepts and got a good responses from students during the sessions. The results of the midterm examination along with the class test marks are shown below as a comparison table.

COMPARISON TABLE OF CLASS TEST AND MIDTERM EXAMINATION MARKS

		Class test			Midterm Examination			
		Conducted on 4th February 2020			Conducted on 13th February 2020			
No	Students	Marks out of 25	Percentage of Marks	Attendance	Marks out of 40	Percentage of Marks	Attendance	Increase in Percentage of Marks
1	Student A	1.5	6%	57%	15.5	39%	65%	33%
2	Student B	2	8%	57%	38	95%	53%	87%
3	Student C	2	8%	86%	24.5	61%	88%	53%
4	Student D	2.5	10%	86%	30.5	76%	88%	66%
5	Student E	3	12%	79%	27.5	69%	71%	57%
6	Student F	4	16%	93%	30.5	76%	94%	60%
7	Student G	4	16%	79%	31.5	79%	82%	63%
8	Student H	5	20%	86%	35.5	89%	88%	69%
9	Student I	5.5	22%	93%	23.5	59%	94%	37%
10	Student J	7	28%	93%	36	90%	82%	62%
11	Student K	8.5	34%	79%	20	50%	82%	16%
12	Student L	9.5	38%	93%	37	93%	94%	55%
13	Student M	10.5	42%	100%	33.5	84%	100%	42%
14	Student N	11	44%	86%	29.5	74%	88%	30%
15	Student O	20	80%	86%	31.5	79%	88%	-1%
16	Student P	22	88%	64%	39.5	99%	71%	11%
17	Student Q	22	88%	86%	30.5	76%	88%	-12%

The above comparison table indicates the percentage of marks increased for 15 students in the range of 16% to 87% respectively in the midterm examination. Only two students got less

percentage as compared with class test: 79 and 76 percentages, respectively. Overall, 88% of students showed a salient improvement in Midterm Examination.

The Quizlet tool was introduced in 19th February 2020 in Grace International Academy. It is a web-based application, a study tool created by Andrew Sutherland in 2005. It has got two modes: study and play. In study mode, Flashcard, Learn, Write, Spell and Test options are available. Flashcard - this helps to learn the types of sets and definitions. It has an option flip, by clicking on the card it flips and shows the definition. It allows students to think and learn the set and definition. Learn - this helps students to learn with different types of questions – flashcards, multiple choices, and written, this makes them familiar with the information in a study set. Write - this helps students to know the terms and definitions in the form of a fill in the blank study tool. Spell -this helps students to practice spellings and pronunciation by listening to the term or definition using Quizlet's audio and they type what they hear? Test -this provides an opportunity for students to test their knowledge in a study set.

Match, Gravity, and Live are the options available in play mode. In the match option, students race against the clock to match the terms and definitions as quickly as possible to gain scores. In gravity, students need to type answers quickly before asteroids fall. In the Live option, it is a real-time classroom game with the team and individual play. Individual play is an engaging game, which helps to learn by matching the terms and definitions from study sets. In team play, players work in teams to correctly match the terms and definitions from the study sets.

Students really enjoyed using the Quizlet tool in classroom activities, especially for learning topics like Number Sense and Set Theory using the Flashcard option, which inspired them to think and relate their answers. The Live game option in Quizlet enabled them to participate effectively as individuals and as a team player in quiz activities.

Apart from Gamification tools, an online tool (Formative) was introduced to students on March 4th, 2020 for the chapter Basic Algebra and used to create an activity. It is a lively interactive tool, which enables tutors to check the answers of students and comment lively, and even it helps to chat with students in real-time. Vicki Davis (2015) states that in Formative assessments students can answer in a variety of methods that are all updated live on the screen. This removes the embarrassment of public hand raising and gives teachers feedback that impacts how teachers are teaching at that moment and even helps to identify where students are struggling in assignments or assessments they complete.

Due to the rapid spread of the COVID 19 pandemic, the Kerala State Government declared a lockdown from 11th March 2020 onwards, and all the educational institutions were closed, and are waiting for further orders from the government for the reopening. This critical circumstance constrained the Grace International Academy for the transformation of conventional studies to an online teaching method. A new timetable was designed for students and teachers to continue the semester in online mode. which allowed planning online activities, based on the tools 1) Kahoot, 2) Socrative, 3) Quizlet, and 4) Formative, which was already introduced in Grace International Academy during the regular class hours, and students are familiar with these tools. Apart from these tools, new ones (Zoom, Google meet, Miro, and Concept board) were introduced to students to interact lively.

A Quizizz online Gamification tool for students was introduced on 13th April 2020. Quizizz is a free tool, and it allows the tutor to conduct student-paced formative assessments with fun and engage students with bonus points and a leaderboard. It supports to use of public quizzes freely created by tutors all over the world. It has got a quiz editor with multiple options to create interactive quizzes with an automatic save feature. It generates class-wise and student wise reports, and tutors can download reports easily in excel or pdf format. Quizizz supports multiple

options for tutors to customize the quiz session, to toggle the level of competition with general or gameplay settings.

As part of revision, several tools were used to conduct activities and online tests using Gamification tools (Kahoot, Socrative, Quizlet, Quizizz & Showbie) as the framework of the semester for the subject Business Mathematics to provide internal marks for students.

RESULTS AND DISCUSSION

On 28th May 2020, Online Feedback was conducted using Google forms in Grace International Academy. As part of the semester completion for the subject Business Mathematics with the following objectives.

- The effectiveness of learning the subject Business Mathematics using the online tools Kahoot!, Socrative, Quizlet, Formative, Quizizz, and Showbie.
- Motivation of learning rate on Business Mathematics using gamification tools (Kahoot!, Socrative, Quizlet, Quizizz, and Showbie).
- Test students' understanding of mathematical concepts using the Quizlet tool.
- Check the factors that boosted engagement in students using Gamification tools:
 - 1) Game points, 2) Student paced activity, 3) Teacher paced activity, 4) Leaderboard, 5) Easily solvable questions, 6) Challenging questions, 7) Individual event, 8) Team event, 9) Can redo the activity, 10) Music in the activity and 11) Instant feedback.
- Check whether gamification tools supported the increase of Critical Thinking and Problem-Solving Skills.

In the Bachelor of Commerce program out of 17 students, 16 submitted their feedback online. A Z-score approach was used to find the effectiveness of online tools in education. According to Jeff Sauro (May 10, 2011), Z-score is the only metric that includes variability in the score. It offers the most precision because it uses the mean, and it tends to generate results in the middle of others.

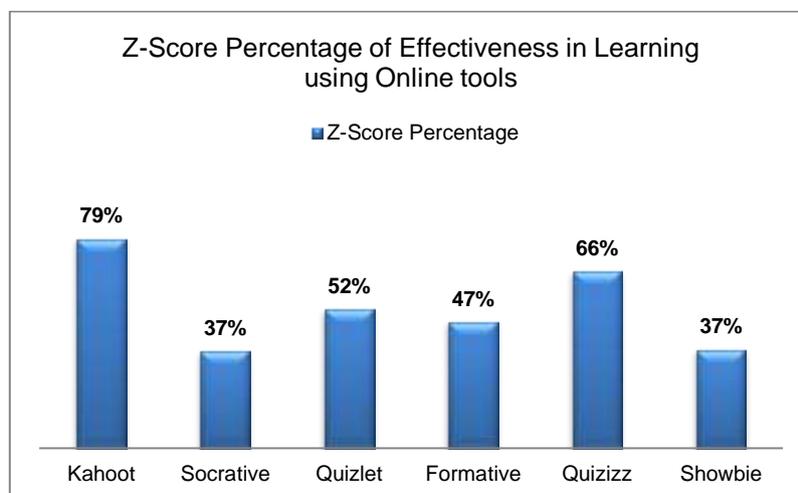


CHART 1: EFFECTIVENESS OF LEARNING USING ONLINE TOOLS

In the above Chart 1, 79% of students stated that Kahoot! is an effective tool for learning the subject of Business Mathematics. It is a game-based learning platform, which allows students to interact with simple and clear instructions. It motivates students with points, leaderboard with music, and it creates enthusiasm in classroom activities. This was observed in the classroom when the leaderboard popped up with scores and names. It supported most of the mathematical symbols in the subject of Business mathematics like permutations and combination, set theory, polynomials, and integration, which enabled to prepare objective type questions like multiple-choice, true or false in the free version of Kahoot!, even it supported to include questions of the chapter matrix in the form of pictures.

37% of students stated Socrative is an effective tool for learning the subject Business Mathematics. Socrative is a formative assessment tool; it supports collaborative activity in the form of a game event. The space race activity in Socrative creates fun and engages students in learning. Due to limited mathematical symbols (subscript and superscript) in Socrative, it only allows preparing questions from the chapter permutations and combinations of the subject Business mathematics.

52.2% of students accepted Quizlet as an effective tool for learning the subject of Business mathematics. Quizlet is a web-based application for helping students to study through interactive tools and games. It has a live collaborative classroom game activity, which creates teams of students by picking randomly from the list of students who are joined in the activity. The team needs to work together to win with other teams by matching the term with its definition. Effective student participation was observed in classroom activities.

47.3% of students agreed that Formative is an effective tool for learning the subject Business Mathematics. Formative is an interactive tool to assess and monitor student's performance. It provides live responses to students to work and allows giving feedback easily and it maintains a good track record of students' work.

66.4 % of students stated that Quizizz is an effective tool for learning the subject Business Mathematics. Quizizz is a free tool to teach and learn, it allows picking a quiz from the quizzes library or creating our own quiz. It allows students to engage at their own pace and provides feedback for their work, no grading is required. It motivates with points and pops up the leaderboard with scores and names. There are more activities related to the chapter Relation Algebra are available in the quizzes library from which suitable activities are selected and conducted in the post covid sessions.

37.06% of students stated that Showbie is an effective tool for learning the subject of Business Mathematics. It is an application to assign, collect and review student's work. It organizes students' work by classes and assignments, even students can see their upcoming assignments and due dates. Teachers can provide grades and feedback in the form of voice notes, annotations, and videos.

To find **Motivation of Learning using Gamification tools** (Kahoot!, Socrative, Quizlet, Quizizz & Showbie) for the subject Business Mathematics, the Z score results shows 81.4% of students were motivated as per the results in chart 2 as shown below.

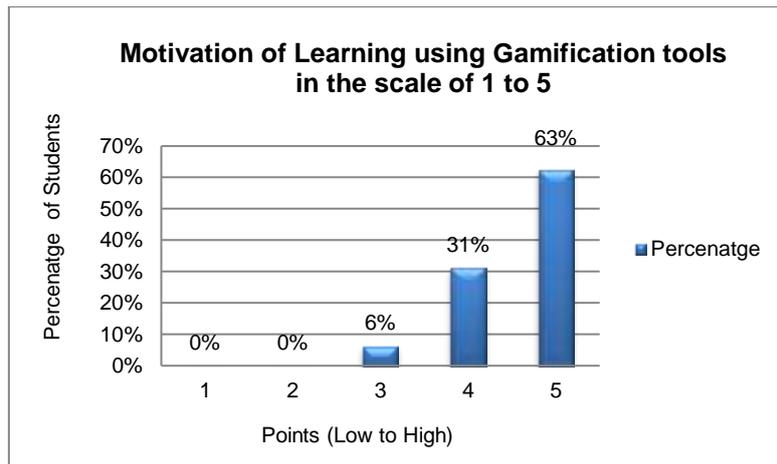


CHART 2: MOTIVATION OF LEARNING USING GAMIFICATION TOOLS

Classroom observations on activities using online tools (Kahoot!, Socrative, Quizlet, Quizizz & Showbie), reveal the effectiveness of participation and engagement of students in individual and collaborative activities. Such activities allow students to discuss, learn and understand the subject easily and to achieve their goals based on their expectations.

To test students' understanding of mathematical concepts, the Quizlet tool was used for activities in the form of flip cards, which use a term to match with a definition. This enabled students to test their mathematical skills.

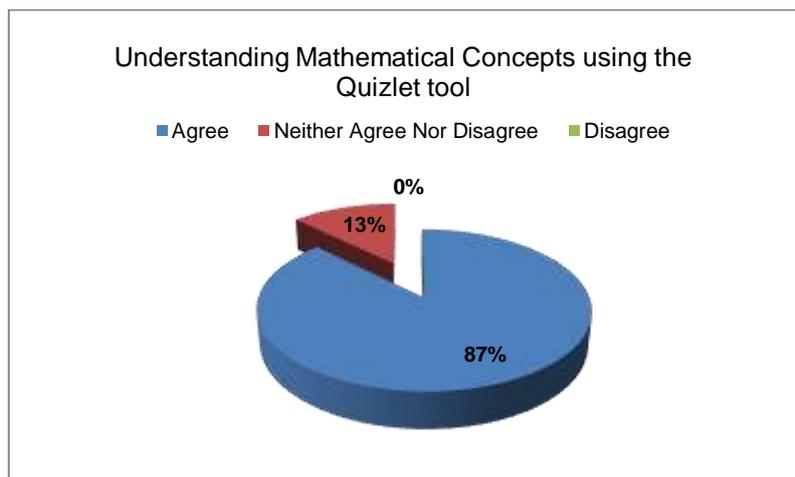


CHART 3: MATHEMATICAL CONCEPTS USING THE QUIZLET TOOL

Chart 3 shows 87% of students agreed on understanding mathematical concepts using the Quizlet tool, a noticeable change in their learning mathematical concepts. This reflected on their performance in class test activities. 13% of students stated they neither agreed nor disagreed in understanding mathematical concepts.

Below Chart 4 represents the factors that boosted students' engagement in online activities.

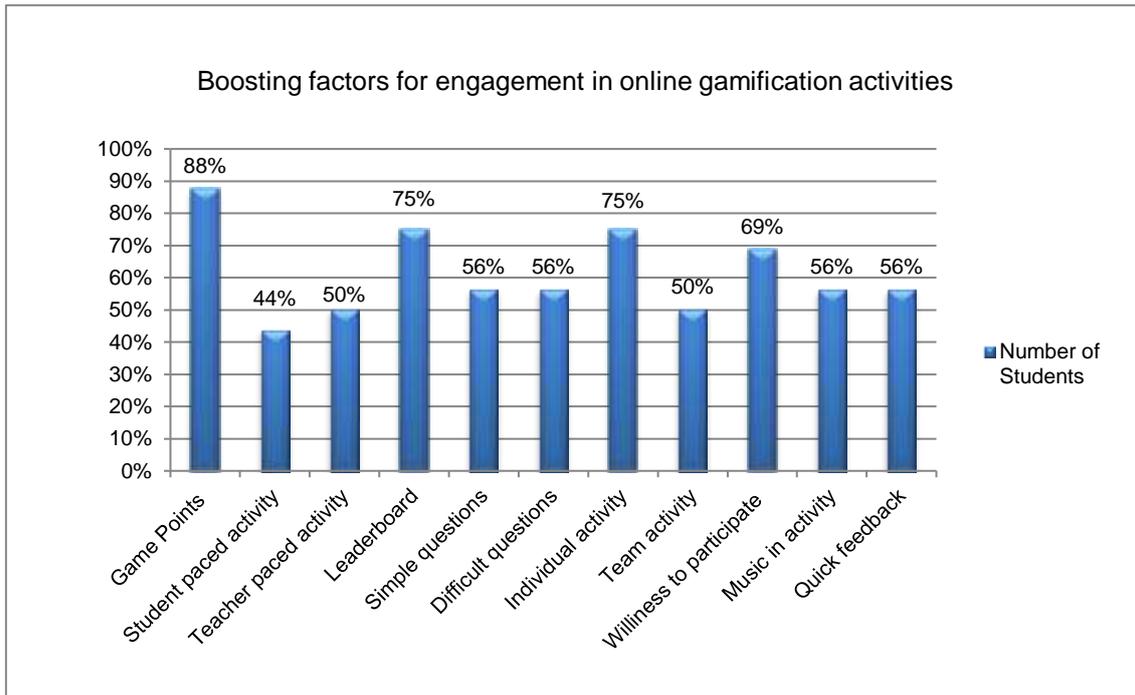


CHART 4: BOOSTING FACTORS IN GAMIFICATION TOOLS

Game points encourage students more likely to keep their focus on the activity. According to the Gamification principle "Reward players often- As players progress and complete the desired task, reward them" (Gamification Principles for user engagement, 2016). In the above chart 4, 88% of students stated that they feel boosted with the motivation of **game points** for accomplishing certain tasks or milestones and being engaged in the activity.

Student paced activity gives time for students to understand and grasp an activity by themselves. 44% of students preferred to have such a pace of activity. This allows them to develop their own learning skills independently. The tool Quizlet has more options to conduct student-paced activities in study and play modes.

Teacher paced activity with timer, 50% of students preferred teacher-paced activity, which makes students feel that they are on the clock with different behaviors of willingness to participate, and enthusiasm to complete the task at the earliest. This allows the teacher to control the activity and move along effectively keeping students engaged.

50% of students reacted positively to have **team activity**. This allowed them to interact and to clarify their answers. "When students work effectively with others, their engagement may be amplified as a result" (Wentzel, 2009) as cited in (James, 2015). In team activity, students develop communication, creativity, and problem-solving skills.

75% of students mentioned **Leaderboard** is one of the major boosting factors in Gamification tools. (Mohd Hishamuddin Abdul Rahman, 2019) States that Leaderboards have the function to

promote competition among students as well as displaying the latest ranks of students in the game. Students will be more motivated to maintain position when they are on top in the leaderboard while the ones who are trailing are more motivated to chase the ones on top, there are studies reported that the leaderboard has lowered the motivation of students who are below points.

56% of students preferred **Simple questions**, most of the activities are designed using Gamification tools where objective type questions, which require a specific answer in the form of matching, true/false, and multiple-choice. Most of the students prefer multiple-choice, true or false, and matching, with this form of questions allows them to select the answer easily. In the case of definitions, students need to memorize well to write the answer.

56% of students preferred **difficult questions** in the form of fill in the blanks and short answers, normally students struggle in fill in blanks and one-word answers. They need to get the correct spellings for the word or to calculate the values using mathematical formulas, such activities develop memory recall and logic skills for students.

75% of students preferred **Individual activity** to test their knowledge as a practice session. It allows them to develop their confidence level in learning. Interaction with students was observed, they felt more comfortable in participating in the activity individually. The results of the activities show the number of attempts of students was escalated, In each attempt, they were able to improve their performance.

50% of students preferred **Team activity**, it allows collaborative learning and fosters new creative ideas and opinions. A team effort can increase motivation in learning. It promotes open and clear communication amongst team members. The team members can discuss notions with each other and able exchange their views on different topics and matters, and ultimately, they can reach to final and uniform answer in a better way. It helps the team members to escalate their vocabularies substantially. They can find out the mistakes due to inadvertence, correct them and present fair and good answers.

69% of students showed **Willingness to participate** in the activity again. Teachers can activate the option (allow multiple entries) for the participants while designing an activity. Multiple entries allow students to practice and learn the concepts well.

56% of students preferred **Music in activity** -tools Kahoot, Quizlet, and Quizizz have inbuilt music in the activity. (Catherine, 2017) States that music makes us creative in improving our mind more enthusiastically by making it more artistic and ingenious. It has the potential to improve our listening as well as our understanding ability and has a unique way to develop the capability of memorizing.

56% of students preferred **Quick feedback** in an activity, it helped them to make progress in their learning. According to (Gamification Principles for user engagement, 2016) **frequent feedback on progress** shows players how their actions are related to achieving their goal.

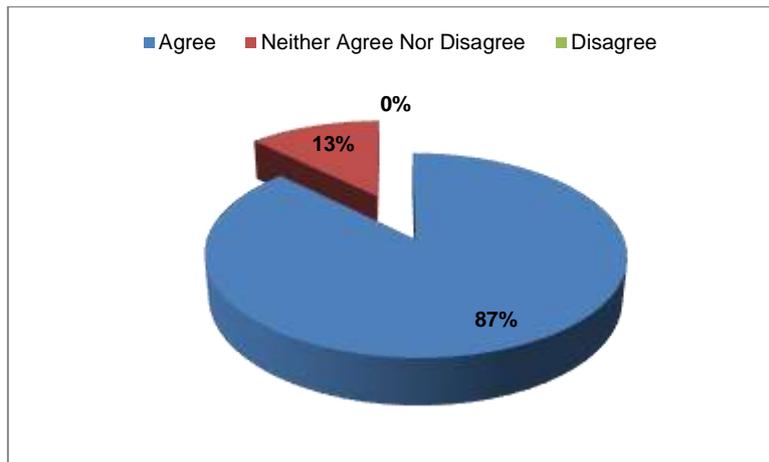


CHART 5: CRITICAL THINKING AND PROBLEM-SOLVING SKILLS USING GAMIFICATION TOOLS

Mathematical problem-solving is one of the most complex to teach, to make students learn and understand different concepts and characteristics and develop skills to solve problems. The form of blended learning which combines traditional learning and online learning enabled students to understand mathematical concepts to test and apply their knowledge to solve mathematical problems using online Gamification tools (Kahoot, Socrative, Showbie, Quizlet, and Quizizz).

Chart 5 above data show, 87% of students agreed on the increase in critical thinking and problem-solving skills using Gamification tools. According to (Why are critical thinking and problem solving essential in today's education?, 2018) Critical thinking improves student's flexibility and learning skills and it helps to express their ideas. If students learn to think critically, then they can use good thinking as a guide by which they live their lives. It will allow students to ensure their decisions are based on facts and logic. Critical thinking and problem-solving skills help students to adapt to any changes in the future.

CONCLUSION

The results show that the Gamification tools substantially enhanced students' motivation in learning and understanding mathematical concepts and it has boosted students' engagement in Gamification activities, which escalated their critical thinking and problem-solving skills. In the context of the subject, Business Mathematics for the students of the undergraduate program (Bachelor of Commerce) of Grace International Academy had challenges to understand the mathematical basic concepts through online learning. The traditional method was used in the initial stage to clarify basic mathematical concepts for students, to form a strong foundation for students in learning and teaching the subject of Business Mathematics. This research reflects both the traditional classroom and the online Gamification tools are the best option in teaching and learning the subject Business Mathematics. Institutional and technological impediments were encountered at the time of implementing the Gamification tools, on the other hand, the Covid 19 pandemic lockdowns allowed us to use online and Gamification tools more often.

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