

CREATING REAL LEARNING EXPERIENCES RATHER THAN TEACHING BASED ON THE TRADITIONAL TRANSFER OF MATHEMATICAL INFORMATION, AT COLLEGE LEVEL

Elizabeth Mena AVILÉS
Tecnológico de Monterrey, Mexico

Ana Gema Guevara AGUILAR
Tecnológico de Monterrey, Mexico

Roberto Rosas RANGEL
Tecnológico de Monterrey, Mexico

Ernesto Save MORENO
Tecnológico de Monterrey, Mexico

ABSTRACT: Innovation in Education is a must in the 21st century education around the world. The TEC de Monterrey system in Mexico is working hard in preparing and encouraging their teachers to innovate and use new educational models. Teachers are constantly implementing new teaching and learning techniques, not only to have better teaching practices in all fields, but also to build important life skills in their students. Competences such as collaborative work, problem solving, leadership and critical thinking are some of the skills that are cultivated by using these techniques. A group of Mathematics' teachers in the Tec de Monterrey Campus León in Guanajuato México, have been using challenges in class as a way to create real learning experiences by using technology, flipped learning, and mystery stories to improve reading comprehension skills as well as mathematical knowledge. Mathematics lessons have evolved from the simple transfer of extensive amounts of information to creating the conditions necessary for students to develop life long experiences. In a preliminary survey about math lessons in our campus, more than 54 % of the total students in this project, mentioned that they find math courses in general very difficult, tedious, mechanical and without challenges. This study suggested that students learned math faster and deeply in a dynamic and fun way, 91 % of students in the final survey answered that learning math through the new method was more meaningful and enjoyable, improving the enthusiasm about learning math amongst students. Math scores were higher in the groups that followed this new educational technique.

Key words: learning experience, dynamic, innovation, challenge.

INTRODUCTION

We are living in times of significant change; our societies, institutions, businesses, occupations and the way in which we communicate and interact with others continue to evolve. Therefore, it is the responsibility of the educational community to generate new learning platforms, models and strategies that when implemented to the students, will help them coalesce to the XXI century professional life. In the Tec, de Monterrey, we strive to provide relevant learning experiences that include hands on practice in the community; this ensures the development of an important level of maturity in the students to deal with different cases, situations, problems and projects. As Karl Fisch so perspicaciously stated in 2007 (Fisch, 2015) "We are currently preparing students for jobs that don't yet exist, using technologies that haven't been invented in order to solve problems we don't even know are problems yet", and our challenge as educators consists in taking advantage of the years in which our students will be with us to help form the future leaders of these changes.

We live and learn with every aspect of our personality. When we combine our emotional knowledge with our physical knowledge, we achieve true human learning, which, according to Claxton (Claxton, 2008) occurs when we no longer know what to do, and therefore any learning experience will pose a certain risk, a gamble, in which we must accept uncertainty free from any anxiety or anguish, living each new challenge as an element of a complex society in which a culture for learning will emerge that will stimulate the individual's confidence in his or her learning ability in any situation. Let us embrace this idea and allow every student to actively experience their responsibility for their own learning and that of their teammates, (Gomez, 2016) following a determined set of instructions, training and actions that based on technology and several communication strategies will develop personal and social skills which will transform into a habit of collaborative learning.

After working with college freshmen for many years, we have noticed that the newer generations have developed additional curricular competencies during their middle school and high school education. While these students display an increased ability to communicate in a language other than their native tongue, follow social roles and effectively work in teams, their logical thinking skills and creativity in problem solving have diminished. This newer generation, commonly referred to as the Millennials, is less devoted to formal reading. Although they claim to spend much time reading, their perusing is mostly confined to social media and brief articles they find on the web to superficially become acquainted with subjects that have temporarily gained their interest. When specifically questioned about their interest in reading books, regardless of the topic matter, we have found a repeating pattern in new college students, only 20 percent have a consolidated interest in reading, while 80 percent state total disinterest.

Although we will not generalize, it is common to find in students entering higher education in Mexico, that a large percentage of them deem certain subjects as too difficult, rejecting fields such as mathematics, arguing that it is a boring and useless branch of education. According to a survey conducted by the National Survey of Habits, Practices and Cultural Consumption by CONACULTA (Cultura, 2010), 77% of the population of Guanajuato reported not reading any books, 49% reported not reading newspapers and 58% never reads magazines. When considering this data it came as no surprise that in 2012 of the 108 countries that make up the UNESCO, Mexico has the next to last place in the reading index, estimating that a mere 2% of the Mexican population has a permanent habit of reading.

METHODS

The pedagogical proposal presented in this innovation project was to promote the passion for reading while simultaneously uncovering the charm behind the world of mathematics. Therefore, the book *The Mathematical Novel* was included in the classroom and homework sessions, thus allowing the students to experience a more individual and collaborative approach to the numerical challenges presented in this book, along with weekly activities associated with the Schoology educational platform.

The idea for this Project arose from the need to promote new technological platforms, different from those that the students are accustomed to use in the system of the Technological of Monterrey. Currently the Blackboard platform is used, which generates a significant expense for the university and indirectly for the students, therefore a project that would validate the use of new, technological innovative projects on platforms such as Moodle, Schoology free version and Design2 was proposed. We must consider that although our students are constantly using technology, being on campus there are very few students that enroll and complete online courses and take advantage of the resources of online education.

To implement the proposal the first task was to create an instructional design of the course to include course sessions that would feel natural to the students. Classwork and homework were also designed that would outline each student's individual responsibility as well as their collaborative responsibility in the group activities. The dates for the work to be turned in either in paper and/or on the platform were also defined. Last but not least was the importance of transmitting the responsibility to the corresponding teacher's in his or her involvement in the project to ensure good monitoring and review of the work of the students as well as motivation for the students to finish their readings along with the mathematical challenges.

Text Selection and Generation

One of the motivators behind this project was to increase each student's annual reading tally by at least one book by the end of this mathematics course. For this reason, choosing a book that would be of an attractive genre and writing style for students between the ages of 18 and 21 was of paramount importance. Although we initially considered using a book in the classic literature genre that would transversally promote Spanish areas, after conversing with several upperclassmen we learned that mystery and fiction sagas are not only more appealing to young adults, but also foster a continuing reading habit. Therefore, a murder novel was chosen; in which the challenge was to discover the killer.

To generate empathy, the novel revolves around four young university students, (which correspond to the number of students in each team) who witness the last minutes of life of the city's ruler, whom explains to them the importance and the negative impact on the community if they do not catch his murderer. Therefore, with his dying breath of air, he urges them to catch his murderer and he gives them the first clue that they must follow. Coincidentally, the beginning of this novel also elaborates on the traits and hobbies of the students, who also share a dislike for mathematics.

In the initial section of the reading, while the plot and the characters' traits were being introduced, the personality of the Millennials was subtly included. The aim of this was not to criticize the Millennials, but to highlight the advantages of this personality in each of the friends' and how they will aid in solving real life problems, regardless of whether or not they were good in a certain area of education such as math, physics, chemistry or sciences in general. This section was also written with enough emphasized information so as to measure in the first exercise of online evaluation, the students' reading retention. This was important, since one of the hypotheses of the faculty involved in the project was that when the young students read only social media excerpts, which are characterized by a very reduced length, they consequently have a diminished retention of details described in a longer or more intellectually challenging reading.

In the later chapters of the novel, two innovative elements were included that would allow the reader, in this case the students, to generate a very real connection between the concepts of a pre-university level mathematical course and reading comprehension skills.

- One challenge (from a total of 9) that they must solve and send online to the city's ruler to demonstrate that their investigation is on the right track. To solve this challenge, it is necessary to use the mathematical knowledge and skills that were presented in class each week. The solution to each of these challenges is accomplished after each student has finished reading each chapter individually and has agreed to assign each responsibility necessary to turn in the results in the correct time and fashion. This activity was designed to be completed outside of the classroom.
- One clue (from a total of 9) that can be solved by using mathematical logic, deduction and common sense that has been acquired in previous stages of the students' life. This clue will allow the characters to continue their search and come closer to finding the murderer's hideout. In order to solve this clue, 25 minutes in the last session of each week were allotted for the students to argue, solve and fundament why they reached that particular solution and to submit it onto the platform, so as to gain access to the following chapter in the novel.

During the development of the novel, a point of concern that influenced the content of the writing was: What will happen if the teams did not reach the correct result for the clue? To address this question and to encourage mathematical analysis, as well as an interest for reading, the decision to start each chapter with the solution that the characters must generate during their trek through the city to find the new challenge, was taken. The possibility of changing geographical locations in further novels, in which clues are found in historical sites, and the inclusion of local legends that would relate to each city or state in which the crime occurred are important discussion points that remain on the table, particularly considering Mexico's rich history and demographical diversity.

Activity Distribution for the students

This activity was designed to be implemented in 12 weeks. Although a normal semester in the Tec de Monterrey is 18 weeks long, it was determined that one of the key elements in this Project was to generate a passion for reading and for solving mathematical challenges, as opposed to a feeling of burden and hindrance to complete their other school activities. For this reason, the decision to eliminate the evaluation and activities of the Tec System was reached.

The project began with a survey of reading habits, and the students' opinion about the relationship between learning about math and reading comprehension. After this we continued with a three-week long presentation of the place, its history, its costumes and social conventions, as well as the role that each of the five main characters had in the community. During this stage, initial information about the students' reading comprehension was gathered by means of online evaluations. This not only served to verify reading comprehension elements but also to familiarize the students with the Schoology (free version) platform. It is important to note that Schoology is a platform that has specialized in the application of gamification as an educational strategy, therefore, since the beginning it was very well accepted by the students. Another great advantage of this platform was the benefit that teachers could include alerts and reminders in the system's calendar that would keep the students aware of their deadlines. Although the project was defined as one predominantly centered around teamwork, it was of vital importance to remind the students by means of their calendar of the activities that were to be solved through group collaboration and those that were to be submitted individually.

During the first class, when the project was presented, the students were divided into groups of four and roles were assigned stressing the importance of individual work, which in this case consisted of reading the chapter pertaining to each week. The teamwork consisted in the following role assignment:

- One student who would be responsible for organizing the time allotted in the classroom. The student in charge of this role would be responsible of reminding the team that the agreements that were made regarding submitting the work that was assigned to be completed outside of the classroom must also be respected. The person in this role could take an agenda with reminders for the team concerning their activities and the dates they agreed upon completing the activities by.
 - One student responsible for formalizing a proposed solution. The role of this team member is very important; since he or she shall be responsible for collecting the information, proposals and methods that each of the teammate will develop and summarize them into the final version, which will be handed in.
 - One student in charge of questioning and validating the results. This member is of vital importance to the group since there may be differences in the propositions of the solution, therefore he or she must be able to mediate the dialog and discussion with the team members to identify the correct proposal and formalize the one they decide to turn in. Even though the group may reach a consensus regarding the correct answer, the student in this role must always question the others to make sure that their proposed solution is, in fact, correct.
 - Last but not least, another student that would be in charge of uploading the work onto the platform. This student must be well familiarized with the correct use of the Schoology platform so as to deliver the work in a timely fashion, adhering to the specifications that were laid out on the rubric.
- During the first two weeks the students had to read chapter 1 and 2 respectively and during class on Fridays they would take a reading comprehension quiz. This phase helped determine each student's initial reading comprehension level as well as introducing the story to the students.
 - From week 3 to 11, the individual reading was divided into two parts:
 - The first part of the corresponding chapter was made available every Monday, in which the characters are confronted by two elements: a challenge and a clue. To have time to read the chapter and propose solutions individually the students were granted of half a week. During class on Thursdays, the students were given time out of class destined to work collaboratively on solving both the collection of evidence and coming to a proposed solution, which must then be uploaded to the Schoology platform. It is important to mention that at the beginning, there were several teams that arrived to class with the solution already completed and were encouraged by the teacher to use the class time to further discuss their solutions to make sure each team member agreed with the result they generated.
 - The second part of the chapter becomes available for the students to read from Friday to Sunday. During this section of the chapter the characters describe the correct solutions they reached and they continue their search. This way the students can effectively compare their proposal to that of the characters' and witness the correct interpretation of the challenges and clues. Part of the reading comprehension evaluation and reflection of the given solutions was encouraged by asking the students, during their classes on Thursdays, to share about the differences in their solutions to those that were presented by the main characters of the novel and to explain why there were differences in their results.
 - From weeks 6-12, during class on Fridays, students were evaluated individually and online regarding the elements that were described in the chapters, so as to measure the variation in reading comprehension.
 - During week 12, and after each team handed in their proposed solution to the ninth and final challenge and clue, the final solution and conclusion to the mystery of the novel became available on the platform.
 - During week 13 the students were again surveyed on their reading habits and their opinion of the relationship between learning mathematics and reading comprehension.

Implementation

This project can be found on the Schoology platform and was implemented on the students of the August-December 2015 semester of the class MA1001 Introduction to University Level Mathematics, which is integrated by students who are lacking in some of the required areas to begin mathematics in their corresponding careers.

To begin the semester, the platform was organized and each student was given clearance to access it. The two surveys were uploaded, along with three reading evaluations, the 9 blocks of the novel, including the readings with the problems that must be solved and the clues that must be deciphered, as well as the solutions that were reached by the characters from the novel and the 9 spaces in which each team must turn in the result of their work. Each of these elements was programmed so that it would only become visible to the students after a specific date. Therefore, the instructional design and the scheduling of the activities on the Schoology platform was vital. A great advantage of this platform was that it would send notifications and alarms to each student's personal email to remind them of upcoming evaluations, readings and deadlines to upload their work; as well as notifying the teachers when an assignment was uploaded that would need to be graded. This platform would not only allow teachers to give feedback to each student or group evaluated, but it would also notify the teacher when the student or group read the evaluation, therefore ensuring that the feedback was understood by the team.

The screenshot displays the Schoology interface for the course 'Introducción a las Matemáticas: MA1001'. The main content area lists several materials and assignments:

- ¿1 y 1 son 11 o 27, ¿De qué se trata la historia?**: Para este proyecto trabajarás de forma individual la lectura de ciertos textos que se irán aperturando en la plataforma y de forma colaborativa deberán ir resolviendo pistas y acertijos que permitirán resolver el misterio. ¡Iniciemos! Disponible 01/8/15 6:00a. m - 22/8/15 11:59p. m
- 26 + 7 + 1947 = 8 + 7 + 21 = 36 = 3 + 6 = 9**: A trabajar!!!! Hay que descifrar la Pista No 1 y resolver el Problema No 1. Oculto
- 10 - 8 + 6 - 4 + 2 - 4 + 6 - 8 + 10**: Ha sido un EXCELENTE inicio!!!! Ahora resolvamos el Problema 2 y hayemos la Pista 2. Oculto
- 26 de julio de 1947.pdf**: Oculto
- Problema 1 y Pista 1**: En esta enlace deberá adjuntar el secretario del equipo la solución de esta actividad. Para poder ser evaluada deberá cargarse durante el tiempo asignado en la clase del día viernes. Vence Viernes, 28 Agosto, 2015 at 11:59 p. m - Oculto
- Solución 1.pdf**: Oculto

The sidebar on the left contains navigation options: Actualizaciones, Desempeño, Libreta de calificaciones, Medallas, Asistencia, Miembros, Análisis estadístico, and Planeación de carga de trabajo.

Responsibility of the Teachers

The development and implementation of this project required the collaboration of several teachers that were in charge of different responsibilities:

- A language teacher was responsible for writing the novella. This was a great responsibility considering that the success of this project depended on the teacher's ingenuity and ability to create suspense.
- A mathematics teacher was in charge of the problems and mathematical challenges that were related to the subjects covered each week as well as programing the math classes into the semester. Including mathematical challenges into the novella was relatively easy, since the author of the novella would leave a space in the story where the students would come across an envelope that would contain a mathematical challenge. Therefore, the math teacher would simply write the content of the envelope and in the following chapter would uncover the solution to the mathematical challenge of the previous chapter.

- An instructional designer was in charge of validating the pedagogic proposal and uploading the program onto the Schoology platform.
- The teacher in charge of accompanying and evaluating the students' work was also responsible for encouraging individual reading and emphasizing each team's responsibility of uploading their work onto the platform. Each week the teacher evaluated each of the solutions and assigned the appropriate sticker to each development, it is important to note that even though the solution might not have been accurate, creativity, enthusiasm, team work and strategy were evaluated, so as to encourage the passion for math and reading.

One of the key factors that greatly influenced the success of the project was that the story was designed ahead of time. This was very important because in each chapter the clue to find the murder must be carefully incorporated into the storyline as well as the mathematical solution to the challenge in the previous chapter of the novel. The author also had to creatively develop the way in which the novella's characters reached the corresponding solutions and how these continued defining the plotline of the story. Needless to say, this was one of the most challenging stages of the project's preliminary design as well as when the faculty team truly experienced the project's transversality.

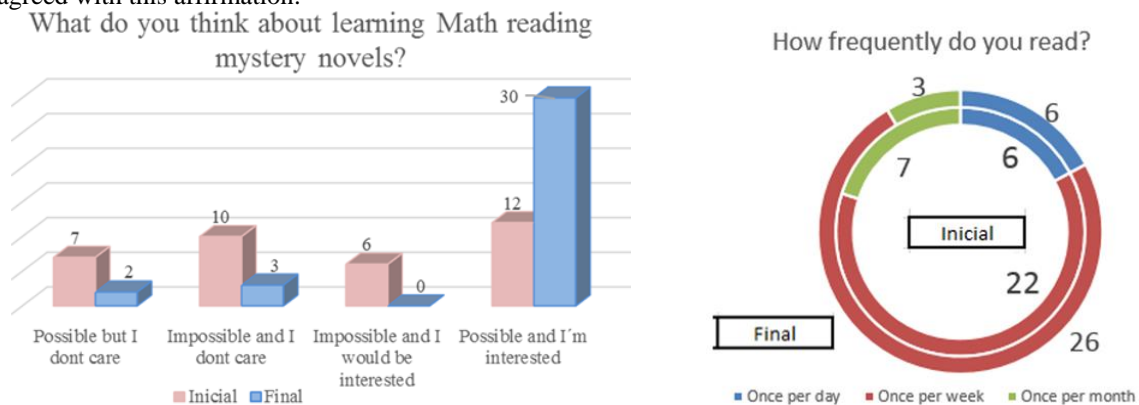
In order to measure the effectiveness of this proposal for Educational Innovation linking the passion for mathematics with reading through the technological platform Schoology, the team of professors that collaborated in this project would record weekly incidences to measure the project's effectiveness and implement improvements, in which the following variables would be reported:

- The planned activity could be carried out, virtual activities were completed each session by means of the platform,
- All products or evidence were handed in/received in time for their evaluation,
- Instruments were employed -such as rubrics and checklists- from the platform to evaluate the activities,
- Descriptions of the reasons that lead to registering an incidence or lack of incidences were reported.

RESULTS

To evaluate the project, two variables were considered. One of the variables considered was the students' interest and perception of reading and the possibility of improving their math skills through reading. The other variable considered was the students' competence in solving mathematical reasoning problems as well as their reading comprehension. Both mathematical reasoning and good reading comprehension are basic skills for the 2020 Plan of the Tecnológico de Monterrey. This plan was not only designed to improve the mathematical reasoning skills in young college students but also as yet another strategy to be implemented in private and public educational institutions to encourage the habit of formal reading in the population of Guanajuato.

Considering that the project stretched from the months of August to November, 12% of the participating students reported a change in their reading habits from 1 time per month to one time per week. There was also a significant increase of those of the sample who believed they could learn mathematics reading a mystery novel, at the beginning of the semester 34% believed this affirmation was possible, whereas by the end of the semester 86% agreed with this affirmation.



Figures 1 & 2. Results at the initial and final of the project.

Regarding the reading comprehension competency measurement of the project, the group had an average of 46/100, 85/100 and 78/100, which was related to the increasing number of visits to the course on Schoology and

the time each student was connected to the platform. As the semester continued, these indicators also increased, demonstrating a 69% rate of improvement of their reading scores as measured by their level of retention, comprehension and memorization.

As far as the work turned in regarding the mathematical clues and challenges, these evaluations also demonstrated an evolution in the group average since they were of 76/100, 87/100 and 93/100 at the midterm cut. This demonstrates an improvement in their competence for logical reasoning and mathematics. It is important to mention that even by the second evaluation, the students continued to question the validity of the evaluations since not all of the elements in the book had yet been covered by their math sessions; however by the last delivery dates, this was no longer an influential factor and the academic achievement rose by 22%.

These numbers allowed us to consider the project successful. The following are some of the comments we received from the students that inspire us to keep innovating, creating more stories and new ways to make their learning experience more meaningful.

- It was easy to read and solve the problems as a team because we helped each other out.
- I liked that the lectures were programmed and distributed from the start. We got better at how we solved the problems and we also helped each other with the reading.
- Schoology's calendar would let us know via email about the deadlines on the reading, which was helpful, especially since there was a lot of reading for some of the weeks.
- During exam week, I lost the thread of the story.
- The Schoology sessions felt like a break from math class. There were some weeks where I had so much homework from other classes, and this activity distracted me from the stress and relaxed me.
- As always I found teamwork real challenging. Initially two classmates did not fulfill their obligations, so the burden on the rest of us felt really heavy. However when the people that weren't working noticed their grades were significantly lower than ours they decided to integrate into the work. It was very evident to the teacher that they weren't cooperating when they wouldn't do anything on Thursdays.
- I am not sure if I have learned math as such, nor if I would consider what we read a book, because our homework wasn't that long. But I definitely liked working like that, the teacher was very motivated, and talking about the novel really got my interest, I was very excited to discover if our solution to the challenge had been correct... and well the end of the story was a bit predictable.
- I don't like reading, and I didn't like that I had to read to do math, however this semester I read this book.

CONCLUSION

The objective of this project consisted in implementing some of the tools proposed by the Model Tec21 to improve the students' abilities by joining two elements, mathematics and Reading. One of the most important findings of this project was that the students were able to learn in a completely different way, without so obviously following a lesson plan, the learning experience became something innovative, stimulating and challenging. In the students' mind, it seemed impossible to imagine that a mystery novel would hold all the elements of a math program. It was also equally gratifying for the students to discover that their preconception that "I was born bad for math and for problem solving" was nothing but a myth. The students were able to propose creative and insightful strategies to find the solutions to the clues and challenges from the novel. Although they sometimes doubted their proposed solutions because they recognized it did not fully adhere to the methodology proposed in the classroom, they discovered that there are several different ways to apply their knowledge to solve a problem. This project would have been demonstrated less effective results if we had not integrated several of the elements that these new generations learn and work with, including: the importance of knowing their role in a team, so as to guarantee their participation in teamwork, the use of a technological platform not only made the reading easier, it also enhanced the follow-up, turning in the assignment and the feedback from each student. These elements made the project more familiar and pleasant for the students.

RECOMMENDATIONS

The next step consists in inviting more teachers from different areas to join us in linking their corresponding subjects to a good story. This project will not only apply to mystery and mathematics; it can be applied to any subject in which the student can take their knowledge and the information they learn in class and convert it to a fun, imaginative context in which they can practice.

A new tendency in education at the university level is to ensure learning by solving real cases that have occurred in businesses. By doing this it is expected that the student will develop the knowledge and abilities necessary to

solve the problems that were presented. We consider that this didactic technique can be easily translated into a novel since the real information regarding the solution to the problem is available, thanks to the case reports by businessmen or administrative employees. The framework of these elements would be essential to highlight and analyze in the story and would be the skeleton of the novel. However, in order to implement the reading assignment and reach solutions during a semester, a large group of professors willing to work at least a semester prior to when the program will be implemented, would be necessary in order to finish all the requirements.

In the Tecnológico of Monterrey, we have teachers with the necessary innovative and creative profiles to implement this new didactic technique. However, choosing to implement a project like this would unfortunately disrupt the faculty's current teaching sessions since much instructional design is necessary. Therefore, we suggest that this project be elaborated in conjunction with other academic bodies so as to lighten the workload and experience the benefit of working with more collaborators.

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