DISCOVER CALCULUS THROUGH ORIGINAL 3D ANIMATED SITCOM “RATVENTURES”

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ABSTRACT

Mathematics classes are traditionally conducted using front-loading teaching strategy in a didactic manner. Our curriculum tends to emphasize the acquisition of computational skills. Many perceive mathematics as a subject that consists of a collection of formulae, rules, and skills. They do not see how mathematical ideas interconnect and much less connection with their daily lives. This project seeks to reimagine our mathematics lessons to enable sustainable learning and organic learning. Organic learning arises from the needs of a context. Through the original 3D animation sitcom “Ratventures”, we aim to contextualize and make mathematics relatable to learners. Sustainable learning builds understanding. Learning activities are designed in relation to each “Ratventures” episode to facilitate the understanding of the targeted mathematical topic through guided discovery approach. Instead of the traditional didactic approach, learners are guided in their discovery of the mathematical concepts, intuitive proof of rules and formulae, and translation of contexts to mathematical applications. In the process, we seek to ease learners into the world of mathematics and make mathematics more accessible by translating learners’ understanding in spoken language to the language of mathematics. A pilot run was conducted on first year engineering students in Nanyang Polytechnic, taking Calculus module. We investigated the effects on learners’ mathematical achievement and engagement with the proposed strategy. The comparison between the control group receiving the traditional didactic manner of delivery and the experimental group, which was subjected to the proposed guided discovery approach, was based on data from three sources (a) survey measuring student engagement; (b) a baseline test, given as pre-test and post-test; and (c) class quiz vs final examination. The experimental group registered significantly higher engagement level than the control group. While no statistically significant difference was found for the baseline test, the experimental group achieved higher normalized gains in their final examination.

KEYWORDS

Storytelling, Mathematics, Teaching for Understanding, Concept-based, Edutainment, Standards:8

INTRODUCTION

Existing Mathematics Classroom

The engineering mathematics curriculum in the polytechnics in Singapore tends to emphasize the acquisition of computational skills in mathematics. Coupled with our largely didactic mode of delivery, many view mathematics as a subject that consists of a collection of formulae, rules and skills. Oftentimes, these facts and skills are counterintuitive to learners. This learning phenomenal is not unique to Singapore. It is well-articulated in the report by National Academy of Sciences, Washington DC (National Research Council, 2000). The report asserts that: "... students often have limited opportunities to understand or to make sense of topics because many curricula have emphasized memory rather than understanding. Textbooks are filled with facts that students are expected to memorize, and most tests assess students' ability to remember the facts."

Such lopsided emphasis on procedural fluency results in learners becoming passive recipients of isolated, memorized mathematical formulas and rules. (Martin, H., 2006). They do not see how mathematical ideas interconnect and build on one another to produce a coherent whole. Learners do not have a positive attitude towards learning mathematics. Perhaps there are occasional mention of how mathematics is connected to other disciplines or their utilitarian value in industries. Nonetheless, most see much less connection between classroom mathematics and their daily lives.

There are approaches to make explicit connections between mathematics and the core engineering modules. McCartan, C. D., Hermon, J. P., & Cunningham, G. (2010) created a model to sustain engineering mathematics learning in a CDIO environment whilst F. Seng, Y. Soo, N. Singh, N. Ling (2009) sought to integrate the learning of engineering and mathematics modules through the use of a common Engineering Formulae booklet. This paper regards mathematics as a language of science, with which engineering is based upon. It attempts to translate the abstract mathematical notations and concepts using layman’s language and from there connects the language with our daily lives that are largely surrounded by engineered environment.

Ideal Mathematics Learning

Learning mathematics is not a fragmented process. In fact, it is a holistic, integrative one that interweaves five aspects that lead to the development of proficiency in mathematics. These 5 strands of mathematics proficiency are procedural fluency, conceptual understanding, strategic competence, adaptive reasoning, and productive disposition (Kilpatrick, Swafford, & Findell, 2001). Not only do learners have to acquire the skills to carry out mathematical procedures (procedural fluency), it is also imperative for them to comprehend mathematical concepts (conceptual understanding) so that they would have to ability to formulate, represent and solve mathematical problems (strategic competence). Especially for non-routine problems, competent learners would be able to use their logical thinking to explain and justify the legitimacy of a proposed strategy or procedure (adaptive reasoning). Other than a sufficient knowledge base, learners also should see sense in mathematics and perceive it as both useful and doable (productive disposition.) Only then will he or she be willing to put in steady effort in learning mathematics to see it pay off.

Mathematical proficiency is not a one-dimensional trait. Our procedural-heavy mathematics curriculum could directly or indirectly negate learners' attitude towards learning mathematics, which might be further compounded by our largely didactic mode of delivery. To navigate and progress in today's world which is built on the integrative experiences of the STEM (science, technology, engineering, and mathematics) fields, it is imperative for us now to shift our emphasis away from building procedural fluency to nurturing thinking mathematics learners.

ORGANIC AND SUSTAINABLE LEARNING IN MATHEMATICS CLASS

The team takes a comprehensive and systemic approach ***in reimagining our mathematics lessons to enable organic and sustainable learning***. In doing so, we aim to engage learners in the learning of mathematics and improve their mathematics achievement.

Organic Learning

Organic learning is learning which develops intrinsically from within the learner when he/she is intrigued by a topic, problem or concept and seeks ways to fulfill this curiosity. Organic learning arises from the needs of a context. To engage learners in the learning of mathematics, we aim to contextualize and make mathematics relatable to learners through the original 3D animation sitcom “Ratventures”,

"Ratventures" is a series of 14-episode sitcom. The story circles around Ah Hock, a karung guni man (a Singlish term: He is our local rag-and-bone man who collects used items such as newspaper, electrical appliances, clothes etc.) and a rat named Ayden. They are co-founders of a food delivery application, "Snitch Food", that serves the rat community. Each episode features the rat's food delivery adventure. The episodes are carefully crafted to provide the contexts for learners to achieve the understanding of the targeted mathematical topics.

While we seek to spark learners' initial interest with a story, our challenge is to sustain learners' interest and engagement and ensure that it does not evaporate as the story ends. Generally, a story captivates attention with a conflict or expectation set up at the beginning. The plot becomes more complex in the middle and finishes with a resolution at the end. The 'end' or "conflict resolution" is then turned into learners’ activity. The story thus evolves into exploration and problem solving. In such a way, we attempt to engage learners not only with a story but with the mathematics in the story.

Stories present themselves as contexts which are complex, ill-structured, infused with uncertainties and assumptions, unlike textbook problems which are well-defined quantitatively to let learners practice their skills. Learners become agent of problem formulation as they begin a mathematical discourse with their peers and/or instructor. This furnishes instructors the medium to humanize the language of mathematics. A new definition and/or notation of a mathematical fact can seamlessly be introduced as learner's self-constructed understanding in spoken language is translated to the language of mathematics. This helps ease learners into the world of mathematics and makes mathematics more accessible. In the process of problem solving, non-linear cognitive thinking takes place - an iterative process of convergent-divergent reasoning. Divergent thinking occurs when learners consider myriad of possible solutions while convergent thinking happens as learners justify an optimal solution. Learners takes responsibility in both problem formulation and problem solving. Learning of mathematics arises from the needs of a context. Learning becomes organic.

Why Storytelling?

Using storytelling to teach mathematics is not new. Mathematics is rich in historical development of ideas. At times, these historical anecdotes are woven into teaching either to provide context to a mathematical topic or to incite positive attitudes towards mathematics. Nevertheless, it is mostly done informally rather than as a structured activity.

Zazkis and Liljedahl (2019) believe that telling stories in mathematics classroom creates an environment of imagination, emotion and thinking. Stories make mathematics more accessible to learners as well as more engaging. They also provide a context for making meaning of abstract mathematical concepts (Cotti, R., & Schiro, M., 2004).

Sustainable Learning

Learning is sustainable if learning is transferable beyond the time and context of its learning. Sustainable learning involves ongoing, purposeful, responsive and proactive learning; the learner effectively builds and rebuilds her or his knowledge and skills base as circumstances change (Hays, J., & Reinders, H., 2020).

Sustainable learning thus entails building understanding. According to Kivunja (2015a, p.286), understanding may be regarded as: " ... the learning process in which learners engage in critical analysis of new ideas that they encounter, link those ideas to concepts and principles that they already know, and through this process gain an understanding and long-term retention of concepts and ideas that they can then apply them in problem solving in new contexts."

Apparently, understanding calls for observable performances or demonstrations of higher-order critical thinking. Understanding is not just knowing something or being able to regurgitate it or demonstrate the skill upon demand. A learner shows understanding of a topic when he or she is able to perform a variety of thought-demanding things about a topic. For instance, find examples and non-examples, provide analogy or metaphor, explain derivation, represent the topic in a new way, apply and generalize. Such are the performances of understanding which take learners beyond what they already know. How do we teach for understanding?

Teach for Understanding Framework

We adopted Blythe & Associates (1998) four-part teaching for understanding framework. The framework fosters deep disciplinary understanding. It comprises four key ideas: generative topics, understanding goals, performances of understanding and ongoing assessment.

Generative topics are concepts, ideas, skills etc that are interesting, accessible to learners and are worth understanding. They provide enough depth, meaning and connections to support learners' development of understanding.

"Facts do not transfer, i.e. they cannot be applied directly to a new situation. When we try to apply our insights from one situation to another, we are always abstracting the conceptual level, generalizing from a specific instance to a broader rule." The key to sustainable learning is to build understanding for conceptual transfer. Erickson and Lanning (2014) concept-based model "differentiates clearly what students must know factually, understand conceptually and be able to do in processes, strategies and skills."

The content in traditional curriculum model has been largely defined by knowledge and skill objectives, using Bloom's Taxonomy. It lists what learners have to know and uses process verbs such as explain, evaluate to suggest the different levels of cognitive necessary to complete the task. While the assumption is that such approach would lead to deeper conceptual understanding, many a time, while educators could readily cite the learning outcomes of a certain topic, they struggled to articulate the conceptual understandings to be drawn from the topics and skills.

To identify generative topics, we used Erickson and Lanning concept-based curriculum design to identify the knowledge, concepts, and skills for each topic in the existing syllabus that are generative. Besides, this concept-based approach also facilitates instructors in framing the understanding goals of each generative topic to help learners focus on the most important aspects of the topics.

Curriculum design guides instructional pedagogy. The generative topics are presented in each episode in Ratventures as one of these three types of stories: story (I) that leads to the discovery of a mathematical concept; story (II) that introduces the intuitive proofs of mathematical formulae and rules; and story (III) that enables translation of contexts to mathematical applications to assess learners' transfer of understanding.

In didactic teaching, we tend to verbally define a mathematical object and its notation and expect our learners to grasp them. However, the ability to regurgitate the definition and memorize the use of the notations does not necessarily reflect learners' grasp of the concept. Stories of type (I) facilitate learners in discerning the meaning of the mathematical object through their everyday language and in visualizing it in different forms, for example, geometrical and graphical forms, in addition to its abstract algebraic expression. At polytechnic level, our curriculum does not require learners to know the mathematical proofs of the formulae and rules used in the syllabus. Learners have been using them "blindly" without understanding its derivation. Stories of type (II) give learners an intuitive idea of the derivation of the formulae and rules without going into the rigor of the mathematics. Knowledge of their derivation helps improve the understanding of related concepts and provide much ease to learners in using them. Stories of type (III) offer real-life, unstructured scenarios for learners to apply what they have learned.

Each learning experience begins with an episode of Ratventures, which engages learners not only for its plot but also its inherent mathematics content. In doing so, we seek to trigger interest and mathematical discourse amongst learners and/or between instructor and learners. Other than to provide an interesting context to introduce mathematical content, the scenario allows instructors to translate learner's understanding in spoken language to the language of mathematics. In such doing, we hope to ease learners into the world of mathematics and makes mathematics more accessible.

While we seek to engage learners with stories in Ratventures, we also craft thought provoking learning activities to sustain learners' interest, as well as to help build and demonstrate their understanding. To facilitate learners in constructing their own understanding of the mathematical object, the activities may commence with relatively simple tasks to more demanding ones (e.g. explain in your own words, give an analogy). Using open-ended and higher order inquiry, learners can be nudged to further extend their learning by generalizing concepts or by extrapolating to a similar or related topic. These inquiry-based activities are scaffolded to cater to differentiated learning abilities.

In the process, by responding to a learner's comment in a class discussion and/or an impromptu review of a learner's work, appropriate feedback is given to help learners develop and deepen their understanding. Such informal ongoing assessments, which occur throughout the entire sequence of instruction, better meets the needs of learning for understanding and make learner's growth visible. In the process, learners become aware of criteria for self-evaluation of understanding, receive feedback and are afforded opportunities for reflection. Such assessments are not only beneficial to learners, they also inform the instructor the effectiveness of his or her instruction and indicate possible improvement to any instructional strategy. Instructor can monitor the progress of learners, discern their barriers to understanding and identify ways to help learners develop understanding.

The design of each learning activity is explicit in its understanding goals so that instructors can focus on facilitating learners in making connection between mathematical topics and between mathematics and their everyday use. In the design of these learning experiences, it is important to afford the opportunities for learners to build on their prior knowledge in the construction of their own understanding of concepts. This facilitates the making of connection between mathematical concepts. By exposing the learners to a range of real-world problems afforded by the concepts within syllabus, they allow learner to apply their understanding and connect abstract mathematics to real-world applications. Wherever necessary, it may be good to harness technology by using ICT tools to investigate and explore mathematical concepts.

Why Teach for Understanding?

Comprehending mathematical concepts makes learners less susceptible to common errors and less prone to forgetting when performing procedures. Clearly, conceptual understanding supports procedural fluency. It also prevents perfunctory application and support appropriate transfer of knowledge and skills as learners encounter different temporal and contexts in problem solving. A good understanding would put learners in a better position to justify their own work without depending on a third party to check. As self-directed learners, they would be able to justify the validity of a proposed strategy or procedure.

RESEARCH

Objectives

This paper proposes guiding students in their discovery of mathematical concepts, rules and formulae for the subject of Differential Calculus through original 3D animated sitcom "Ratventures". The 3D animations of scenarios in "Ratventures", together with their associated learning activities, are created based on the principles of building understanding and to allow contextual learning.

We seek to investigate the effects on year 1 engineering students' mathematical achievement and their attitude towards the learning mathematics through the adoption of the proposed strategy. To address these 2 concerns, the following hypotheses will be tested: (1) There are no statistically significant differences in students' achievement that can be attributed to the proposed strategy at 5% significance level and (2) There are no statistically significant differences in students' positive attitude toward learning mathematics that can be attributed to the proposed strategy at 5% significance level.

Participation

Calculus is a core subject for all first-year engineering students in Nanyang Polytechnic (NYP). The NYP Institutional Review Board (IRB) approved the pilot run to be conducted in the second semester of the academic year 2020 (AY2020S2) for 6 tutorial classes of first-year engineering students in NYP. About 95% of the 122 students consented to participate in the pilot run. Participation was voluntary. The participants could withdraw any time during the pilot period. The 6 tutorial classes were spilt into 3 experimental groups with 63 consenting participants and 3 control groups with 53 consenting participants.

All students in both control and experimental groups were taught the same mathematical content and received the same assessments. The main difference lies in the delivery strategies. Those in the control group were taught using conventional front-loading teaching strategy in a didactic manner while those in the experimental group were guided in the discovery of the mathematics content using the animated learning materials crafted for the purpose of this study.

Delivery Content using Ratventures

While there are 14 episodes of Ratventures, only 4 episodes were fully animated for use during the pilot period. Table 1 shows how the generative topic of "What is derivative?" is dissected into facts, understanding and skills according to Erickson and Lanning (2014) concept-based model. Table 2 summaries the scenarios presented in the 4 episodes and their discussion points.

Table 1. Facts, Understanding and Skills for "What is Derivative?"

To Know (Facts)	To Understand (Understanding)	To Do (Skills)
Derivative: - Definition - Notation	• Derivative in different presentation forms: numerical, graphical and algebraical. • Derivative as a point / function	
	Derivation of rules of differentiations and formula based on the definition of derivative	To find the derivatives of different function types and different combinations of functions based on rules of differentiation and formulas of derivatives.

Table 2. Content of the 4 Episodes of Ratventures

Episode / Story Type / Topic	Scenario	Trigger / Discussion Question
Episode 1 Story Type: I What is Derivative?	Ayden received order for 2 glasses of soya bean milk. He used a cylindrical glass and a conical glass to collect the drink from leftovers discarded by a hawker. Happily, he added 1 spider in each glass as extra toppings for his rat customer, hoping to secure good rating for his newly launched food delivery application, Snitch Food, However, his rat customer complained that only one of the 2 glasses contained the extra topping.	Which glass did the spider escape from? Explain your answer in layman terms, in graphical form and using the language of mathematics.
Episode 2 Story Type: III Application: What is Derivative?	Ayden received an order of ice-cream. The delivery destination is right across the end of a bridge which has a speed limit of 5m/s. His "rat" customer was upset with receiving less than full serving of ice-cream and chided him for speeding. Ayden recalled being hindered by someone in wheelchair during his delivery journey but still managed to make his delivery right on time.	Did Ayden speed? Explain your answer in layman terms, in graphical form and using the language of mathematics.
Episode 3 Story Type: II Differentiation Rule: Addition	Ah Hock was getting ready for his dinner date at his own apartment. Ayden helped Ah Hock spray his greying hair black. Suddenly, they saw a spider on the wall, which he was worried might scare off his date. Ah Hock tried to catch it with his spray-stained hand but to no avail. Instead, he left a dirty mark on the wall. Ayden jumped onto Ah Hock's hand and made another attempt, but the spider was still out of reach. Then they heard footsteps walking towards them and thought Ah Hock's date was arriving. At this instance, they both tiptoed to reach for the spider and finally caught it. However, it was a false alarm. Ah Hock's date was not within sight yet but 3 stains were left on the wall.	With the help of a fully labeled diagram, explain the 3 stains on the wall and how it helps us visualize addition rule of differentiation.
Episode 4 Story Type: II Differentiation Rule: Product	While waiting for his date to arrive, Ah Hock decided to lay a tablecloth to cover his rather tattered table. However, the new tablecloth he bought was too small to cover the entire	With the help of a fully labeled diagram, explain how much tablecloth the ratoon stretched to cover the

	rectangular table. Ayden recruited his "ratoon" to help Ah Hock stretch the tablecloth. Just as he tried to tape the stretched tablecloth to the table, his date arrived.	entire table within the instance and how it helps us visualize product rule of differentiation.

Research Instruments and Results

The comparison between the control and experimental groups was based on data from three sources: (a) survey measuring student engagement conducted after interventions; (b) pre-test and post-test specifically designed for the targeted conceptual topic "What is derivative?"; and (c) class quizzes as baseline assessments vs students' achievement in the final exam based on the relevant topics.

Student Engagement in Mathematics Scale (SEMS) (Leis, M., Schmidt, K. M., & Rimm-Kaufman, S. E., 2015) was used for students to self-report their learning attitude in learning mathematics. The survey consisting of 15 Likert-scaled questions, which was conducted after each intervention. Question numbers 1 – 4 are statements regarding social engagement, question numbers 5 – 8 cognitive engagement and question numbers 9 – 11 emotional engagement. Question numbers 12 – 15 test their self confidence in mathematics. A rating value of 1 represents "Strongly Disagree" while 5 means ""Strongly Agree".

Table 3 shows the survey questions, results of the Mann–Whitney U test, and the mean ratings for each question of the engagement survey for the different study groups. According to the Mann–Whitney U test, the most significant difference between the two groups is for question numbers 1, 2 and 3 ($p < 0.05$), which show more social interaction amongst learners and/ or instructors in the experimental group that are tethered to the instructional content. There are weak evidence showing differences ($p < 0.10$) between the two groups for question numbers 6, 7, 10 and 12. Questions 6 and 7 point towards the extent to which learners show their willingness to exert effort to understand content and work through difficult problems while question 10 refers to learners' connection to content, interest in learning and thinking about the content. The experimental group exhibits though weak but higher rating than the control group. There is a weak but higher level of anxiety in learning mathematics for the experimental group.

Table 3. Mann -Whitey U Test Result of Engagement Survey

No.	Survey Question	p - Value	Mean Rating	
			Control Group	Experimental Group
	SOCIAL ENGAGEMENT			
1	Today I discussed/brainstormed/talked with my classmate(s) about math in class.	**0.00001**	3.52	4.37
2	Today I helped my classmate(s) with math when he/she/they didn't know what to do.	**0.02260**	3.22	3.62
3	Today my classmate(s) helped me with math when I didn't know what to do.	**0.04036**	3.52	3.86
4	Today the discussion in my math class helped me understand the topics.	0.17384	3.89	4.13
	COGNITIVE ENGAGEMENT			
5	I paid as much attention as I could in my math class today.	0.15560	4.13	4.40
6	I put in as much effort as I could in doing the tasks in my math class today.	0.08544	4.17	4.43
7	My math class today made me do a lot of thinking.	0.08186	4.11	4.37
	EMOTIONAL ENGAGEMENT			
8	I felt bored in math class today.	0.24604	3.91	4.16
9	I enjoyed thinking about math today.	0.37346	3.89	4.11
10	Learning math was interesting to me today.	0.08544	3.72	4.11
11	I liked the feeling of solving problems in math class today.	0.80258	3.94	4.06
	SELF CONFIDENCE			
12	Studying mathematics makes me feel nervous.	0.05876	2.78	3.19
13	Mathematics makes me feel uncomfortable.	0.40090	2.70	2.89
14	I learn mathematics easily.	0.22628	3.07	2.87
15	I believe I am good at solving mathematical problems.	0.64552	3.17	3.06

Figure 1 shows that the mean ratings for all questions are higher for the experimental group except question numbers 14 and 15 which indicate learner-reported self confidence in learning mathematics. It is worth noting that higher rating for question 12 and 13 expresses higher anxiety in learning mathematics.

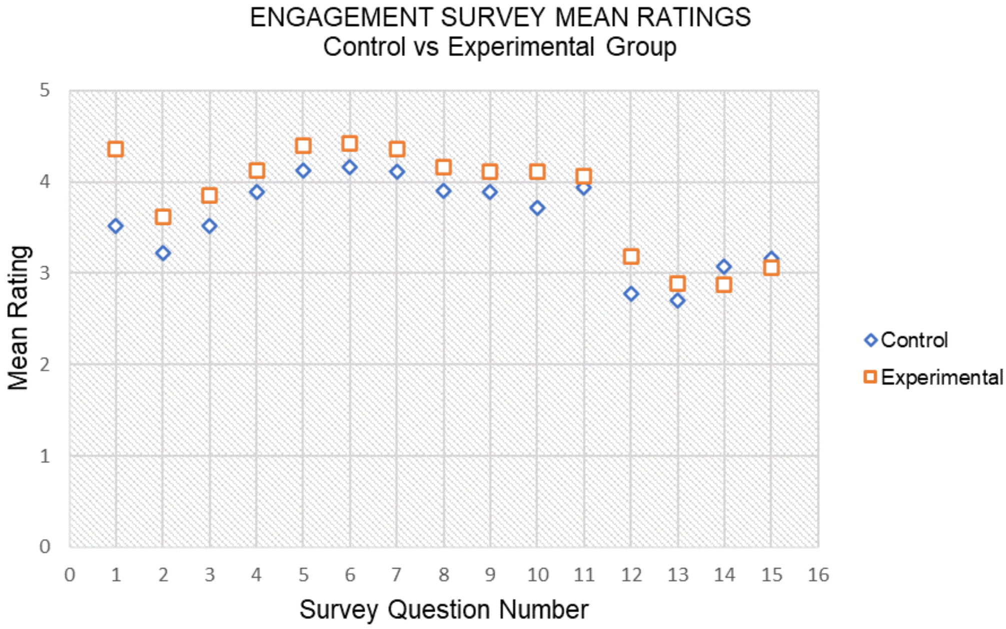

Figure 1: Graph of the Mean Ratings for each survey question between the control and the experimental group.

In the survey, participants were also asked to comment on what they liked about the class. Table 4 shows the top 3 themes that emerged from a thematic analysis (Braun, V., & Clarke, V. 2006) of the comments in the survey. In the analysis, common threads were identified in each comment and were coded. Codes of similar content were then grouped to generate the following three themes.

Generally, students find the proposed way of delivering mathematics classes to be engaging / interesting / fun / entertaining. The teaching materials used, for instance, the contexts presented in the 3D animation clips added a fun element to the classes while the mathematical discourses generated in the attempt to tackle the tasks presented in the animation clips made the class engaging. In comparison to passive learning, the discussion amongst the students and teachers that tethered to the instructional content made the class more interactive.

Table 4. Top 3 themes and their sample comments

	Themes	"What do you like about the class?"
1	Engaging / Interesting / Fun / Entertaining	Novel and unconventional method of teaching, interesting and thought provoking.
		It is engaging and makes me think like a lot
		I like how the class explains how the formulas are derived.
		It makes me think on a deeper level
2	Teaching Materials Used	It is engaging by using story telling although the end is unexpected.
		How the cartoon presents its questions
		The rat videos help explain the concept better
		The videos were very engaging and funny. There were a few learning points to take note in the video
		I like how it was a unique way of teaching through interactive videos. As such, it didn't feel as daunting to learn and understand
		I like how the concepts are simplified to help those without A-math or calculus background understand why we need calculus.
3	Interactive	It promoted teamwork and engagement with friends and teacher, which we will usually not get during math lessons
		I discussed with classmates and each of them contributed their idea so that we can learn from different perspectives

To assess if there is any improved mathematics performance, a pre-test consisting of 8 MCQ questions was given to the participants and a similar post-test was conducted right before and after the lesson for “What is derivative?” respectively. A 5% significance t-test on the difference of the mean scores of the pre and post tests for both the control and experimental groups (p-value = 0.10 > 0.05) showed no significance between the 2 groups in their mathematics performance.

On the other hand, as part of the assessment plan of the module, students have to undergo class quizzes and their final examination scores on the targeted topics. Their normalized gains, calculated as

$$g = \frac{exam\ score - quiz\ score}{100 - quiz\ score} \quad (1)$$

measured the improvement divided by the maximum possible improvement. The average gain was calculated for the both the experiment and control groups and used as an indication of how much was learnt in the respective groups during the course. A t-test on the difference in their average gains (p-value = 6.09E-11 < 0.05) showed that the experimental group performed significantly better than the control group. While the positive result may point to enhanced efforts by the students due to more positive attitude towards learning of mathematics, it may be too quick for us to conclude that the proposed strategy improved learners’ mathematics achievement. More pilot runs on different cohorts are necessary to eliminate the possibility of the experimental group in this run being an exceptionally engaged one.

DISCUSSION

The Calculus module like other mathematics modules in NYP heavily emphasizes on computation proficiency. Computation is an integral part of learning mathematic. The proposed approach aims to shift the emphasis a little by introducing more conceptual understanding in the delivery using 3D animation, “Ratventures” to engage learners and hopefully improve their mathematics achievement.

Using 3D animation may seem juvenile for the tertiary students. There was initial concern that the novelty may wear off as students are exposed to more episodes. Students’ responses thus far seem to suggest that they are intrigued by discussion triggered by the stories in Ratventures.

However, the delivery of the classes may not come easy for many instructors as it involves mindful facilitation, a stark deviation from didactic teaching. It is imperative for instructors to ensure that learners possess the necessary prior knowledge before the planned lesson or include review of prior knowledge in the planned lesson. Failing which, the class may evolve into one that focuses on topics not related to targeted ones. With facilitation as key mode of delivery, the discussions in class can be very divergent. Not to be distracted, instructors have to be very mindful of the understanding goals for each lesson in order to lead students to the discovery of the intended mathematical object. The process is no doubt time-consuming.

In an education landscape that is examination oriented, students are naturally concerned if the understanding they acquired during the classes will be assessed during examination. Else, students see no purpose in understanding if questions are solely testing on mathematical computation. It is noteworthy that didactic teaching is not all bad especially since many students are used to the mode of learning and the content delivered are crucial to achieving assessment success. However, if we are committed to nurturing thinking mathematics learners, a wholistic approach to the curriculum design is necessary to ensure that our assessment plan is in line with our pedagogy and learning outcomes. It would take more than a mere change in delivery material and mode to meet our objectives of improving students’ mathematical performance.

This study perhaps does more in terms of easing learners into the world of mathematics and make mathematics not as alien as it seems. It allows students to appreciate that the language used in everyday life can be seamlessly translated to the language of mathematics, for which engineering is based upon.

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