Implementation of the

XRP Course in Paraguay

AUTHORS:

Andrew Cunningham

Hillary Quezada

Luca Scotto

Avila Thompson

ADVISORS:

Lina Muñoz

Dorothy Burt

SPONSORS:

Fundacion Paraguaya

LOCAL COLLABORATORS:

Prof. Sebastian Cañete

Ing. Amalio Enciso

MAY 2024

The Implementation of the XRP curriculum in the Cerrito School of Paraguay

An Interactive Qualifying Project submitted to the Faculty of WORCESTER POLYTECHNIC INSTITUTE in partial fulfilment of the requirements for the degree of Bachelor of Science

by
Andrew Cunningham
Hillary Quezada
Luca Scotto
Avila Thompson

Date:
30 April 2024

Report Submitted to:

Prof. Sebastián Cañete, Director Amalio Enciso
Escuela Cerrito, Fundación Paraguaya

Prof. Lina Muñoz, Prof. Dorothy Burt
Worcester Polytechnic Institute

ABSTRACT

Fundación Paraguaya is a non-profit organization that funds self-sustaining schools, one being Escuela Agricola Cerrito, in Benjamin Aceval. These schools promote the learning of various technical skills to empower students towards promising careers. As part of their initiatives, the school has introduced STEM education, launching a robotics program using the Experiential Robotics Platform (XRP). The objective was implementing the course in Escuela Agricola Cerrito by facilitating workshops with students and professors, and by developing materials in Spanish including presentations, lesson plans, a tutorial video, extra tools, and a website to make the course accessible to teach in other schools and in other Spanish speaking countries. To achieve this we conducted classroom observations, interviews, surveys, and a focus group to gather information about teaching and class dynamics.

ACKNOWLEDGEMENTS

Our team would like to thank the following people for helping us reach our project goals. To director Amalio Enciso for his interest in robotics and wanting to implement a course in Escuela Agrícola Cerrito. To Prof. Sebastian Cañete for his help facilitating the workshops and for volunteering to work with Prof. Brad Miller on the translations of the digital course. The four professors: Mr. Alberto González, Mr. Matias Godoy, director Amalio Enciso, y el Prof. Juan Carlos Altemburger who participated in the robotics workshops, lending us an hour of their time to learn about programming and robotics. To prof. Lina Muñoz and Prof. Dorothy Burt for guiding us during the entire project. They helped a lot with their ideas and motivated us to maintain quality work.

We would also like to thank the students at Escuela Agrícola Cerrito who participated in our XRP workshop. We hope they enjoyed the course and keep on learning about robotics and programming. It was our pleasure to meet and spend time with everyone.

Lastly, we'd like to thank our sponsors, Fundacion Paraguaya, Escuela Agrícola Cerrito, and our university, Worcester Polytechnic Institute, for the opportunity to carry out the project.

EXECUTIVE SUMMARY

Figure 1: XRP Robotics Exhibition during the Science Fair at Escuela Agrícola CerritoSDG Progress Report 2020

XRP Initiative in Paraguay

Currently robotics education in Paraguay is limited to private schools and small competitions. More often than not students from more privileged economic classes compete, and due to the high costs of implementation it is difficult for lower economic class schools to implement the curriculums. Centro Educativo los Laureles (CEL), for example, is a foundation looking to expand the opportunity to learn robotics to more schools. The potential of robotics is ever expanding in today's world and has been used to improve countless fields of work. Some institutions in Paraguay, such as Escuela Agricola Cerrito, have expressed interest in investing in and expanding the opportunity to teach robotics (Figure 1). Unfortunately, as mentioned before, Robotics can be a difficult subject to teach due to the high price of the robots and parts. This is what WPI's professor Brad Miller and DEKA research chief development officer David Rogers are looking to solve.

EXECUTIVE SUMMARY

They developed the Experiential Robotics Platform (XRP), an introductory level robot kit comprised of affordable robotics parts. Costing 65 USD, the kit utilizes inexpensive 3D printed and electronic components to create opportunities for any school to implement its' robotics curriculum. The kit is also complemented by a free access e-text and course to learn how to assemble and program the XRP robot. According to Prof. Miller, XRP "changes the paradigm for teaching. It's a robot that costs less than a textbook. Potentially every student in a classroom could have one". (Racicot, 2022)

For the robot's coding, the website, www.xrpcode.wpi.edu, is used to upload and save programs to the XRP. An internet connection is only needed for the installation of micro python and navigating to the website. After that, all programming can be done offline.

Before this project, the XRP had only been implemented in classrooms in the United States. However, WPI's Institute of Science and Technology for Development (InSTeD) has a departmental initiative centered around spreading knowledge around the world. They decided that the XRP curriculum was an excellent candidate for the implementation of robotics education in developing countries. The course has been carried out in countries such as Namibia, Ghana, and Morocco but never has it been implemented in Latin America nor translated to a language other than English. This project addresses the successes and brings to light the two main challenges that will have to be addressed when implementing XRP globally: Adapting the course into a different language and teaching the course within a developing country.

Purpose and Goals

One of the main goals of our project was to co-create visually attractive, easy-to-understand course materials in Spanish, for Fundación Paraguaya's Escuela Agrícola Cerrito (Cerrito School); a rural boarding high school in

EXECUTIVE SUMMARY

Paraguay (Figure 2). The idea was that this course can be used to implement the Introduction to Robotics courses across Latin America, and other Spanish speaking countries. This was done in collaboration with the Cerrito School robotics professor, Sebastian Cañete, using the XRP curriculum created in English by Professor Brad Miller and his team. Another key goal of the project was to leave "installed capacity" at the Cerrito School, which entailed leaving several professors with the skills and knowledge to teach the Introduction to Robotics course going forward. Additional goals included "beta testing" the teaching materials we developed in Spanish, by co-teaching the Introduction to Robotics course alongside robotics professor Sebastian Cañete, to two levels of students at the school. We also compiled feedback for Professor Brad Miller on how well the XRP robot, and the course itself performs on site in a developing country.

Our course is a first step in Fundación Paraguaya's desire to guide students in applying robotics in the workforce, such as for farming. For students not interested in farming, the course provides them with an opportunity to practice their STEM (Science Technology Engineering Mathematics) skills. The course also presents the students with the opportunity to learn how to work with a partner, problem solve, and develop critical thinking skills (Figure 3). Our two main goals were achieved by delivering the Introduction to Robotics course materials in Spanish to the Cerrito School, and by teaching a group of four Cerrito School professors the Introduction to Robotics content, alongside the robotics professor Sebastian Cañete.

Figure 3: XRP kits decorated by second- and third-year students.

Figure 2: Robotics Workshop with 3rd year Students

Methods

Figure 4: The professors participating in the workshop.

At the start of our project work in C Term, we interviewed multiple professors involved in WPI's InSTeD initiative. Prof. Rob Kruger, head of Social Science and Policy Studies, previously worked with a team that implemented a robotics curriculum in South Africa. He emphasized the fact that despite potential differences in resources, students in developing countries are just as, if not more, intelligent, and motivated to learn. Prof. Kruger made clear to avoid paternalistic attitudes and focus on sharing knowledge, ensuring the content is perceived as valuable for the students. We also spoke to a WPI alum, Annie Hughes, who has experience teaching the XRP course in various countries. She gave us more classroom focused teaching recommendations and strategies for class structure. Prof. Brad Miller, head of the XRP initiative, also worked with us in C Term, through weekly labs that taught us how to teach the curriculum and use the XRP robot.

Before we began creating any material, we wanted to understand the differences between Cerrito School (Paraguayan standards) and the United States when it came to teaching and how classes are conducted. Through classroom observations, we found that visual teaching methods were prevalent at Cerrito, with practical problem-solving emphasized. Based on this, we collaborated with Professor Cañete to create visually engaging presentations for the Introduction to Robotics course. Following the classroom observations, our team interviewed the professors of the classes to better understand their teaching methodology and what they think works in the classroom. Surveys were also used to analyze the experience in robotics of adult faculty who were part of one of the workshops we facilitated (Figure 4). For the last method in our project, we conducted a focus group with some of the second- and third-year students participating in the workshops. This focus group aimed to get an idea of how the course was going, giving us insight to adjust the course materials accordingly. We wanted to ensure that the students understood the material and enjoyed the class experience.

Results and Deliverables

The results of our methods led us to create the following deliverables: Robotics workshops with students and professors, course materials that include lecture presentations and detailed lesson plans, an introduction to Robotics video, extra tools, and a website that compiles all the materials and other resources. All these materials were created to be used by professors teaching the XRP Introduction to Robotics course in Spanish going forward. We facilitated workshops with professors and administrators so that they could learn the course content and help teach it in the future and expand the program. The team created attractive, visual-heavy lecture presentations, starting week one, and co-taught the workshops with Professor Cañete (Figure 5). Each presentation is meant be a visual support for the professors to use during actual instruction of the course with their students. The presentations contain content slides which define and explain key concepts and activity slides that give students time to practice and understand the concepts with a more hands-on and visual approach. These will serve as the materials and guides for teaching the course in Spanish. Eventually, our team turned to only observing the use of the presentations by Professor Cañete, to

Figure 5: Prof. Sebastian Cañete facilitating the workshops using our presentations.

evaluate their effectiveness, and to fine-tune them to be understandable for students as well as professors after every workshop. Once the lessons were perfected, we created more detailed plans to help the professors structure the lessons better.

Our group also produced a Spanish version of the original introductory video made in English by Sparkfun on how to assemble the XRP robot. This video includes an explanation of the contents included in the XRP Kit, how to assemble the robot, and how to install the program onto the robot to begin programming. We also created a website that includes all the presentations, lesson plans, tutorial video and a set of supporting documents to serve as extra tools to help teach the course based upon our observations in the classroom. The web page can be found using this link:

https://sites.google.com/view/xrp-curso-de-robotica

This includes a reference sheet of the translation of the basic coding blocks in the XRP code website to Spanish. It also includes teaching tips for the professors who will be delivering the course, based on what we felt worked in the classroom according to our observations of the robotics professor teaching the course.

Recommendations and Conclusion

We accomplished our goal of providing Cerrito School with visually attractive course materials and curriculum in Spanish to impart an Introduction to Robotics course.

During our time at Cerrito, we observed many classes, as well as workshops in which the materials we co-created were utilized and were able to outline some pedagogical improvements that could be made. We suggest that particular attention be given to the following recommendations as well as those outlined in the teaching tips. To keep a solid pace for the course, we created lesson plans with time allocated to each section. We recommend that teachers stick to these allocations to the best of their ability to prevent the class from falling behind. Since the coding blocks are all written in English, we created a reference sheet so the students can explore the code blocks and play around with their robots; since they often felt they could only follow what was on the board since they didn't remember or understand what certain code blocks can do.

With the presentations, lesson plans, and extra materials we have co-created, we believe that Cerrito School has all the tools needed to impart an introductory robotics course in Spanish that strengthens students' STEM knowledge along with problem-solving and teamwork skills, while still being fun and a rewarding experience for the students (Figure 6). In addition to giving the Cerrito school these materials, we taught the content of the course to four professors and administrators so they could support Prof. Sebastían in teaching the course in the future. Since we had a very short amount of time to teach them the content, they were only able to complete about half of the course with the professors. We recommend that the four professors finish the course with Prof. Cañete and then review the content on their own to prepare to teach.

The next step for the Cerrito School would be to develop a follow-up course that helps students connect their work fields, like agriculture, with robotics. This way they can use the robot to complete tasks in their specific work disciplines. To do this the XRP has grooves where you can add newly designed 3D parts onto the robot. Students can design innovative and creative systems to allow the robot to do many small tasks from picking up trash to transporting materials.

We are thankful that we were able to create this opportunity for the students at Escuela Agrícola Cerrito. As well as, for the opportunity to contribute to the efforts of WPI's Institute of Science & Technology for Development, and the Global STEM Education Initiative, to make STEM education accessible to low-income students in developing countries.

Figure 6: The last robotics workshop

RESUMEN EJECUTIVO

Figure 7: Exposición de Robótica XRP durante la Feria Científica en la Escuela Agrícola Cerrito

La initiativa de XRP en Paraguay

Actualmente la mayoría de la educación en robótica en Paraguay se limita a escuelas privadas y pequeñas competencias de robótica donde compiten estudiantes de las clases económicas más privilegiadas. El Centro Educativo los Laureles (CEL) es una fundación que busca expandir la oportunidad de aprender robótica a más escuelas. La robótica está en constante expansión y tiene potencial para mejorar todos los campos de estudio. Algunas instituciones en Paraguay, como la Escuela Agrícola Cerrito, han expresado interés en invertir y expandir la oportunidad de enseñar robótica (Figura 7). Dado que la robótica es una materia difícil de enseñar debido al alto precio de los robots y sus piezas, el profesor de WPI, Brad Miller y el director de desarrollo de investigación de DEKA, David Rogers, se han puesto la meta de ofrecer un curso asequible para profesores de la escuela secundaria. Es así como desarrollaron la Plataforma de Robótica Experiencial (XRP), un kit de robótica económico en comparación con el resto del mercado. Cuesta 65 dólares y utiliza componentes electrónicos e impresos en 3D económicos, creando oportunidades para que cualquier escuela implemente un currículo de robótica. El kit también está complementado por un texto electrónico de acceso gratuito y un curso para aprender cómo ensamblar y programar el robot XRP. Para el Prof. Miller, XRP "cambia el paradigma de la enseñanza. Es un robot que cuesta menos que un libro de texto. Potencialmente, cada estudiante en un salón de clases podría tener uno". (Racicot, 2022)

Para la programación del robot, se utiliza el sitio web

www.xrpcode.wpi.edu

para cargar programas en él. Solo se necesita una conexión a internet para instalar Micro Python y acceder al sitio web. Después de eso, la programación se puede realizar sin conexión al internet.

Antes de este proyecto, solo se usaba XRP en los Estados Unidos. El Instituto de Ciencia y Tecnología para el Desarrollo (InSTeD) de WPI que se centra en difundir el conocimiento en todo el mundo. Decidió que el XRP era una buena plataforma para implementar la educación en robótica en los países en desarrollo. El curso se ha llevado a cabo en países como Namibia, Ghana y Marruecos, pero nunca se ha implementado en América Latina ni se ha traducido a otro idioma. Este proyecto enseña los éxitos de sus antepasados y hace que nos fijemos en dos desafíos que tenemos que abordar durante la implementación del curso: adaptar a un idioma diferente e impartir el curso en un país en desarrollo.

Propósito y metas

Uno de los objetivos principales de nuestro proyecto fue cocrear materiales para un curso en español de Introducción a la Robótica, específicamente para la Escuela Agrícola Cerrito de la Fundación Paraguaya, un internado rural en Paraguay (Figura 8). La idea es que este curso pueda implementarse en otros países hispanohablantes. Con este objetivo, trabajamos en colaboración con el profesor de robótica de la Escuela Cerrito, Sebastián Cañete, utilizando el currículo de XRP en inglés creado por el profesor Brad Miller y su equipo en WPI. Otro objetivo clave del proyecto fue dejar "capacidad instalada" en la Escuela Cerrito, entre varios docentes, para impartir el curso de Introducción a la Robótica en el futuro. Los objetivos adicionales incluyeron "pruebas beta" de los materiales de enseñanza que desarrollamos en español, impartiendo conjuntamente el curso junto con el profesor de robótica Sebastián Cañete, a los estudiantes de segundo y tercer curso. También recopilamos comentarios para el profesor Brad Miller sobre qué tan bien se "desempeña" el robot XRP y el curso en un país en desarrollo.

Este curso en español es un primer paso para alcanzar el objetivo de Fundación Paraguaya de guiar a los estudiantes en la aplicación de la robótica en situaciones agrícolas. Para los estudiantes que no están interesados en la agricultura, el curso les brinda la oportunidad de practicar sus habilidades STEM (Ciencia, Tecnología, Ingeniería, Matemáticas). El curso también brinda oportunidades a los estudiantes para aprender a trabajar con un compañero, resolver problemas y desarrollar habilidades de pensamiento crítico (Figura 9). Nuestros dos objetivos principales se lograron al entregar los materiales del curso en español a la Escuela Cerrito y al enseñar a un grupo de cuatro profesores de la escuela el contenido de Introducción a la Robótica, junto con el profesor de robótica Sebastián Cañete.

Figure 9: Un robot XRP decorado por estudiantes

Figure 8: Taller de robótica con estudiantes de tercer año

Métodos

Figure 10: Los adultos que participaron en el taller de robótica.

Al comienzo de nuestro trabajo con el proyecto antes de viajar a Paraguay, entrevistamos a varios profesores que participaron en la iniciativa InSTeD de WPI. El profesor Rob Kruger, jefe del Departamento de Estudios de Políticas y Ciencias Sociales en WPI, trabajó anteriormente con un equipo que implementó un plan de estudios de robótica en Sudáfrica. Él enfatizó el hecho de que, a pesar de las posibles diferencias en recursos, los estudiantes en países en desarrollo son igual de, si no más, inteligentes y motivados para aprender. El Prof. Kruger dejó claro que debemos evitar actitudes paternalistas y centrarnos en compartir conocimientos, asegurando que el contenido sea percibido como valioso para los estudiantes. También entrevistamos a una exalumna de WPI, Annie Hughes, quien tiene experiencia enseñando el curso de XRP en varios países. Hughes nos brindó recomendaciones sobre métodos de enseñanza y estrategias para estructurar el curso. El Prof. Brad Miller, jefe de la iniciativa XRP, también trabajó con nosotros durante el trimestre de preparación antes del viaje a Paraguay, a través de clases semanales que en las que nos capacitó en cómo enseñar el plan de estudios y usar el robot XRP.

Antes de comenzar a crear cualquier material, queríamos comprender las diferencias entre la Escuela Cerrito (estándares paraguayos) y los Estados Unidos en cuanto a la enseñanza y cómo se conducen las clases. A través de observaciones, descubrimos que en Cerrito predominaban los métodos de enseñanza visuales, con énfasis en la resolución práctica de problemas. Basándonos en esto, colaboramos con el Profesor Cañete para crear presentaciones visualmente llamativas para el curso de Introducción a la Robótica. También realizamos entrevistas con los profesores de las clases que observamos para obtener una mejor comprensión de su metodología de enseñanza y lo que creen que funciona en el aula. También se utilizaron encuestas para analizar la experiencia en robótica de los docentes que participaron en uno de los talleres que facilitamos (Figura 10).

encuestas para analizar la experiencia en robótica de los docentes que participaron en uno de los talleres que facilitamos (Figura 10). Para el último método en nuestro proyecto, realizamos un grupo focal con algunos de los estudiantes de segundo y tercer año que participaban en los talleres. Este grupo focal tenía como objetivo obtener una idea de cómo iba el curso, brindándonos información para ajustar los materiales del curso en consecuencia. Queríamos asegurarnos de que los estudiantes comprendieran el material y disfrutaran de la experiencia en clase.

Resultados y productos finales

Los resultados de nuestros métodos nos llevaron a crear los siguientes productos finales talleres con estudiantes y profesores, materiales de clase que incluyen presentaciones en PPT y planes de clase detallados, un video de introducción a la robótica, herramientas adicionales para estudiantes y profesores y el sitio web:

https://sites.google.com/view/xrp-curso-de-robotica

Figure 11: El Prof. Sebastián Cañete usando las presentaciones PPT para enseñar el taller de robótica.

que compila todos los materiales. Todos estos materiales y recursos se crearon para ser utilizados por los profesores que van a impartir el curso en español en el futuro. Facilitamos los talleres con profesores y administradores para que pudieran aprender el contenido del curso para ayudar a enseñarlo en el futuro y, de esta manera, ampliar el programa. Desde el inicio de nuestro proyecto, comenzamos a crear presentaciones llamativas y con gran contenido visual y a impartir los talleres junto con el profesor Cañete (Figura 11).

Las presentaciones contienen diapositivas de contenido que definen y explican conceptos clave y diapositivas de actividades que brindan a los estudiantes tiempo para practicar y comprender los conceptos con un enfoque más práctico y visual. Estos también servirán a los profesores como materiales y guías para la impartición del curso en español. Finalmente, observamos las clases dirigidas por el profesor Cañete usando nuestras presentaciones para evaluar su efectividad y mejorarlas para que fueran comprensibles tanto para estudiantes como para profesores. Una vez que se perfeccionaron las lecciones, creamos planes de clase más detallados para ayudar al profesor a estructurar mejor las clases.

El video de introducción a la robótica en español fue adaptado del video original realizado en inglés por Sparkfun sobre cómo ensamblar el robot XRP. Este video incluye una explicación del contenido incluido en el kit XRP, muestra cómo ensamblar el robot, y cómo instalar el programa en el robot para comenzar a programarlo. También incluimos un sitio web que compila todos los materiales para el curso, el video, y documentos de respaldo que sirven de herramientas adicionales para dar el curso. Estos documentos incluyen una hoja de referencia de la traducción al español de los bloques de programación básicos y recomendaciones sobre estrategias de enseñanza para los profesores que impartirán el curso.

Recomendaciones y Conclusión

Logramos nuestro objetivo de proporcionar a la Escuela Cerrito materiales del curso visualmente llamativos y un plan de estudios en español para impartir un curso de Introducción a la Robótica.

Durante nuestro tiempo en Cerrito, observamos muchas clases, facilitamos talleres en los que se utilizaron los materiales que co-creamos y pudimos delinear algunas mejoras pedagógicas que podrían realizarse. Sugerimos que se preste atención a las siguientes recomendaciones y a las descritas en el Apéndice H de este informe. Para mantener un ritmo sólido durante el curso, creamos planes de clase con tiempo asignado a cada lección. Recomendamos que los profesores se ciñan a estas asignaciones lo mejor que puedan para evitar que la clase se quede atrás. También es importante que todos los estudiantes estén trabajando en el mismo tema en un momento dado. Dado que todos los bloques están escritos en inglés, creamos una hoja de referencia para que los estudiantes puedan explorar los bloques de código y jugar con sus robots.

RESUMEN EJECUTIVO

Con las presentaciones, planes de clase y materiales adicionales que hemos cocreado, creemos que La Escuela Cerrito tiene todas las herramientas necesarias para impartir un curso de introducción a la robótica en español. Un curso que además de fortalecer el conocimiento STEM de los estudiantes junto con las habilidades de resolución de problemas y trabajo en equipo, sea divertido y una experiencia gratificante para los estudiantes (Figure 12). Además de entregar estos materiales a La Escuela Cerrito, comenzamos a enseñar el contenido del curso a cuatro profesores y administradores para que pudieran apoyar al profesor Sebastián en la enseñanza del curso en el futuro. Recomendamos que los profesores completen el curso y continúen estudiando el contenido por su cuenta para estar aún mejor preparados para enseñar o dirigir futuras clases de robótica

Un curso que además de fortalecer el conocimiento STEM de los estudiantes junto con las habilidades de resolución de problemas y trabajo en equipo, sea divertido y una experiencia gratificante para los estudiantes. Además de entregar estos materiales a La Escuela Cerrito, comenzamos a enseñar el contenido del curso a cuatro profesores y administradores para que pudieran apoyar al profesor Sebastián en la enseñanza del curso en el futuro. Recomendamos que los profesores completen el curso y continúen estudiando el contenido por su cuenta para estar aún mejor preparados para enseñar o dirigir futuras clases de robótica.

También sugerimos que el siguiente paso para la Escuela Cerrito seria desarrollar un segundo nivel del curso que ayude a los estudiantes a conectar la agricultura con la robótica y que puedan usar los robots para hacer tareas en esta área. Para hacer esto, el XRP tiene ranuras donde se pueden agregar nuevas piezas diseñadas en 3D al robot.

Estamos agradecidos de haber podido crear esta oportunidad para los estudiantes de la Escuela Agrícola Cerrito y contribuir a los esfuerzos del Instituto de Ciencia y Tecnología para el Desarrollo de WPI y la Iniciativa Global de Educación STEM, para hacer que la educación STEM sea accesible para estudiantes en países en desarrollo.

Figure 12: El último taller de robótica

AUTHORSHIP

Section	Primary Author(s)
1. Introduction	All Authors
2. Background	Hillary Quezada
2.1 The Teaching and Use of Robotics	Avila Thompson
2.1.1 Robotics for Future Careers	Avila Thompson
2.2 Paraguayan Education	Hillary Quezada
2.2.1 Societal Factors	Hillary Quezada
2.2.2 Rural Areas	Hillary Quezada
2.3 Uses of Robotics/STEM in Paraguay for the Future	Avila Thompson
2.3.1 Robotics in Paraguay	Avila Thompson
2.4 Curriculum Co-Creation	Andrew Cunningham
2.4.1 Course Adaptation and Curriculum Co-Development	Andrew Cunningham
2.4.2 Previously Used Materials and Content	Andrew Cunningham
2.4.3 Community Outreach	Andrew Cunningham
2.5 Teaching Methodology	Luca Scotto
2.5.1 Passive Learning	Luca Scotto

AUTHORSHIP

2.5.2 Active Learning	Luca Scotto
2.5.3 Assessment and Feedback	Luca Scotto
2.5.4 Problem Solving and Critical Thinking	Luca Scotto
2.5.5 Fun	Luca Scotto
3. Methodology	All Authors
3.1 Classroom Observation	Luca Scotto
3.2 Teacher/Adult Interviews	Avila Thompson
3.3 Student Focus Groups	Hillary Quezada
3.4 Data Analysis	Andrew Cunningham
3.5 XRP Hardware Kit	Andrew Cunningham
3.6 XRP Code	Andrew Cunningham
3.7 Ethical Concerns (IRB)	Andrew Cunningham
4. Findings, Deliverables, and Conclusions	All Authors
4.1 Introduction	Luca Scotto
4.2 Findings	All Authors

AUTHORSHIP

4.2.1 Analysis of Classroom Observations	Hillary Quezada
4.2.2 Teacher Interviews Results and Analysis	Avila Thompson
4.2.3 Adult Survey Results and Analysis	Andrew Cunningham
4.2.4 Student Focus Groups Results and Analysis	Luca Scotto
4.3 Deliverables	All Authors
4.3.1 XRP Robot Assembly and Informational Video	Andrew Cunningham
4.3.2 The Introduction to Robotics course (using the XRP Robot)	Luca Scotto
4.3.3 Course Materials	Luca Scotto
4.3.5 XRP Course Resource Website	Avila Thompson
4.3.6 Translation of the Course User Guide into Spanish	Andrew Cunningham
5. Conclusion and Recommendations for the Future	Luca Scotto
Appendices	All Authors

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

1. INTRODUCTION

Robotics has seen a large increase in popularity over the years. Innovation using these task-oriented machines is being seen across disciplines and in countries all over the world. Schools have begun making robotics an essential part of their course work, due to its ability to spark interest in the STEM (Science, Technology, Engineering, Mathematics) field, encourage critical thinking and bolster creativity. A non-profit organization, Fundación Paraguaya, has shown increasing interest in implementing robotics in their schools.

The Fundación Paraguaya's primary focuses are environmental sustainability, helping to eliminate poverty, and providing education to the community. As a part of these focuses, they want to promote and implement teaching and using technology and STEM in their self-sustaining schools. One of these schools, The Cerrito Agriculture school, located in Benjamin Aceval (a town in President Hayes Department of Paraguay), has started several initiatives such as using drones, doing small scale robotics workshops, to incorporate robotics to its curriculum. Further proof of this is the new robotics professor who was hired this year. Cerrito is interested in teaching an introduction to robotics course due to the possibility of expanding the course to include applications in agriculture, and the other work disciplines found on campus.

An introduction to robotics course is difficult to implement due to robots and parts being expensive. This is where the XRP (Experiential Robotics Platform) robot comes into play. Created by Brad Miller, a retired WPI (Worcester Polytechnic Institute) professor, and DEKA research chief development officer David Rogers, their main purpose was to create a robot that can expand robotics curriculums to schools who cannot afford the expensive robotic components. The complete kit costs about $65 USD and allows for students in teams of two to each have their own robot. Schools will still need to provide students with access to computers and an internet connection to program robots. Currently the course has only been rolled out in high schools in New England, while workshops have been done in Africa. Our group will be the first to expand the program to another continent and adapt the course into a different language. This project will be used to expand XRP to the rest of Latin America so students in developing countries can also participate in robotics programs.

Our project's goal was to co-create a curriculum for a robotics class in the Cerrito school in Paraguay, with the robotics teacher Sebastian Cañete. This involved creating lesson plans, class materials and facilitating 2-hour workshop classes to assess the materials created. We also worked with Prof. Sebastian on the logistics of getting a translated version of the

INTRODUCTION

XRP course material created by Prof. Brad Miller team. As part of the original English curriculum, SparkFun created a video of how to put the robot together and install the software. As another one of our deliverables, our group created a Spanish version of this video with the help of the students from Cerrito. The course needed to be entertaining and worthwhile for the students. We wanted our course to inspire more students to take an interest in STEM and help develop critical thinking/problem-solving skills, giving more opportunities to the kids at Cerrito School.

Our course is designed to introduce robotics at a basic level. The six modules include lessons in beginner programming, covering topics from how to use loops to utilizing the distance sensor. There is also a minor amount of building included in the first module. These modules were split into seven 1-hour classes. The core structure of these classes was short 15-minute lectures followed by a 20–30-minute period for activities with the robot. The XRP curriculum is centered around the idea that professors and students can continue to grow and collect knowledge in STEM fields following their time with this course. Students will have practiced critical thinking, technological, and mathematical skills in our course; these skills can be used in other facets of life. They will also be able to learn through our teaching of Robotics applications how continuing study in the field of robotics can help them in their future careers. They will also be equipped to enter to compete at a regional and possibly global level, as well as the possible integration of a fully-fledged robotics team at the school.

2. BACKGROUND

Integrating a new Robotics program with a focus on STEM (science, technology, engineering, and mathematics) application is important for the development of problem-solving skills in today's youth. Amalio Enciso, the director of Escuela Agrícola Cerrito, recognized the benefits and opportunities of introducing robotics education to students, thus spearheading this initiative. The goal of this project was to identify and address the challenges with co-creating a curriculum in Spanish for an XRP (Experiential Robotics Platform). The course was implemented in Escuela Cerrito in Paraguay, with a newly hired robotics teacher, Sebastian Cañete. We wanted our course to inspire more students to take an interest in STEM and particularly in Robotics, so it can help them develop critical thinking and problem-solving skills, while ensuring the course experience is entertaining and worthwhile. Additionally, the versatility of the XRP platform allows for adaptation to various applications, including agriculture, owed to its foundational robotics kit and accessible course structure. Looking ahead, future iterations of the program will incorporate new extensions, including opportunities for 3D printing, to further enhance students' learning experiences.

2.1 The Teaching and Use of Robotics

A study done at the University of Salamanca Paseo de Canalejas in Spain found that students who were introduced to robotics learning have been able to "relate and connect their previous knowledge and experience with future ones." (University of Salamanca Paseo de Canalejas, 2013, pg. 316) Students who are introduced to STEM thinking early often develop exceptional problem-solving skills that can be applied to future careers, or any problem-solving oriented challenges they face.

Classes like these are also gateways to interest in STEM fields and promote students to seek out and further their knowledge. Many students in the US will join robotics teams or curricula following their first introduction to STEM; and even more of those students go on to pursue a higher education in the field. "Educational robotics... can create a meaningful learning environment, be it in ordinary school classes or in after-school programs, according to the skills required in the 21st century..." (Kathia Pittí, Curto, B., Moreno, V., & Paloma, M., 2013, pg. 321). This same article states that in Latin America, many students have previously benefited from the implementation of robotics in their school. One of the main purposes of this project is to ensure that the students find value in what they are being taught. The concepts they are learning can open many doors and spark creative solutions to many of the challenges they will face. The students at Cerrito school can utilize the skills taught to them beyond the scope of just improving the agricultural processes at their school, an understanding of robotics is appliable in most modern-day fields.

2.1.1 Robotics for Future Careers

Rodrigo Canek, Yeisson Chicas and Oscar Rodas (2019), did research on high schoolers from Guatemala’s exposure to robotics and found “that 4 of the 5 students started...an engineer career or STEM related career in a university.” These students participated in the FIRST Global Challenge (more detail on page 32). Just like them, many students in introductory level robotics courses are interested in this program. FIRST Global also creates its games surrounding problems our planet is facing; by giving these students the mindset to fix these problems they can grow into innovative change makers in the future. The FIRST program was designed to empower future careers in STEM, going so far as to provide full ride scholarships to eligible colleges for students that have shown exceptional growth and development through their time in the program.

2.2 Paraguayan Education

After the dictatorship in 1991 there was an effort for refinement of the education system in Paraguay. This reform's main objective was to stabilize the democratic regime and improve school performance, specifically of the young generation. The government wanted to expand education to make it more accessible for those in underprivileged communities. (Sandoval, 2012)

One of the changes to the education system is the number of years within each educational cycle. In the original system, there were only two levels of schooling, elementary school was six years (1st to 6th grade) and secondary school was another six years (7th to 12th grade). In the older structure, elementary schooling was the required level a child must attend. Once the changes were implemented the system was broken

BACKGROUND

into 2 levels: Basic Education (1st to 9th grade) and Middle Education (10th to 12th grade) and 3 cycles 1st, 2nd, and 3rd. In the new system, they made pre-school (an added level) and basic education (1st to 9th grade) the required schooling for a student in Paraguay. Figure 13: depicts the structure of the education system in Paraguay in 1973-1992 and the system since 1993. (Sandoval, 2012) The shaded areas are the mandatory grades for every child in Paraguay. In the original system, the students only had to attend up to the 6th grade, while in the new system, they must attend 9th grade. Still in either system children are not required to finish high school meaning higher education was also optional and often dismissed especially in rural areas.

Edad	Estructura anterior (1973-1992)		Estructura actual (desde 1993)		
	Año	Nivel	Año	Nivel	Ciclo
3			Maternal A	Inicial	
4			Maternal B		
5			Preescolar		
6	Preescolar	Inicial	1°	Educación escolar básica	Primero
7	1°	Primaria	2°		
8	2°		3°		
9	3°		4°		Segundo
10	4°		5°		
11	5°		6°		
12	6°		7°		Tercero
13	1°	Secundaria	8°		
14	2°		9°		
15	3°		1°	Educación media	
16	4°		2°		
17	5°		3°		
18	6°				

Figure 13: Previous and Current Structure of the Paraguayan Educational System (Sandoval, 2012)

Another change is curriculum renewal. The process of the renewal mainly involves redefining the main ideas of the content being taught in schools. The National Council of Educational Reform implemented three "transversal axes" which include family, environment, and democracy into the curriculum. These axes are incorporated into all the levels of basic school education and teacher training. Meaning although, all the content of what will be taught will be the same, what changes is the way professors decide to teach based on what the needs and relevancy for each of the students are. The curriculum itself doesn't have an emphasis on courses that are STEM focused but Centro Educativo Los Laureles to expand the interest on robotics across the country. Considering the societal and environmental factors of each school's community. (Sandoval, 2012)

Paraguay's community has a predominant rural and traditional culture. Therefore, two factors must be taken into consideration when talking about its education system. The first is the young population and the second is the existence of two dominant languages: Spanish and Guarani. Compared to many other countries in Latin America this categorizes Paraguay as a multiethnic, multicultural, and multilingual society. (Sandoval, 2012)

2.2.1 Societal Factors

The Triple Alliance War resulted in the killing of up to 70% of the male population in Paraguay. (Alix-Garcia et al., 2022) According to an early 2000's census of Paraguay's population, the population less than 19 years old is almost half the total population, about 49.4%. This means the population between 0 and 14 years old, which is the age range for students in the level of basic education, is about 40% of the total population. The rest of the younger generation between the ages of 15 to 29 years old makes up about 26% of the population and more than half of them, 58.3%, live in rural areas. (Corvalán, 2006)

Along with the young population in Paraguay, the linguistic diversity of the country must also be considered when trying to implement a STEM program in a rural school. In Paraguay, there are two national languages spoken, Spanish and Guarani because of this 51% of the population speak only Guarani, 25% speak only Spanish, 20% speak both, and 4% speak a different language. This creates a challenge for the education system, especially since there is a vast difference in the percentage of Spanish/Guarani speakers in rural and urban areas. Only 23.3% of the urban areas use Guarani as their primary language, meanwhile 72% of the rural areas use Guarani as their primary language. (Corvalán, 2006) Meaning the implementation of a new STEM related program considered the variety of linguistic knowledge, and varying ages throughout the country and how that can change the content being taught and how it's being taught.

2.2.2 Rural Areas

Considering both factors mentioned, we must also investigate education in rural areas. Compared to urban areas, these are at higher economic disadvantage. According to the Ministry of Education 87.3% of the schools in Paraguay offer basic education (1st to 9th grade) while private and subsidized sectors (mainly in urban areas) offer the rest of the levels of education (10th to 12th grade). Even to send kids to school requires money, that most of these families don't have. It is no surprise that the percentage of people in poverty in urban areas is significantly less than that of rural areas. Below is a table indicating the evolution of those in poverty, and extreme poverty in rural and urban areas, as well as the whole country from the years 1994-2002:

Área	1994	1995	1996	1997/8	1999	2002
Urbana						
Pobres extremos	7,8	6,8	4,9	7,3	6,1	7,1
Pobres no extremos	19,1	16,9	16,3	15,9	20,6	20,5
Total	26,9	23,7	21,2	23,1	26,7	27,6
Rural						
Pobres extremos	S/D	21,4	S/D	28,9	26,5	25,6
Pobres no extremos	S/D	15,8	S/D	13,7	15,4	15,7
Total		37,2		42,5	41,9	41,2
En todo el país						
Pobres extremos	S/D	13,9	S/D	17,3	15,5	15,6
Pobres no extremos	S/D	16,4	S/D	14,8	18,2	18,3
Total		30,3		32,1	33,7	33,9

Figure 14: Paraguay, Evolution of Poverty (Corvalán, 2006)

Poverty and economic problems factor into sending kids to school. Rural areas also face a higher rate of illiteracy compared to urban areas. Studies show only about 5.1% of people, ages 15 and up, in urban areas, are illiterate, compared to 12.9% in rural areas. This also plays into their lower test scores on subjects such as Communication, Math, and Social Studies as shown in the table below:

Áreas evaluadas	Comunicación		Matemática		E. Sociales	
Categorías	% de logros 1998	% de logros 2001	% de logros 1998	% de logros 2001	% de logros 1998	% de logros 2001
Escuelas urbanas	51,35%	53,01%	48,98%	46,55%	58,88%	61,36%
Escuelas rurales	47,53%	49,62%	44,18%	45,21%	54,45%	59,75%
Escuelas oficiales	41,55%	50,10%	45,10%	45,05%	55,53%	56,67%
Escuelas privadas	66,03%	57,70%	60,33%	50,20%	67,93%	65,18%
Escuelas Subvencionadas	58,08%		50,98%		59,95%	
Resultado nacional	51,08%	51,30%	46,68%	45,88%	56,78%	60,55%

Figure 15: Paraguay Average Percentage of Correct Answers in the Mathematical Communication and Applied Social Studies Tests in the 6th EEB (SNEPE) by Strata, Years 1998-2001 (Corvalán,2006)

Focusing on the mathematics column in the table above, there is about a 1-5% difference between the math test scores in rural and urban areas. Meanwhile private schools have a 5-15% difference in math test scores. Math, being an integral part of STEM, should be focused on more in public schools specifically in rural areas, which is something we can note when implementing a STEM-focused program like robotics.

For this project we wanted to be able to consider all these social and economic factors when implementing a new program that is more STEM focused. It's important to try to teach them the basics of Robotics with an understanding of their educational system so it can integrate well within the schools using the program. We also wanted to make the most engaging program that could possibly spark an interest and increase the number of people following a STEM career for a better future.

2.3 Uses of Robotics/STEM in Paraguay for the Future

Robotics is a field that has seen rapid growth over recent years. Humans have begun to use it for everything during our daily lives from cleaning homes to playing a song. Beyond this, innovators have begun implementing robotics into labor intensive jobs, like agriculture, to ease strenuous activity for humans; while in turn, producing products more efficiently. Robots successfully have been used for many things in agriculture, such as, seeding, harvesting, weed control, chemical applications, and much more (N. Vamshidhar Reddy, A. V. Vishnu Vardhan Reddy, S. Pranavadithya and J. Jagadesh Kumar, 2016, pg 184). In developing countries like India, which relies on its agriculture, they believe the implementation of robotics in farming could drastically affect the growth and output of the country. While automated machinery is not a new concept in today's world, agriculture robots- or agribots- go far beyond a driverless tractor. They have been used for GPS mapping of seeds and weeds, and chemical applications in certain intervals. Some robots have also been programmed for planting, so that all seeds are placed in the correct intervals, and deep enough into the soil so more crops can grow (Mohd Saiful Azimi Mahmud, 2020, pg. 132). As a country that sells wheat and corn as one of its most profitable products, Paraguay could immensely benefit from the implementation of robotics into its work force.

2.3.1 Robotics in Paraguay

The popularity of robotics has been steadily on the rise in Latin American countries. Paraguay specifically, has seen the emergence of robotics teams, workshop groups, and competitions on a regional, and global scale. FIRST (For Inspiration and Recognition of Science and Technology) Robotics Competition is an international program that runs a series of events and competitions throughout the year designed to spark creativity and interest in students. Students who participate in FIRST programs are creating robots to compete in games themed on global issues like ocean cleanup, recycling, and much more. After becoming an incredibly successful steppingstone for students in the United States FIRST teams began to branch out globally. In 2017, Team 6982, or Team CEL, was founded with the help of Team 1622, aka Team Spyder, from Hudson Valley California. CEL was based out of La Centro Educativos Los Laureles, an education center in Asuncion. Shortly after their founding, in 2018 they participated in FIRST Power Up, at a regional event in Hudson Valley. Following this CEL evolved into the Paraguayan representative in the FIRST Global Challenge (FGC), an Olympic style event that is held in a different country each year that was founded in 2016. Having students from Paraguay participate in programs like FRC and FGC is extremely valuable because it promotes interest in STEM fields, and specialized skills that are often not taught to the students in schools.

Another program, called CoderZ, is an entirely online program designed to teach students K-12 about programming using a virtual robot. The program is designed to be used by anyone, especially those with no proficiency in robotics. CoderZ trained a small group of professors in Paraguay, with no previous experience, on how to implement STEM, coding, and robotics focused learning “on the ground”. Initially they struggled with the necessity of STEM education, and the increasingly great cost of materials and programs to implement in Paraguay. However, once the inital resource obstacle was overcome they could continue to reuse the technology and materials for all the following groups of students. According to Intellitek, “The CoderZ program also looks to create career readiness, allowing students to follow whatever path they choose with better hard and soft skills than before. The program promotes discovery, curiosity, creativity, and experimentation, opening doors for academic excellence” (Intelitek, 2020). For the last three years, many programs like CoderZ have been emerging across Paraguay and are attempting to bridge the STEM diversity gap. This was also a goal of our project, and reviewing previous implementations and understanding their struggles was helpful to avoid them on our own.

2.4 Curriculum Co-creation

Through WPI's experiential learning program, there have been several IQPs focusing on STEM education, as well as robotics more specifically, in Africa. Previous robotics IQPs utilized materials from introductory courses developed by VEX, a robotics program that hosts competitions for elementary through university students, for a long time, and recently started using the Experiential Robotics Platform (XRP): the pilot project of WPI's OpenSTEM program.

2.4.1 Course Adaptation and Curriculum Co-development

As per its mission statement displayed on the WPI website, the OpenSTEM program was designed to be adapted to meet different cultures and existing educational infrastructures and provides educators with inspiration, guidance, and support via free digital content, affordable materials, and community support. XRP is an entry-level open-source robotics ecosystem intended to expand global participation in robotics, inspire future engineers, and serve as a springboard for STEM education (Worcester Polytechnic Institute, 2023). Both courses are loaded with useful information that can be translated to teach kids around the world, which is something that VEX has already done to accommodate program and competition participants in over fifty countries worldwide. Both their documentation as well as all the elements within the coding environment has a Spanish version. As of the beginning of this IQP, courses associated with XRP are exclusively available in English. Additionally, the XRP code platform is only available in English. Students can use Google Translate to view the page in Spanish, but not the entire page gets translated, and there are certain terms where the direct translation is not the term that is used colloquially. Looking into the successful ways that the VEX program was adapted for developing countries was pivotal in adapting XRP for Latin America.

In addition to offering the course in different languages, the course should also be adapted to take different forms. As discussed in previous sections, the structure of lessons in Paraguay is not so heavily lecture and reading based as it is in the United States. Unfortunately, the XRP program as well as the pre-existing programs that have been previously implemented by WPI and other places are entirely reading based to get the students up to speed. While the content in these courses is introductory and delivered in easy-to-understand modules, the fact of the matter is that even if translated to Spanish, students could wither have a hard time or not enjoy learning this way, which is what makes the curriculum co-creation concept so critical for this implementation of the XRP. To create the most successful course possible, we implemented a mix of content from previous groups, materials we created on our own, and materials co-created with the robotics teacher at Cerrito School, Sebastian Cañete.

Before addressing the content and creating the lesson, we referred to the interview with Robert Krueger: Professor and Department Head of Social Science at WPI. Professor Krueger encouraged the team to consider the way we come in with prepared lessons to make everyone as receptive as possible to what it is we have to say. As outsiders, we made sure not to exert ourselves and our way of thinking onto the professors or students at the school. To do this, it was important to consider the way that lessons are currently being taught so that style can be replicated as closely as possible. It was also important that we don't overstep our bounds as consultants. Our goal was not to tell the professors what to do; we wanted to work with them to create a product that would work well for everyone.

2.4.2 Robotics Curricula Developed in Previous IQPs

The IQPs examined were from WPI's Windhoek, Namibia, and Rabat, Morocco Project Centers. Two of the Projects were an assessment of general STEM education, and the other two were assessing and implementing Robotics programs specifically. The robotics programs researched were both based on the VEXcode IQ and VEXcode VR programs. One team worked with the TIC Lab at the University of Rabat to explore how educational robotics can best be implemented in Moroccan schools. One of the platforms they started with was the VEXcode VR program. VEXcode VR utilizes code blocks that can be dragged and dropped and customized to control a virtual robot (Figure 16). The program allows students to complete various challenges with their robot to learn coding principles (Dell'Aera et. al., 2023).

BACKGROUND

Figure 16: VEXcode VR User Interface (VEX Library, 2022)

They then moved on to use the VEXcode IQ platform (Figure 16) and base further lessons off of that, which was also done by another group, who created a program called RobotiKids. The VEXcode IQ platform uses the same code structure and interface as VEXcode VR but implements a hardware component (Gowaski et. Al. 2022). Students receive a kit with diagrams of how to build the robot and information on activities that can be completed with it.

Figure 17 was taken from the RobotiKids Technical Manual, which was developed by the group as supplementary material to the VEXcode IQ program. The group worked with Association Anoual in Rabat to develop this program based on the VEXcode IQ platform. The manual is filled with images from the kit, of the robot, and screen shots of the VEXcode IDE detailing how students can complete supplementary activities created by the group (Gowaski at. Al. 2022). Overall, the manual seems like an excellent tool that would supplement the pre-existing platform. Something similar would be good to develop in Paraguay both for use at La Escuela Agrícola Cerrito and for other schools around Latin America. An addition of supplementary resources like this such as a cheat sheet, condensed lesson slides, or videos would be an excellent vehicle for curriculum co-creation since group members could work with a sponsor on developing supplementary lessons with the format and structure that students and professors are already used to and prefer as well as highlighting the content that has been determined to be most essential.

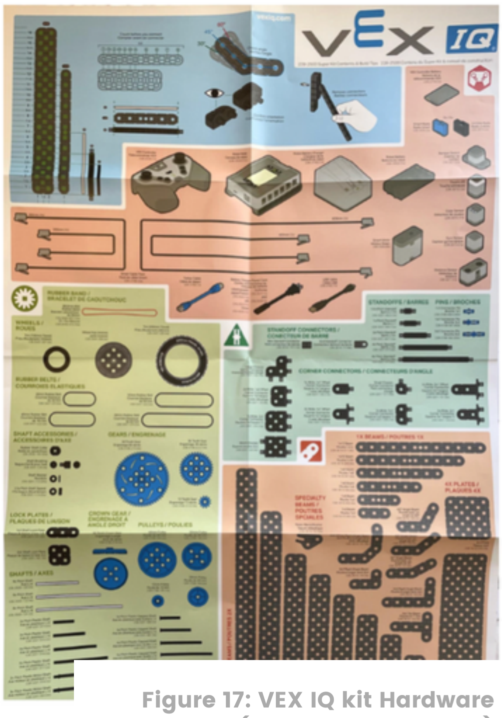


Figure 17: VEX IQ kit Hardware illustration (Gowaski et. al., 2022)

2.4.3 Community Outreach

The Morocco IQP teams worked with Association Anoual, which is an NGO working to increase the capabilities of youth and inspire them to make social change. In Namibia, there is a similar program called Physically Active Youth.

"The Physically Active Youth (PAY) program is a community-based strategy meant to help and aid children and youth-at-risk in low-income neighborhoods in Namibia. It focuses on addressing the physical health, academic status, personal development, and community involvement of the youth. PAY offers after-school programs for students to engage students such as the robotics program with a goal of developing their skills and improving their attitudes towards STEM" (Asumadu et. al., 2021)

The team's goal with this project was to educate the kids about robotics and then get them into competitions. The team created a guide for PAY and for others on how to generate sponsorship funds and detailed information that should be sent to the sponsors. To teach the students, the group implemented the Pan-African Robotics Competition (PARC) online Robotics learning platform. They made several videos, most of which are unfortunately now inaccessible to us. The available videos provide a step-by-step tutorial featuring only a WPI student explaining how to use the virtual robotics platform provided by PARC, as well as some basic robotics concepts. Our intention is also to create videos featuring a set of Cerrito School students showing how to build the robot instead of a WPI student. This is another aspect of co-creation that would be good to implement because students seeing their peers' completing activities with the robot will give them more confidence in their own ability to learn how to work with it.

Another deliverable included with the one of the Namibia teams' reports is information about a program called Live Remote Tournament (LRT). "LRT was developed by the Robotics Education & Competition (REC) Foundation during the Covid-19 Pandemic to give teams the ability to compete in robotics competitions safely. In LRT, teams will compete in head-to-head matches with other teams in a newly-developed environment similar to an in-person event" (Asumadu et. al., 2021). This competition unfortunately stopped happening after COVID, however preparing the students for a competition would be an excellent way to motivate the students to learn, which was made evident by the Namibia team. The school has the option of several other online competitions, or they can also consider hosting a competition of their own. The Cerrito school receives no government funding and has several enterprises within itself run by staff members and contributed to by the students to generate funding for the school. Hosting robotics competitions, classes or events could be a good way for the school to bring in extra money.

2.5 Teaching Methodology

According to Nacy E. Adams, there are six levels of understanding, knowledge, comprehension, application, analysis, synthesis and evaluation. This concept is known as Blooms Taxonomy by Benjamin Bloom (Figure 18). (Adams, 2015) The first level of the "pyramid" is knowledge. This refers to the ability to remember specifics from a subject, such as topics or definitions. This section can be easily tested by simple memory questions. The next step would be comprehension, where, to put simply, learners understand what they memorize. Being able to describe the subject to others or compare certain subjects to others is a way to reinforce the learning of concepts. At this stage of learning students should have an understanding of the things they memorized. They should be able to summarize the subject and studied concepts to others. Once an understanding of concepts is established learners should be able to start applying the concepts to problems or situations that they encounter. The next level of learning would be the ability to analyze articles and other material in the subject matter. They should be able to debunk myths or contradictions, and to see how ideas are built from the foundational concepts. The next two levels are closely related, evaluation and creation. The best example of this is when professors peer review papers or write their own papers. One's knowledge of the subject is in depth enough to judge other creations in the subject matter and create their own. (Adams, 2015)

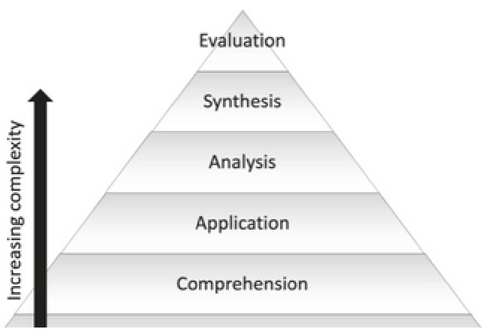


Figure 18: Bloom's taxonomy, a description for how much a person knows a topic. (Adams, 2015)

We hope that our finished materials and teaching allowed the professors to create and make changes to their lectures and plans to teach the course effectively. After completing the robotics course students will be able to analysis basic coding and robotics material as well as giving them a strong foundation if they wish to pursue coding/robotics in the future.

2.5.1 Passive Learning

The first step in teaching a new subject is introducing the theories, topics, and examples. While the students are not actively learning in this stage, it is necessary to build a foundation for later activities. During this stage the professor can interact with students and check if they are understanding the lecture by asking questions or giving time to think in between sections.

An alternative to lecturing is assigning reading material to the students for them to study key concepts on their own. The main problem with this is that reading materials are often intimidating to most and may not pique the interest of the subject. The lectures let the teacher adjust subject matter and the depth needed to keep the students engaged. The students are also allowed to jump into the lecture at any time to ask questions, while students reading may become stuck on a topic with no immediate solutions. Lectures appeal to a major attribute of humans that being communication. At the start of the age of the internet, some universities were looking into the idea of distance learning. This idea was built upon as the internet develops and the recent Covid-19 pandemic, but yet students still prefer to attend lectures. This contrasts with the vast increase of distance work. Working from home is seen as a positive that is sought after. While students have access to content online and lectures through videos many chose to come to the lectures in person. This is due to a variety of reasons, lectures can be seen as a social event, the satisfaction of attending a lecture, and the space encourages work. The idea that humans are social creatures helps the fact that students can see their friends and the in-person interactions between professors and other students are sought after. For many students attending the lecture is the first step to a productive day of completing work. Being in an environment where others are being productive incentivizes one to also be productive, leading to a cascade effect. For teaching robotics, lectures are important for explaining how parts work and are used. Robotics is similar to math where concepts should be shown and examples done by a professor, therefore the expertise from the professor to answer questions while lecturing is more efficient than having the students read on their own. On the other hand, students must understand the concepts before attempting anything hands on. This is why lectures are a good teaching method for teaching robotics. While there have always been questions on the effectiveness of lectures, they are essential to the learning process but can only elevate learners to the comprehension level of understanding. (Charlton, 2006)

2.5.2 Active Learning

To advance to the next level learners must take control. Typically, this is done through homework problems but there are many methods to have students participate in the learning experience. In robotics this is done through activities where they solve “situations”. These are known as problem statements, where we want the robot to perform a specific activity. For example, have the robot follow a black line. This is the core strategy in teaching robotics, first lecture on new topics/concepts then have the students apply them in problems. If a student actively thinks about the concepts and tries to apply them, this is considered active learning.

2.5.2.1 Day to Day

There are many methods that professors can use during a lecture such as questions, and discussions. Some examples from retired Professor Whetten that help create an active learning environment are problem-based learning, reflection time, and an interactive classroom. (Whetten, 2021) The implementation of problem-based learning will not be a challenge with robotics. Once a subject is taught and the basics are understood, many of the assignments will involve a challenge for the students to solve. The nature of robotics will cause problems within the challenge that must be diagnosed/troubleshooted and analyzed. As the course progresses, students will develop their problem-solving skills, and the challenges will become harder. After each project, a self-assessment can be administered on what they learned during the project along with things they still don’t know. For team-based projects, group dynamics can be assessed, and their experience can be shared with the professors. This will build their analyzing skills and help strengthen their understanding of the subject. Finally, a group will make the projects less intimidating to the students. They will be able to help each other so students will not give up and lose motivation.

2.5.2.2 Active Curriculum

While actions taken by the teacher throughout the course to encourage active learning are helpful, it is more efficient to have the course tailored to it. For example, the pacing of lecturing new materials and then applying those in problems or mini projects, assigning problems or papers to build the analyzing skill in that field. A common assignment is giving an incorrect solution or conclusion and students having to analyze the solution and point out the mistakes. In higher level courses, students read papers on the subject, applying the knowledge they learned to dissect them. Then the big projects, in group or individual, encourage creation and are true tests of knowledge. An important technique for creating an effective course is assigning course objectives to specific assignments. This is often seen in the field and given to students on syllabi for various classes. Let's look at an example course structure that would be given to a student.

	HW 1	HW 2	Exam 1	HW 3	Final Project
Objective 1	A	A	A		A
Objective 2		A	A	A	A
Objective 3				A	A
Objective 4				A	A

Table 1: An example of a course structure one might see on a syllabus.

While the pacing of the example course has some issues, an important section that is missing is what level of understanding a student should be at. A better structure to design the course from is given by Figure 19 below:

We list each action/assignment that the students will partake in and state the objective it targets along with the level of understanding that will be achieved/practiced with each. This way we can ensure that we are building that pyramid for our students. This can be used to organize activities and strategies in course creation.

	Course Objectives		
	Understand	Apply	Create
Course assignments			
Attendance	X		
Group project		X	X
Term paper	X	X	X
Exams	X	X	
Journal		X	X
Test questions			
Question 1	X		
Question 2	X	X	
Question 3	X		
Question 4	X	X	
Question 5	X		X

Figure 19: A course structure diagram that goes into more depth about the goals of each assignment. (Whetten, 2021)

2.5.3 Assessment and feedback

The final stage in learning is assessment. This is an important part of learning because not only will it displace mistakes and misconceptions made during the learning process but encourage a discussion within the student when feedback is received. Good feedback is curated to the individual, general feedback does not help anyone. The assessments should test the main course objectives. The concept of teaching for the test is valid as long as the tests and projects are designed based on the course objectives. (Whetten, 2021) Once students are at the analysis level of understanding, having peers grade each other, builds that evaluation section of the pyramid. Learning is a constant process where understanding of a concept is always improving, and assessment is the end of the cycle.

2.5.4 Problem solving and Critical Thinking

While these methods are all good for teaching a specific curriculum, having a subject that has lasting effects in other areas of the student’s life is a goal for every class. The skills that are always practiced are problem-solving and critical thinking. This is an everyday skill that makes life easier and can be developed faster within classes. These skills get the most practice during the active part of learning. STEM (Science Technology Engineering Math) based topics train these skills. Solving problems is at the foundation level of STEM, the most effective of these subjects would be engineering as many engineering projects have problems that are relatable to students lives. Students take what they learned from the class and find a solution that they can apply in real life situations. This process of taking what you have learned and using it to solve problems applies directly to life. Students, without knowing it, learn and practice the process needed to approach unfamiliar situations. They learn the basics of the concept, apply, receive feedback, and then learn from that feedback. For robotics the feedback is instant, whether the robot successfully completes the task or not. They then go through the trouble shooting process where mistakes that were made are found and they learn from it. Students should gain confidence within themselves after completing a course, due to another unknown subject being understood. (Hafni et al., 2020)

2.5.5 Fun

An important aspect of all courses is that they are fun to take. When something is enjoyable a person will be more engaged with the subject. One way to make a course fun is to share what a student has learned. Sharing knowledge with others gives validation of their work and proves to oneself that they understand the subject. Specifically for robotics, having final projects be presented to younger kids allows for students to show pride in their projects but also shows the younger generation how fun STEM can be. This can open a kid’s mind to wanting to pursue a career in STEM. Having an end goal also keeps students engaged with the project. They are not just doing this for a grade, this is being presented to others. (Eguchi, 2021) As long as the robotics course includes challenges and problems to solve using the robot the course will be fun. Students find either seeing the robot do want they wanted to be interesting or failing in a funny way like falling off the table etc.

3. METHODOLGY

This project aimed to implement an introduction to robotics course at The Agriculture Cerrito school in Benjamín Aceval, Paraguay. To be successful, this course aimed to contribute to students' development of critical thinking and problem solving, spark interest in STEM, and create enjoyable experience for them. The main objectives of our project were as follows:

No. 01

Co-create presentations and lesson plans with the robotics professor, Sebastian Cañete, to be used in the implementation of a robotics course in Cerrito school.

Adapt the available Experiential Robotics Platform (XRP) robot curriculum designed in WPI to the Paraguay and Cerrito School culture and environment.

Implement the presentations and course materials in classes to adjust and receive feedback from Sebastian Cañete to improve and enhance the materials.

No. 02

Create a tutorial video with students from Cerrito School to teach how to assemble the XRP robot and set up the software to program it.

To achieve these goals at the Cerrito school, our team needed to gather information on the following areas:

1. The culture and structure of STEM classes at Cerrito School.
2. The experience that the professors have with robotics and STEM education.
3. The expectations the students have of the robotics course.

Using participant observation, interviews, and focus groups we filled the knowledge gaps that background research could not have provided us with. This knowledge was then used for the co-creation of lesson plan, course materials, and explanatory videos that future iterations of this class can use. By utilizing the data collected by these methods our course was able to adapt aspects of the XRP curriculum to the academic culture at Cerrito School and help us in achieving our goals. This section will outline the steps we took to use these methods to collect useful information for our project.

3.1 Classroom Observation

To understand how students learn at Cerrito, we conducted participant observations during math, chemistry, and informatics classes. This gave us an opportunity to see how classes in the Cerrito school were run. (Reference Appendix B for how we structures our observations) These observations informed our decisions in the creation of the robotics classes and the creation of course materials so that they were familiar to the students and professors. Robotics is a new experience for many students, so we created an environment where they felt familiar and comfortable to help ease any intimidation caused by the subject. Like how principals monitor professors, we participated and observed the class without disturbing the classroom. We focused on monitoring how the professors interacted with the students, how the class schedule was structured, and how students responded to other peers and professors. In addition to this, we also noted how topics were taught, and the teaching strategies professors used the most. Our group visited a Math/Chemistry class taught by Dr. Lorena Llano and an Informatics class taught by Professor Sebastian Cañete. The guide used for our notes and summary of our observations from these classes are written in Appendix C.

The main goal of this project was to create a course where the professors at Cerrito feel confident teaching, and that the students enjoy learning. The data found in this method went towards ensuring the course blended well with the school's culture in preferences as we worked toward the final deliverables.

3.2 Teacher Interviews

Besides just observing the in-classroom dynamics at the Cerrito school, the team also really wanted to speak to the professors and administrators about their thoughts on the program. We were also hoping they could provide some much-needed insight into what we observed in the classroom and any experience they can offer from their time teaching. From these interviews, we can gauge the curriculum's compatibility with the school, and its longevity after we depart. (See Appendix D and E for a summary of the responses for each professor respectively.)

Interview with Robotics Professor

GOAL: Determine the new robotics professor at the Cerrito school, level of understanding in the robotics field; as well as any challenges he might have to teach and/or understand the material we create.

Interview with Mathematics Professor:

GOAL: Determine the understanding of robotics/STEM courses in other professors at the school. As well as learning what methods of teaching worked best for them, the style we should use to develop the robotics curriculum, and any other pieces of advice to ensure that the curriculum can work for any possible professor and students.

3.3 Adult Class Survey

Our group also taught the XRP robotics course to a few of the administrators and professors at the Cerrito school. The group included the director of the school, Amalio Enciso, teacher Juan Carlos Altemburger, of Agrarian Administration, Alberto Gonzalez, the Academic Director, and Matias Godoy, the Academic Secretary. Within this group, surveys were given out to the four participants to gather knowledge on their educational background and their experience with robotics. The surveys included questions (Appendix F) that focused on what types of classes they have enjoyed in the past how they see this course being implemented in Cerrito school curriculum, and why they were interested in robotics. It was important to us that we made this course easy to understand for the professors as they will be supporting the robotics professor on future Robotics courses. Understanding their robotics knowledge and asking for pointers on how to teach the material to students at Cerrito served as further insight to creating better course material.

3.4 Student Focus Groups

Insight from the professors at Cerrito School was important, but we also wanted to hear from the students that were taking the course. Considering the students were our curriculum's main target, their thoughts and opinions were important to the longevity and success of the course. The focuses groups were conducted after lesson 3.

When talking with high school students rather than professors, informed consent from both students and the school director was required (Appendix H). This also included a clear outline of the purpose, procedures, risks, and benefits of the research. Secondly, there was an assurance that privacy and confidentiality is maintained for every participant. Lastly, these focus groups were culturally sensitive, and respectful of the traditions, customs, and beliefs at the school. Our team decided to employ focus groups to collect feedback from the students on the robotic course we were implementing. This method allowed us to create a discussion amongst peers rather than a one-on-one conversation with strangers, which encouraged students to speak their minds regarding the topic. The group discussions were held after school to not hinder their class schedule and included students taking the course who volunteered to speak with us.

The focus of the questions addressed how we were doing as professors (Appendix G). We gave these questions halfway through the course. We wanted to see what the students thought of the course so far and how useful the course has been to them. We asked what they had learned so far from the course and how they thought about the way the topics were presented.

These questions were sectioned into three categories: engagement questions, exploration questions, and exit questions. Engagement questions introduced the topic of discussion and made the participants comfortable. Exploration questions were more in-depth questions about the topic(s) of the discussion. Finally, exit questions were asked to check if anything was missed in the discussion. A facilitator made sure the students were respectful of one another as well as responsive to get the most information. The facilitator also remained neutral throughout the discussion to not discourage any students from their answers. An assistant facilitator was attentive and took notes making sure there were detailed comments for every student. Not only did we use this information for the final lectures of the course, but this feedback was given to Cerrito professors so they can use it in the future when implementing the XRP robotics course.

3.5 Data Analysis

Our data collection period began in the days after we guided the students through assembling their robots. We thought it would be important to gain insight into how classes are taught in this School and what was the preferred learning and teaching method of the students and professors, respectively.

Initially, we conducted observations in two classes, during which we took notes intended to aid in our course structure design. These notes were then combined to paint a picture of the environment of a typical STEM class in la Escuela Agricola Cerrito.

We took notes, and when possible, generated a transcript from our interviews and focus groups. Once we got the finalized notes or transcript, we coded responses and discussion topics. The coding process involved first reviewing and reflecting on what was said and then creating categories in which responses could be classified. We then went through the notes and transcript in detail, adding a tally to the category associated with each response, and adding new categories when necessary. At the end of this process, we had a list of general ways students answered questions and themes that their answers touched upon along with the number of times each one was mentioned. This method was used to keep track of which teaching methods were discussed by students and professors most and least frequently. This data was also compared with the data that was gathered in the classroom to determine if there was any connection between what the students and professors wanted and what was done in practice. This was also compared with the thoughts of the administration staff gathered from our survey.

3.6 XRP Hardware Kit

Professor Brad Miller has developed an inexpensive robot and a curriculum accessed through the Read the Docs platform. Participants also can make an account on Canvas to follow the same modules as through Read the Docs and interact with other users. The purpose of the XRP robot is to be able to introduce robotics at a low cost so that more people can have access to learning about robotics. The curriculum has been implemented in high schools in New Hampshire and Namibia. Paraguay was the first implementation where a translation of the curriculum was necessary. With this project, it is hoped that we will provide schools across Latin America with the resources and materials to implement an inexpensive robotics course. This helps with Miller's end goal of using XRP to teach robotics in developing countries.

Robotics is often thought of as a three-legged stool because it is the synergy of mechanical design, electrical design, and computer science. If one of these three "legs" is missing, then the stool will not be able to stand. This means it is important for students to learn about all three of these sub fields. Naturally, computer science comes into play when programming robots, but students can learn about electromechanical design through building their kits. Mechanical design is learned by building their kits and seeing how all the pieces fit together. For the more advanced students, there is also the option for them to model and print their own pieces to the robot. Electrical design is learned when students are wiring all their sensors and connecting them to the controller. This kit is such a great introduction to robotics because it educates students on every component of robotics without being too overwhelming.

The XRP Hardware kit was designed by Professors in the Robotics Engineering Department at WPI in collaboration with hardware companies, such as Sparkfun. Sparkfun is an electronic distribution company that focuses on electrical and robotics engineering education. They sell kits and guides with custom electrical components complete with software for people to learn engineering concepts. The XRP hardware kits include low-cost and donated components so that it could be a more feasible option for lower-income communities and developing countries. The final cost is one hundred fifteen dollars, which is much less expensive than competing kits such as VEX kits, but there is an educator and FIRST team discount which brings the cost down to sixty-five dollars.

The kit comes with everything needed to get started with the robot except for batteries and a cable. Any Micro USB cable capable of power and data transfer can be used and any AA batteries can be used to complete the required materials to assemble the robot. The kits come with a chassis, motor/encoder assemblies, wheels with O-ring tires, a custom circuit board, a battery case, an ultrasonic rangefinder, a line following reflectance sensor, a servo motor with a servo arm, and all the brackets, mounts, and cables required (All shown below in Figure 20 and Figure 21). The custom circuit board is a Raspberry Pi Pico with 4 motor controllers, 2 servo controllers, an inertial measurement unit (IMU) for navigation, a power regulator, and Qwiic connectors for expansion soldered on. All the non-electronic components are 3-D printed, which makes the kit inexpensive and allows for the pieces to pressure fit with each other and the robot to be assembled without any tools. Furthermore, all the CAD files for these pieces are available publicly online, so users can print themselves replacement pieces if anything breaks or is missing, and will make it easier for the more advanced users to design custom mounts to expand the robot's capabilities if that is something that they are interested in.

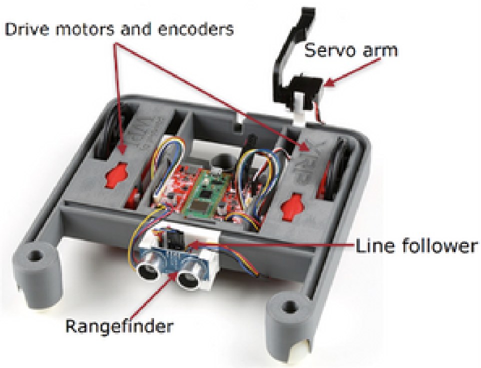


Figure 20: (Left). Assembled XRP Hardware Kit (Miller 2023)

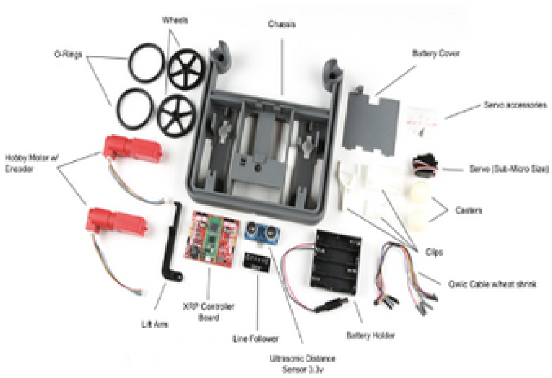


Figure 21: (Right). XRP Hardware Kit Components (Miller 2023)

The packaging for the kit has a QR code on it that brings people to the User Guide developed by WPI faculty and students, which contains a video produced by Sparkfun1 detailing how the robot should be assembled. Unfortunately, this video is only available in English. On the team's first day in the classroom with Prof. Cañete, we walked all of the students through the process of assembling the robot. The students who felt comfortable enough with the process helped us create a video we planned, in a similar style to the one from Sparkfun, detailing the assembly and initial set-up of the robot in Spanish to be used both in Cerrito and in other Spanish-Speaking Communities that implement the XRP.

The team, advisors, and professors in Paraguay all unanimously agreed that the assembly of the robot is an essential element in the process of learning about the robot and how all the components work with each other. For this reason, both Prof. Cañete and members of the team have tried to disassemble their robots, which we were able to do successfully, so the same robots can be used from class to class and year to year. If the electronic components do not break, the kits can be re-used infinitely because the plastic pieces can be reprinted if the need arises. Reusing the kits both saves money for lower-income communities and reduces waste.

3.7 Using XRP Code in and Introductory Robotics Course

XRP Code is the platform developed by WPI OpenSTEM for students to program the robot they have assembled from the XRP kit. XRP code is a web app that works on Google Chrome and Microsoft Edge with any operating system. It gives users the option to write code in MicroPython, which is a programming language compatible with C and Python optimized for microcontrollers, or Blockly.

Blockly is an effective way for students who are unfamiliar with coding to learn the concepts. It is very comparable to coding with Scratch. Blocks are grouped in the control panel by action/command and all blocks from the same section are the same color. This allows the students to visually see the capabilities of their robot that they can take advantage of. It also fosters an understanding of the foundations of the code behind what they are doing by seeing how the blocks are set up. When students create a Blockly file on XRP code, they will have a workspace in front of them where they can drag in a sequence of blocks and then run the code on the robot (Figure 28).

While a few of the students and faculty in Cerrito have experience with Python and other programming languages, the majority do not, so all the lessons were taught based on Blockly. Prof. Brad Miller of the Robotics Engineering Department at WPI, who is one of the co-creators of the XRP Program, created several challenges for students to tackle using the Blockly code. These challenges helped students learn programming concepts and how to use the XRP robot. The students preferred to learn with hands-on activities and lots of visual aids. The same is seen with teaching, as professors stated and showed, they use an active classroom with lots of visuals. So, we developed PowerPoint slides with short 10 – 15-minute sections where the teacher lectures about robotics concepts with many diagrams. Then the student teams are released for the next 20 – 30 minutes to work on a challenge related to the concepts in the lecture with XRP code and their robot. Topics and challenges were selected and developed from material given to the team by Prof. Miller and Annie Hughes, found in previous and concurrent IQPs, and based on preferences of the team. In the initial phase of the project, this process was done exclusively by members of the team, and then we started involving Prof. Cañete in the process when he became more comfortable with the content of the course and started creating lesson plans fully on his own.

Figure 22: XRP Code Blockly Integrated Development Environment (IDE) with Code Blocks

While students were working, the team and Prof. Cañete went around the class to work with teams 1 on 1 who needed extra help. Bonus challenges were also built into the lesson plans so that early finishers still had something to do. After the set amount of time was up, the team went over a solution to the challenge, and interested students showed their solutions as well.

During the lessons taught by Prof. Cañete, the team took notes on how the lesson was going, so that updates could be made to the slides when necessary. The notes and updated lessons were used to create lesson plans for our version of the XRP course. Our goal of writing the lesson plans was to provide an in-depth structure for the course as well as to include information that would be helpful for someone teaching the class, such as troubleshooting common issues. This will allow our course to be adapted to be taught by any teacher at La Escuela Agrícola Cerrito or any other school in Latin America. Our lectures materials were designed to be used in two-hour blocks, so the lesson plans will allow professors to break up the modules based on their schedule. The materials and PowerPoint presentations created for these classes can be used year after year by Prof. Cañete and can also be used as a self-paced lesson by interested students.

3.8 Ethical concerns (IRB)

Since our project directly involved the input of both minors and professors through interviews, surveys, and focus groups, we created an IRB application and that used best practices to protect the autonomy of all the students and staff involved. This application was submitted and approved upon our arrival to Paraguay. The primary way we did this was by creating a declaration of consent (Appendix A). This made it clear to participants how the data collection worked, why it was collected, and what happened to the collected information. All the professors and students who are 18 plus gave informed consent to the study. For students under 18, the academic director of the school, Prof. Amalio Enciso, provided consent on behalf of their parents. Meaning that anyone on campus who was interested in participating was able to.

The way questions were crafted varied between the students, who are mostly if not all minors, and the staff members. Regardless of the audience, all questions were crafted in a neutral way to not pressure any of the respondents. All the information collected was only shared internally within the project team and advisors. No information collected was given out, because it was only collected for the purpose of determining the best way for us, as people unfamiliar with the school's practice, to co-create the course with Professor Sebastian Cañete, who is a new staff member. All notes and transcripts were stored as Microsoft Office Documents stored in the group SharePoint Site administered by WPI.

4. FINDINGS AND DELIVERABLES

4.1 Introduction

This chapter presents the collection of findings and deliverables the team has identified/created. It explains how the findings garnered through our methods have impacted on our deliverables. The team implemented four methods to collect information that helped in the creation of their deliverables, including: classroom observations, interviews, surveys, and focus groups. Informed with data collected through these methods, the team created five deliverables in Spanish for our sponsor to support the teaching of an Introduction to Robotics course: lesson plans, course module presentations, a video explaining how to assemble the XRP robot, extra tools/resources for professors, and a website to house these materials.

4.2 Findings

4.2.1 Analysis of Classroom Observations

Classroom observation at the Cerrito School offered valuable insights into how classes are run and the level of student-teacher interaction. One of the goals of our course material was to have it integrate well with the school's learning environment and to use effective teaching practices, so students will be excited as they engage with a new robotics program. Of the two classes we observed, each showed their own distinct structures, which worked well for their respective participants. The computer science class had a relaxed and collaborative environment compared to the math class, which was more structured and systematic. In the computer science class, the focus was on practical application as the students were immediately engaged with their assignment using Excel. The professor also helped each student, and because of the openness of the class, students were comfortable with helping others that were stuck on something. In the math course, the class was more structured and had more general explanations of concepts directed toward the whole class. Examples were provided and usually worked on alongside the professor so students could fully grasp the steps to solving a problem.

The information gathered from the observations was valuable for the creation of our deliverables as it gave us insight on how to go about teaching our course. Since the learning environment is slightly different from what we are used to, we wanted to make sure that the materials we were creating for the Introduction to Robotics class were using the most effective teaching methods. This would increase student engagement, and hopefully would encourage some students to continue following robotics in the future, as well as interest students who have little to no experience to want to learn about it.

With the results from our observations, we gained insight into the learning environment and student-teacher dynamics at Escuela Cerrito. From the informatics class we learned the students are open to a collaborative learning environment and are always ready to help one another. From the mathematics class, we saw students do well with understanding concepts through active participation of example problems. The results from our observations were used to create and re-fine when working on our presentations. Our presentations are very visual and have many activities to keep the students engaged. Each activity slide has three activities where those who advance quicker than others can attempt the third one which promotes critical thinking.

4.2.2 Teacher Interviews Results and Analysis

4.2.2.1 Analysis of interview with the Robotics Professor

The Cerrtio school's new robotics professor pursued a career in education when he discovered his natural passion for teaching, and how much he enjoyed collaborative learning environments. He does not take the traditional approach to student teacher relations, preferring instead to be seen as a peer then an authority by his students. This mindset also feeds into his style of teaching, which is more oriented toward chatting with each of the students individually to help them solve problems. He believes this robotics course presents a lot of appeal for the students. The rise of robotics in agriculture-related fields, such as automation in cultivation and irrigation, aligns with Cerrito School student interests and current course work. From his answers to the above questions our team gained a better understanding of the style of teaching the professor intended to use for the course in the future. Since our objective was to create an easy to implement course, we tailored the materials to be more activity based so he could spend more time interacting with the students and foster the supportive learning environments he valued from his own educational career.

4.2.2.2 Analysis of interview with the Mathematics Professor

This Doctor of Chemistry soon discovered she had a passion for teaching that led to teaching students' math and chemistry at Cerrito School. She transitioned from tutoring peers, to working in a lab, to educating children in a classroom setting and has now been teaching for 24 years.

When asked about suggestions for an Introduction to Robotics course, she suggested linking advanced concepts back to basics, for skill reinforcement. Our team has kept that in mind when creating the course material. Many of the problems presented to the students utilize a combination of the new concepts they had just learned and the basic concepts, like driving forward, one of the first things they learn. The doctor encouraged our team to incorporate practice problems and again emphasized the importance of student motivation and helping students understand the relevance of what they are learning. This tied well into the exercise-based practice problems that our group made based on the results of the interview with the robotics professor. Our group also included slides detailing the practical application of what the students were learning and explanations for why coding elements were helpful in numerous situations. All in hopes of reinforcing the relevance of what they were learning like the doctor suggested.

4.2.3 Adult Survey Results and Analysis

In addition to imparting the Introduction to Robotics course to groups of second and third-year students (ages 17 & 18) at the Cerrito School, we carried out the course, accompanied by Prof. Cañete, with four staff members of the school. These included school administrators and people working in or that have worked in Agrarian Administration at the Cerrito school. While only one of them is currently teaching, they have all taught either agricultural courses or computing courses. All four participants have a range of three to fifteen years of experience working at the Cerrito School, and all confirmed that they have had positive experiences working at Cerrito School, and with its students.

Our team carried out the course with this group of professors with the goal of allowing them to develop the ability to support Professor Cañete in teaching the course to students in the future, as well as supporting him in robotics-related activities organized by the Cerrito School. Before imparting the course, our student team carried out a survey with each member of the group to gauge their level of robotics understanding, and to ask for pointers on what sort of content they feel should be included in the course, as well as how they felt the course should be taught.

None of these four professors had previous experience with educational robotics or coding. Of the four of them, only one had any direct experience working with robots, which was acquired through working with drones at the Cerrito School campus, as well as playing with robotic toys with his children. Despite this, they had all heard about robotics and seen the capabilities of robots through their university studies and/or through the media. The background of these professors will be helpful to them when they teach the Introduction to Robotics course in the future. Since they all have agricultural experience, we hope that they will be able to apply the knowledge they gain through continued studying of the XRP curriculum to show students how the XRP robot, and robots in general, can help with agricultural work. This group of Cerrito School staff, working together with Prof. Cañete, could also develop an agriculture-based robotics course in the future to be offered at the Cerrito School.

All four participants indicated in the survey we carried out with them that what they have heard about robotics previously is exciting to them, and that they were motivated to learn something new. They also indicated that they were excited for the Cerrito School students to participate in the new robotics component of the school curriculum. They all agreed that the Introduction to Robotics course would allow students to develop problem-solving and critical thinking skills and a background in systems thinking that can also be applied to their daily experiences. In addition to the critical thinking concepts that these staff members see being developed through the introduction of this course, they believe it is important for students to understand the different parts of the robot, and how these interact with each other and the environment.

The insight gained from this survey allowed us to better understand the climate of robotics in the Cerrito School. Robotics is a topic that is interesting for students and professors alike, both due to the novelty they associate with it and – particularly on the side of the professors – potential applications of the field to help the school in its agricultural and animal production efforts. The survey also allowed the team to better understand what we would need to focus on in preparing these faculty members to help Prof. Sebastián teach the course in the future. For this reason, we did not have him take the survey because our focus was to gain insight on the perspectives of the professors we were teaching. One of our primary objectives of the project was to make sure we left the Cerrito School with an installed capacity to be able to keep teaching the course and to expand the school's XRP robotics program. The survey indicated that these professors have no programming experience, meaning that as we taught them the course, we would need to explain terminology and concepts they would need to apply before getting into XRP specifically. We also learned that we would need to review the necessary algebra and geometry concepts with them so they could be at a level to not only do the necessary math but to teach it as well. This became evident both through the survey and through teaching them the course.

Insights from the survey allowed us to successfully deliver the course to these professors, however, due to time restrictions, we were only able to get through about half of it with them, so Professor Sebastián will finish getting them through the course after we leave, and they will also need to practice with the robots on their own to successfully teach the class to students.

4.2.4 Student Focus Group Results and Analysis

To gather data to help us refine the robotics course content presentations and lesson plans, our team also decided to conduct a focus group that would allow for a discussion with Cerrito School students about the course. Our team spoke with a group of 11 students that was comprised of 5 second year students and 6 third year students. Our team asked a variety of questions that explored three main topics: students' expectations regarding the Introduction to Robotics course, students' experience in terms of robotics, and students' suggestions for the course.

Overall, during the discussions, students shared their experiences and concerns regarding the course we had begun implementing. A common theme that emerged was nervousness and apprehension about the course due to the lack of prior programming knowledge. This let us know the importance of making sure that the classroom learning environment would be supportive, allowing students to feel confident about this new subject. In terms of course structure and delivery, students said they preferred more hands-on activities rather than theory-based classes. They acknowledged, however, the need for a balance between the two to grasp the concepts effectively. The students also expressed their struggles with the language barrier they had to face while programming, as some of the programming concepts in the robotics field continue to be expressed only in English. They stated that they felt that not understanding English hindered their ability to fully engage with the course. This being their biggest obstacle, some students were still determined to overcome it and independently try to understand the coding concepts.

Considering the students' feedback, we realized that it was important to incorporate their insight into the final deliverables. For example, when developing the classroom presentations, we strived to ensure they were as engaging as possible, while ensuring that the content presentation slides were presented in an easy-to-comprehend order. We also created reference sheets to aid students in following the coding concepts which included topics and basic terms translated from English to Spanish. Many students were interested in using python to code the XRP, as this was a separate goal of the course access to outside resources was provided on the website. Support was also given in class to the students who wanted to try using python. Students found the application of math section of the course to be interesting and wanted to see more of it. Changes were made to the lesson plans for controllers to incorporate more of the math behind it. Despite the positive feedback we received from students on the materials we developed, there is still potential for improvement. Results from this student focus group were just one of the many factors that helped create and refine the course materials.

4.3 Deliverables

The results of our methods led us to create the following deliverables: an introduction to Robotics video, the introduction to robotics course in Spanish, course materials that include lecture presentations and detailed lesson plans, recommendations for teaching the course in Spanish and a website that compiles all the materials and other resources. All these materials were created to be used by professors teaching the XRP Introduction to

Robotics course in Spanish going forward. We facilitated workshops with professors and administrators so that they could learn the course content and help teach it in the future and expand the program. We also served as liaisons between Fundación Paraguaya and WPI to coordinate the translation of the XRP user guide into Spanish to make this resource explaining the basics of using the XRP robot available to professors and students involved with our course.

4.3.1 XRP Robot Assembly and Informational Video

As explained in previous sections, after the launch of the XRP robot, Sparkfun produced a video explaining how to assemble the robot, and how to get started with XRP code. The video, available at https://youtu.be/_7Y6D_kw098, was only produced in English at the beginning of our project, so our team established as a project goal the production of a Spanish version of the video. The robot kits come unassembled because building the robot is an excellent way for students to learn about the electromechanical design aspects of Robotics.

We wanted the video to show the assembly process, and how to get started with XRP code, just like Sparkfun video in English, but we also wanted the video to explain to students the purpose of each component of the robot, while they were assembling it. The latter responded to feedback we received from Cerrito students and staff members that they would like to learn about each piece of the robot while they are building it. To accomplish this, we included information in the video about each component as it was being placed on the robot.

The Sparkfun video in English features two professors who work for the Sparkfun company. We wanted our Spanish version of the video to feature students, because we thought student viewers would more easily relate to other students putting the robot together. We also thought it would be more impactful for viewers, who are just learning to assemble and use the robot, to see other students who have been able to successfully learn from the course.

Our first step in creating the video was to write the script in English. We referenced and followed the same structure as the Sparkfun video, making sure both videos would provide the same instructions. (In February 2024, before arriving in Paraguay, we were able to secure permission from Ms. Cassy Grace, Creative Supervisor of Marketing & Communications of SparkFun Electronics, Inc. to adapt the Sparkfun video into a Spanish version.) After writing down all the instructions to assemble the robot, we went back through and added explanations about the purpose of each component, and how they all work with each other.

After we prepared the draft video script in Spanish, it was reviewed by WPI Professors Lina Muñoz and Dorothy Wolf, as well as Professor Sebastian Cañete from the Cerrito School. These professors helped us with the script's grammar and "flow" and with choosing the words to clearly refer to each component. After we incorporated their feedback, we conducted a read-through of the script with two Cerrito School students, who volunteered to be part of the video. As they read through the script, they would stop, or Prof. Cañete would stop them, if something didn't sound right, so we could re-work the language. After we ran through the whole script, and made updates to develop a final version, we sent the final version to the students so they could practice before we recorded the final version. We felt that it was important to make the writing of the script collaborative, and to "get as many eyes on it" - with as many different levels of understanding - as possible, to ensure that it would be easy for anyone to understand.

When it came time to film the video, we decided to use the same visual format as Sparkfun, showing both students during the introduction and closing sections of the video, but just their hands working with the robot for the remainder of the video. This allows the view portrayed in the video to be the same as what the viewer sees while assembling their robot on a desk. We believe this will make the instructions in the video easier to follow. Filming this way also allowed the Cerrito students to read from the script during the more technical explanations, so they didn't have to memorize the script in its entirety. This method made it easier on the Cerrito School students and expedited the filming process.

This video we produced in Spanish provides an explanation of how to assemble the XRP robot, provides information about the purpose of each component, and provides instructions for getting started with XRP code. We hope it will be a useful resource for all Spanish speakers getting started with the XRP robot, and recommend that it be watched by users, in and out of the classroom, when they first receive their XRP kits.

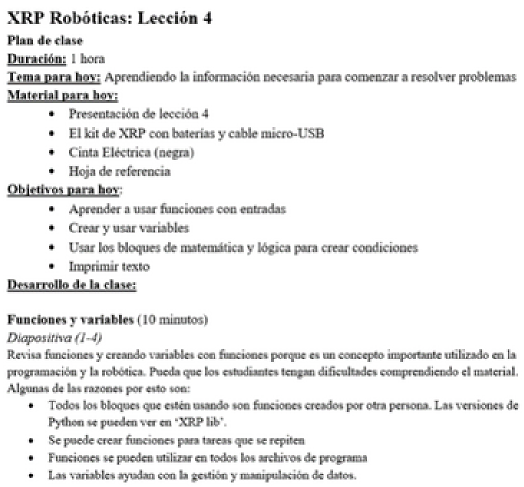
4.3.2 The Introduction to Robotics course (using the XRP robot)

Our team created lesson plans, visual presentations to support class lectures, and extra tools such as a reference sheet and teaching recommendations, in Spanish, to guide professors at the Cerrito School in teaching an Introduction to Robotics course, using the XRP course content provided by Prof. Brad Miller and his team at Worcester Polytechnic. The course content was divided into 6 one-hour lectures based on the 6 modules of the XRP course content. The visual materials to support class lectures include information on building the robot, using the coding environment, the distance sensor, the line follower, the servo, and coding topics. They include concepts such as creating functions and variables, using loops, and applying math to real life problems. The goal of the Introduction to Robotics class is to introduce students to basic programming topics, robotics, applications of math, and to help them improve problem solving skills. While taking the course, students learn how to work effectively in groups of two, and to trouble shoot issues they face manipulating the robot or the code.

4.3.3 Course Materials

4.3.3.1 Lesson Plans

Lesson plans are essential for any teacher to carry out a course successfully. The lesson plans our team created for the Introduction to Robotics course are designed to help guide the teacher in introducing the concepts to students, and to structure the presentation and pedagogy for each new concept introduced. The lesson plans "walk" the teacher through each slide of the associated visual presentation, clarifying information on the slide, and providing additional information the teacher needs to know about each topic. This includes tips on certain issues, or examples to share with students. The lesson plans also state the recommended amount of time that should be spent on each slide/topic. The time necessary to impart each concept was first estimated when the draft lesson plans were drawn up, then adjusted based on our observations of the concepts being imparted in the classroom. A sample section of one lesson plan is found in Figure #23.



XRP Robóticas: Lección 4

Plan de clase

Duración: 1 hora

Tema para hoy: Aprendiendo la información necesaria para comenzar a resolver problemas

Material para hoy:

- Presentación de lección 4
- El kit de XRP con baterías y cable micro-USB
- Cinta Eléctrica (negra)
- Hoja de referencia

Objetivos para hoy:

- Aprender a usar funciones con entradas
- Crear y usar variables
- Usar los bloques de matemática y lógica para crear condiciones
- Imprimir texto

Desarrollo de la clase:

Funciones y variables (10 minutos)

Diapositiva (1-4)

Revisa funciones y creando variables con funciones porque es un concepto importante utilizado en la programación y la robótica. Pueda que los estudiantes tengan dificultades comprendiendo el material. Algunas de las razones por esto son:

- Todos los bloques que estén usando son funciones creados por otra persona. Las versiones de Python se pueden ver en 'XRP lib'.
- Se puede crear funciones para tareas que se repiten
- Funciones se pueden utilizar en todos los archivos de programa
- Las variables ayudan con la gestión y manipulación de datos.

Figure 23: A part of one of the lessons plans.

In Figure #23 we see a description of the slides on the topic of "Funciones y variables" with the suggested times. The beginning of each lesson plan includes the theme, duration of the class, the materials needed and the objectives to be completed for the day. The development of the lesson plans represented the heart of our project, as when the course is distributed to other schools in Latin America the professors will be using these plans, in addition to the translated curriculum, to impart their classes. The visual materials we developed to support class lectures might be adjusted by each professor's needs or likes, but the lesson plans will likely remain the same.

4.3.3.2 Visual Presentations

From the results of the classroom observations and interviews with professors we learned that Paraguayan students learn primarily through visual and auditory methods. We did not want to create a class with a format that was unfamiliar and uncomfortable for the professors and students as this would be an extra barrier for them to face. We decided, therefore, to create visual presentations as the primary form of imparting the content for the Introduction to Robotics (XRP) classes. On these presentations we limited the use of text. The approach uses mainly images and short verbal explanations, and the concepts are delivered verbally by the teacher instead of having students read a course text. The principal format we used, which we repeated during each class session, was to verbally explain a new concept for 10 minutes, then have students carry out an activity to implement the concept. This style of pedagogy incorporated the manner of teaching we thought best to implement with Cerrito School students and professors: passive learning from the short, 10-minute lectures, followed by active learning by carrying out the activities. For more complicated topics, examples were done with practice problems to build students' comprehension before tackling activities and problems.

Figure 24 is a sample slide from the visual presentations we created. As can be seen in the Figure, pictures and short explanations were used in the presentations. While using these visual presentations as guides, professors can then go more into more depth while imparting the class. To facilitate this style of eaching, all the visual presentations we developed have speaker notes, when needed, including a brief script or idea that the teacher can follow. These notes, along with the lesson plans we developed, provide the teacher with enough information and guidance to impart a successful Introduction to Robotics course in Spanish.

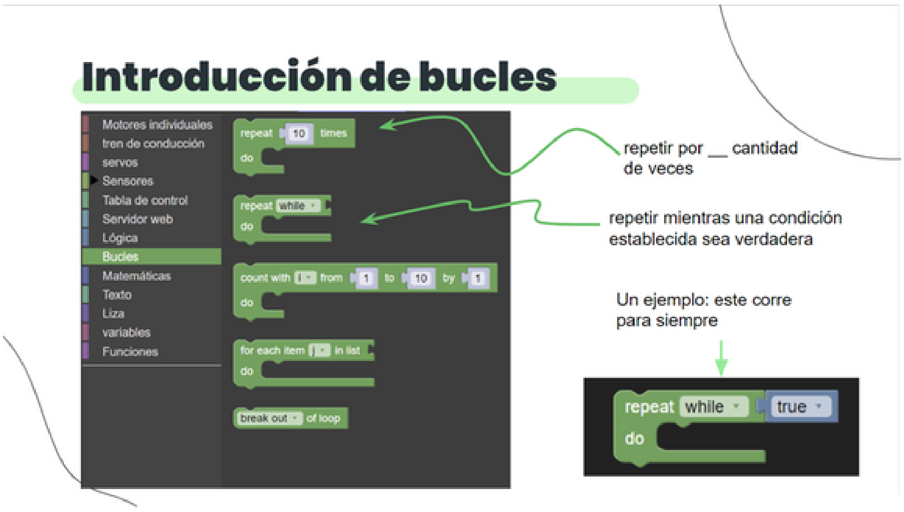


Figure 24: One of the slides from the visual presentations

The "fun" aspect of the Introduction to Robotics class was very easy to achieve - whether the students' programming attempts succeeded or failed, they had fun. When the students made mistakes, they would laugh at the robot falling off the table or running into a wall. If they were able to complete an activity, they would video record the robot, and show it off to their friends.

While imparting the classes we noticed that the hardest part was getting the students to learn the programming code through trial and error. This was due to the programming blocks being in English - students did not understand what a block would do. It also represented another barrier for students, as they would often forget what the blocks would do because they are in English. Students would have to remember what the English word was, then remember what it meant. This led experience led our team to create a programming “cheat sheet” for students to reference.

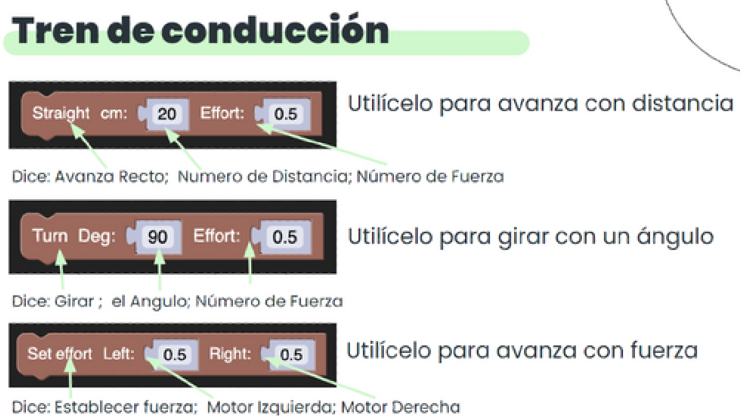


Figure 25: An example of the reference sheet explaining some of the blocks of code.

This sheet contains translations of programming blocks in English into Spanish. (Without a translation application it was impossible for students to "play around" with the code.) Currently, it is not possible to change the language of the programming blocks, so the temporary solution we found was to create the "cheat sheet" (Figure 25). We hope that in the future a better solution can be found for this issue. To pursue a career in coding one must eventually learn English since all the major coding languages are in English. We concluded through our experience, however, that, at this "beginning" stage of the learning process, having the programming blocks in English represents too much of a barrier - too soon - and many students become discouraged.

4.3.4 XRP Course Resource Website

Another deliverable our team created is a website for future professors of the Introduction to Robotics course. The web page itself can be found here:

https://sites.google.com/view/xrp-curso-de-robotica

This website will allow professors to access all the resources our team created during our time at the Cerrito School. Using Google Sites we created a two-page resource site which includes: Lesson Plans, Visual Presentations, Activities; an Outline of each course section; and the pre-existing resources provided by Professor Brad Miller and the XRP team at Worcester Polytechnic Institute (Read the Docs Manual (in English), and CAD files of the 3D printed pieces).

Figure #26, is an image showing the home page of the resource site. At the top-right of the screen, one can see the site pages, the first being the 'Pagina Inicial', or home page, as seen in the photo. This page contains six icons which are linked to the different resources offered. In the Figure, one can see the link to the reference sheet created by our team (Hoja de Referencia), the link to the Read the Docs manual (currently being translated into Spanish by Professor Cañete), and the link to the CAD resources to print out spare parts for the robot. Beneath that (not visible in the figure) are the links to the google drive folder, extra activities, and python tutorials for more advanced classes or interested students.

Figure 26: Home page of the Resource Site

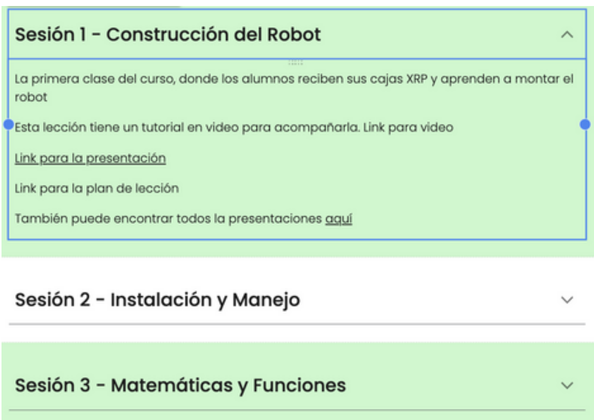


Figure 27: Descriptions of Course Sections

Further down on the homepage, as seen in Figure #27 above, users can find the descriptions for each section of the course. This includes the topics covered, the links to the corresponding visual presentation and lesson plan, and any other resources that might be useful for that specific lesson. In the second site page, all the lesson plans and presentations are displayed, side by side, for ease of browsing. In the future, additional materials can be added to this page to enhance its usefulness for users.

4.3.5 Translation of the course User Guide into Spanish

When someone buys a new XRP robot kit, they receive a box with a QR code that links to a User Guide. The User Guide is on a platform called Read the Docs, which interfaces with GitHub, allowing developers to update the guide in GitHub, and the changes will immediately update the Read the Docs web page. The User Guide contains information about how to assemble the robot, information about how each component works, and sample code to get the students started with each component. The User Guide is important because people who purchase the kit for themselves will need it to get started with using their robot. In addition, anyone who purchases an XRP robot for student use at their school will need it to familiarize themselves with the robot before teaching the Introduction to Robotics course (using the XRP robot). The User Guide can also be a good resource for students taking the course if they need a refresher on a topic.

At the beginning of our project, the User Guide was only available in English. For the XRP initiative to be deployed effectively in Latin America, our team determined that it was critical for this guide to be translated into Spanish. From our observations at the Cerrito School, we concluded that the students want, and will benefit, from access to this reference both while they are coding and as supplemental material to review outside of class.

During initial meetings with Professor Brad Miller at WPI, during the planning stages of this project in January and February 2024, the translation of the User Guide, and the logistics thereof, were one of the first items we discussed. We agreed that a literal translation of the content into Spanish, developed with Google Translate or a translator, while a step in the right direction, was not the best way forward. There are several words within the User Guide, for example, that don’t translate to Spanish well, and there are different words or phrases used to refer to these concepts or components in Spanish, compared to English. To guarantee a translation that would be the most helpful, our team and Prof. Miller agreed that the translation work should be done by people who are already familiar with the robotics/programming content in Spanish, so that the correct words would be utilized, and the information would "flow" well.

During a meeting with Professor Miller, after our team had been in Paraguay for a couple of weeks, we learned that a translation of the User Guide into Spanish had not been started yet. We mentioned this to Prof. Cañete, who informed us that he would be happy to help with the translation. After Prof. Cañete agreed to volunteer to create a translation of the User Guide into Spanish, we met with Austin Shallit (a WPI alumnus who worked with Professor Miller on the XRP initiative while he was a student), who connected the User Guide in English to the translation application that WPI uses for other projects and showed our team how to use it. The application is called Transifex, and allows many people to collaborate on translating content. As shown below in Figure 28, a translator can open the application, select a section of the User Guide and see the content in English, along with a text box to insert the Spanish version. After one person translates, the translation needs to be "reviewed" (blue button) by pre-established reviewers for the translation to be formally accepted. These changes will then be shown on the Spanish tab of the User Guide on the Read the Docs website.

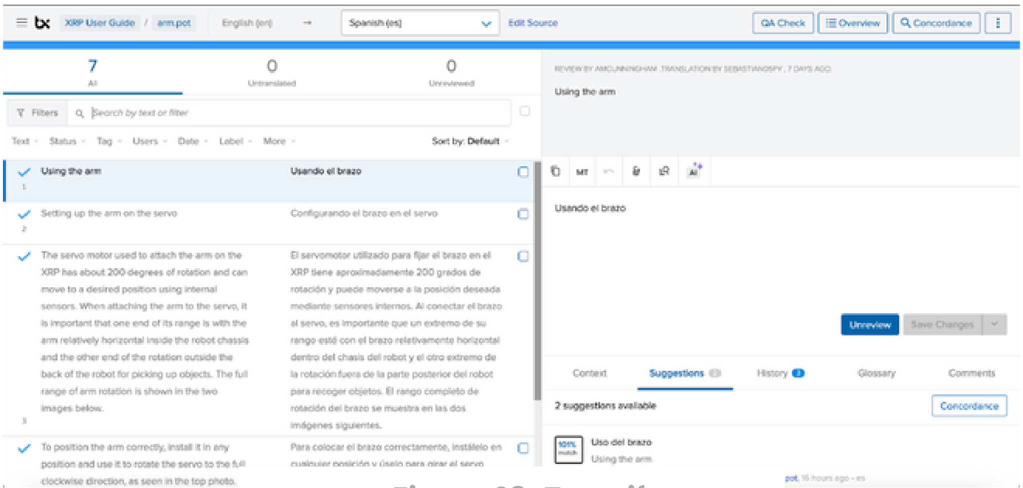


Figure 28: Transifex translation editor

Currently, Prof. Cañete is the only person actively translating the User Guide into Spanish, but the platform has the capacity to include several collaborators. The best part of how the translation application works is that if an update is made to the guide in English, all the translators are notified, and Transifex will flag the corresponding section(s) in Spanish. This will allow collaborators to easily see where changes need to be made and prevent any extra work or hassle.

The User Guide is only one of the materials that is available for students and professors participating in the Introduction to Robotics course (using the XRP robot). The course content is also available as a course on Canvas, which goes into much more detail than the User Guide in terms of teaching the capabilities of the XRP robot, and includes several activities and challenges for course participants, at different levels. Each page in the Canvas course is linked to a page on "Read the Docs", which is the same platform that hosts the User Guide.

As a next step for making the XRP initiative and course available to a wider audience, we recommend that the course text on Canvas be translated into Spanish once the translation of the User Guide into Spanish is completed.

5. RECOMMENDATIONS & CONCLUSION

5. Recommendations and Conclusion

From our interviews with professors, classroom observations, student focus groups, and surveys with those in the adult class we were able to co-create a course that is suitable for the professors in Cerrito. That is why we worked with teacher Sebastián Cañete to co-develop materials that focus on the auditory and visual aspects of teaching, such as slide presentations, lesson plans, a tutorial video, and extra materials. We expect that these materials will help professors have successful courses. In addition, to make the courses more accessible and organized, we compiled all the materials in a website or Google drive. Ownership of the account with the site and drive was transferred to the Cerrito school. The school will now be able to implement an introduction to robotics course.

For the implementation of the course to be successful, we have recommendations from the results of our observations of the robotics workshops being carried out by Sebastián Cañete at the Cerrito School, using our materials. We find that it is more time-efficient to address the whole class when introducing a topic. Rather than demonstrating a new concept repeatedly to small groups of students, a demonstration can be done to the entire class using a PowerPoint or similar presentation. When a group asks a question, if the question could be a common one shared by other students, it should be repeated so the whole class hears both the question and the answer. This way time is not wasted going around the classroom answering the same question. One on one time with the professor should be used to help students work through concrete issues with the robot, or to aid students who are really struggling with solving the problem. These strategies will help keep the class on track. There will always be a difference, in terms of speed of comprehension, between groups of students - having extra tasks planned for students who are ahead on a topic is a good idea, so that students who are grasping the concepts more slowly do not feel behind. This way students do not become discouraged. Before changing topics during class, asking if everyone is ready to move on to the next subject can ensure that no student is left behind. These recommendations were assembled onto one sheet and are included in the extra materials provided to the professors at the Cerrito School. (Appendix H)

Using the materials, we have created Cerrito should have all the tools needed to host a successful introduction to the robotics course. Our team created many support materials ranging from visual aids to a tutorial video. We have also included in the course package some recommendations for future professors teaching this course, and some tips to ensure students understand the content presented to them (See Appendix H). However, there are limits to the knowledge this course presents to the students; after all, students learn programming at the most basic level to allow for ease of understanding and there is very little building, working with electrical components, and design work involved with the course. For the course to have a greater immediate impact we recommend a second course, at a more intermediate level, be implemented. The XRP is designed with a capacity for expansion in mind. An additional course might entail students designing extra parts to fit in the slots around the robot, printing them, and programming the robots to complete a task using these new designs. From our findings, we know Cerrito is interested in applying robotics in agriculture. A second course would allow them to focus more on applying the robots to agriculture now that the students have the foundational skills from the first course.

We also believe the introductory course could be revisited and perfected. This project was the first to bring a robotics course, with a more accessible price, to a country outside the United States. Our goal was to create the first of a series of courses that can be replicated in any school in Latin America, that has access to computers and any internet connection. The schools could then create a secondary course where robotics would be applied in the area relevant to them. This project's success means students in developing countries would learn about robotics and possibly pursue a career in STEM. Right now, only Spanish and English-speaking countries have access to a usable curriculum and materials, to achieve the full dream of the InSTeD program and XRP more languages need to be adapted.

REFERENCES

Adams, N. E. (2015). Bloom's taxonomy of cognitive learning objectives. Journal of the Medical Library Association : JMLA, 103(3), 152–153. https://doi.org/10.3163/1536-5050.103.3.010

Asumadu, A. K., MacDonald, S. A., Blechinger-Slocum, D., & Gunville, M. R. (2021, May 12). Launching a Competitive Robotics Team for Physically Active Youth. DIGITAL WPI. https://digital.wpi.edu/show/3r074z109

Bezanilla, M. J., Fernández-Nogueira, D., Poblete, M., & Galindo-Domínguez, H. (2019). Methodologies for teaching-learning critical thinking in higher education: The teacher's view. Thinking Skills and Creativity, 33, 100584. https://doi.org/10.1016/j.tsc.2019.100584

Canek, R., Chicas, Y., & Rodas, O. (2019). Fomenting STEM Careers through Robotics Competitions: A Work in Progress. 2019 IEEE Integrated STEM Education Conference (ISEC), 270–273. https://doi.org/10.1109/ISECon.2019.8882058

Charlton, B. G. (2006). Lectures are such an effective teaching method because they exploit evolved human psychology to improve learning. Medical Hypotheses, 67(6), 1261–1265. https://doi.org/10.1016/j.mehy.2006.08.001

Corvalán, J. (2006). Educación para la población rural en siete países de América Latina. Síntesis y análisis global de resultados por países. Revista Colombiana de Educación, 51. https://doi.org/10.17227/01203916.7684

Cuervo, D. P., Link to external site, this link will open in a new tab, Caro, D. P., Link to external site, this link will open in a new tab, Torres, A. T., Link to external site, this link will open in a new tab, Cortés, O. P., & Link to external site, this link will open in a new tab. (2022). Producción científica sobre educación STEM en Latinoamérica: un estudio bibliométrico. Praxis, 18(2), 278–304. https://doi.org/10.21676/23897856.3787

Duarte, C. I., Jankowski, M. R., Tillotson, C. M., & Wilson, E. A. (2018, October 23). Assessing STEM Education in Namibia: focusing on the primary level. DIGITAL WPI. https://digital.wpi.edu/show/w3763707j

REFERENCES

Educación y cuestión social en Paraguay, una implicación compleja desde la perspectiva de estudiantes y directivos | REVISTA ESTUDIOS PARAGUAYOS (RESPY). (2022). https://epy.dreamhosters.com/index.php/RESPY/article/view/42

Eguchi, A. (2021). Key Factors for Keeping Students Engaged in Robotics Learning. In W. Lepuschitz, M. Merdan, G. Koppensteiner, R. Balogh, & D. Obdržálek (Eds.), Robotics in Education (pp. 38–48). Springer International Publishing. https://doi.org/10.1007/978- 3-030-67411-3_4

Fiscus, E., Dell'Aera, T., Henry, R., & Thomson, L. (2023, May 4). Using Educational Robotics to Promote Creative Computational Problem Solving. DIGITAL WPI. https://digital.wpi.edu/show/5m60qw23b

FRC Event Web : Team 6982 (2018). (n.d.). Retrieved February 19, 2024, from https://frc-events.firstinspires.org/2018/team/6982

Gowaski, E., Kumar, N., Jaworski, H., & Palmer, J. (2022, April 28). A Robotics Curriculum for Association Anoual to Support Moroccan Youth's STEM Education. DIGITAL WPI. https://digital.wpi.edu/show/bv73c383g

Hafni, R. N., Herman, T., Nurlaelah, E., & Mustikasari, L. (2020). The importance of science, technology, engineering, and mathematics (STEM) education to enhance students' critical thinking skill in facing the industry 4.0. Journal of Physics: Conference Series, 1521(4), 042040. https://doi.org/10.1088/1742-6596/1521/4/042040

IJMET_07_04_018.pdf. (n.d.).

Mallik, A., Liu, D., & Kapila, V. (2023). Analyzing the outcomes of a robotics workshop on the self-efficacy, familiarity, and content knowledge of participants and examining their designs for end-of-year robotics contests. Education and Information Technologies, 28(6), 7225–7264. https://doi.org/10.1007/s10639-022-11400-1

Miller, B. (2023). Making STEM fun: XRP Robots and resources [PowerPoint Slides]. Department of Robotics Engineering, Worcester Polytechnic Institute.

Open Learning with Science, Technology, and Robots | Worcester Polytechnic Institute. (n.d.). Retrieved February 5, 2024, from https://www.wpi.edu/c/openstem

REFERENCES

Pittí, K., Curto, B., Moreno, V., & Rodríguez, M. J. (2013). Resources and features of robotics learning environments (RLEs) in Spain and Latin America. Proceedings of the First International Conference on Technological Ecosystem for Enhancing Multiculturality, 315–322. https://doi.org/10.1145/2536536.2536584

Racicot, A. M. (2022, October 5). Innovative Robot Kits Aim to Spread Global STEM Access, Opportunities, and Inspiration. https://www.wpi.edu/news/innovative-robot-kits-aim-spread-global-stem-access-opportunities-and-inspiration

Reddy, N. V., Reddy, A. V. V. V., Pranavadithya, S., & Kumar, J. J. (2016). A CRITICAL REVIEW ON AGRICULTURAL ROBOTS. INTERNATIONAL JOURNAL OF MECHANICAL ENGINEERING AND TECHNOLOGY (IJMET), 7(4), 183–188. https://iaeme.com/Home/article_id/IJMET_07_04_018

Robótica – Centro Educativo Los Laureles. (n.d.). Retrieved February 19, 2024, from https://cel.edu.py/v2/robotica

Sandoval, L. O. (2012). Reforma educativa y conservación social. Aspectos sociales del cambio educativo en Paraguay/Educational reform and social conservation. Social aspects of educational change in Paraguay. Revista Latinoamericana de Estudios Educativos, 42(4), 55–90. https://www.proquest.com/docview/1448779529/citation/D83AFC12382C4319PQ/1

Whetten, D. A. (2021). Republication of "Principles of effective course design: What I wish I had known about learning-centered teaching 30 years ago." Journal of Management Education, 45(6), 834–854. https://doi.org/10.1177/10525629211044985

Wodon, Q. (2016). School Infrastructure in Paraguay: Needs, Investments, and Costs. Washington, DC: World Bank. https://doi.org/10.1596/978-1-4648-0448-9

APPENDICES

Appendix A: Declaration of Consent (Eng/Esp)

______ Classroom Observation / Interview

Date:
Facilitators:
Participants:
Consent Declaration:
We are a group of Students from Worcester Polytechnic institute in Worcester, Massachusetts, United States. We are collaborating with Prof. Sebastián Cañete and Prof. Amalio Enciso at the Cerrito Agricultural School to develop an Introductory Robotics course based on the robot and course developed in the Experiential Robotics Program at Worcester Polytechnic Institute (WPI XRP).

To accomplish this, we are conducting a study that gathers data on learning styles and experiences in STEM education. All data collected from classroom observations, interviews, and focus groups will only be accessible to the four members of our team, our two advisors, select employees of Fundación Paraguaya, and the Institutional Review Board of Worcester Polytechnic Institute (WPI IRB). Information expected to be reported is the participant's name, information, age, and any additional lifestyle information. After collection, all our data will be anonymized and will be presented quantitatively to demonstrate which learning and teaching practices are most prevalent and/or most preferred. We will also anonymously include information regarding previous STEM experiences of participants and suggestions and input for the course.

Participation in this study and any observations, interviews, or focus groups we conduct is completely voluntary, and all questions are optional; If you don't feel comfortable answering them, you don't have to. You may decide to stop participating in the study at any time. Responses will only be used with your permission. We thank you for your time and responses to help us advance our project.

Do you want to voluntarily participate in this study?

Observación de la clase de / Entrevista: ________

Fecha:
Facilitadores:
Participantes:
Declaración de consentimiento:
Somos un grupo de estudiantes del Instituto Politécnico de Worcester en Worcester, Massachusetts, Estados Unidos. Estamos colaborando con el Prof. Sebastián Cañete y el Prof. Amalio Enciso de la Escuela Agrícola de Cerrito para desarrollar un curso de Introducción a la Robótica basado en el robot y el curso desarrollado en el Programa de Robótica Experiencial del Worcester Polytechnic Institute (WPI XRP).

Para lograrlo, estamos realizando un estudio que recopila datos sobre estilos y experiencias de aprendizaje en educación STEM. Todos los datos recopilados de las observaciones en el aula, las entrevistas y los grupos focales solo serán accesibles para los cuatro miembros de nuestro equipo, nuestros dos asesores, empleados selectos de la Fundación Paraguaya y la Junta de Revisión Institucional del Instituto Politécnico de Worcester (WPI IRB). La información que se espera que se informe es el nombre, la información, la edad y cualquier información adicional sobre el estilo de vida del participante. Después de la recopilación, todos nuestros datos serán anónimos y se presentarán cuantitativamente para demostrar qué prácticas de aprendizaje y enseñanza son más frecuentes y/o preferidas. También incluiremos de forma anónima información sobre experiencias STEM anteriores de los participantes y sugerencias y aportes para el curso.

La participación en este estudio y en cualquier observación, entrevista o grupo focal que realicemos es completamente voluntaria y todas las preguntas son opcionales; Si no se siente cómodo respondiéndolas, no es necesario que lo haga. Puede decidir dejar de participar en el estudio en cualquier momento. Las respuestas sólo se utilizarán con su permiso. Le agradecemos su tiempo y respuestas para ayudarnos a avanzar en nuestro proyecto.

¿Quieres participar voluntariamente en este estudio?

Appendix B: Classroom Participant Observation

Las clases relacionadas con STEM serán las elegidas.
(STEM related classes will be the chosen)

Escuela Cerrito ejecuta 2 estilos de enseñanza
(Cerrito school runs 2 styles of teaching)

La típica experiencia en el aula
(The typical classroom experience)

La experiencia práctica, de la cual, según nuestro conocimiento, no existe ninguna que involucre STEM (por ejemplo, un curso práctico de robótica). Si se ofrece algo similar, esta clase también se observará.
(The hands-on experience, of which from our knowledge there are none that involves STEM (ex. A hands-on robotics course). If something similar is offered this class will be observed as well.)

El proceso será muy similar a las evaluaciones docentes
(The process will be very similar to teacher evaluations)

El profesor nos presentará y notificará a la clase de nuestras acciones, (Junto con el permiso)
(The professor will introduce us and notify the class of our actions, (Along with permission))

2 personas se sentará cerca de los bordes de la clase y tomará notas sobre las acciones de los profesores y estudiantes.
(2 person will sit near the edges of the class and take notes on the actions of the teacher and students)

Lo compararemos con lo que estamos acostumbrados.
(We will compare it to what we are used to)

La estructura del aula y el plan de estudios tambien serán un foco para la toma de notas.
(The structure of the classroom and curriculum will also be a focus for note taking)

Los observadores participarán en el clase para escuchando activamente como si fueran estudiantes de la clase.
(The observers will “partake” in the classroom by actively listening as if they are a student in the class.)

Appendix C: Classroom Participant Guide

Classroom organization:

1. How is the class structured?
2. Is the content covered logical?
3. Are there clear transitions from subject to subject?
4. Are topics linked together?

Teaching Strategies:

1. How does the teacher convey the information? What materials do they use?
    a. Slides, whiteboard, reading lectures, videos.
2. How does the teacher pace the class?
    a. How much time is spent stregthing skills and understanding?
    b. Are there times for students to take in information and develop questions?
3. How are assignments being used to teach the course?
    a. Are answers gone over in class?
    b. Is there a discussion about homework where students bring up questions?

Student-Teacher Interaction:

1. How do the students participate in class?
    a. Do they take notes? Are they distracted? Or talking during class? Doing other homework?
    b. Are they bored?
    c. What is their behavior?
        i. Do they talk back? Are they disrespectful?
        ii. Are they speaking Guarani?
2. Is the teacher enthusiastic when teaching the students?
    a. Is the teacher energetic?

Summary of Informatics Class Observation:

Our observation was in an informatics course where the students were working on how to use excel. The professor had put up an activity on the board and the students immediately knew to start it. During the allotted class time, the professor helped each student with any questions. It's safe to assume that day was to test if they understood the concept of which functions to use from the topics taught on previous class day. The classroom environment was open and relaxed compared to classes we are used to, and the students were very used to helping each other in the activity, making sure the other understood the concept. One thing we noticed is the professor went one by one to help students with similar questions instead of answering the questions in front of the whole class. This could prevent people from falling behind waiting for the teacher to come up to answer your question when it could be the same as another students.

Summary of Math/Chemistry Observation:

Our observation began in the middle of chemistry class and extended through math class. The professor wound up extending Chemistry into some of the time that was allocated for math. This was likely because the students had a test the next week. During the lecture, the professor explained concepts and taught the students memorization tricks. She offered examples to the students and then selected students to solve other problems on the board while the others did them on their notebooks. There was a break between chem and Math; no breaks during a subject; and the 10-minute break was extended to a 30-minute break. During instruction, students were engaged with the professor and were writing down notes from the board. Whenever a student fell behind, they would typically turn to their neighbor to ask questions and help each other. For both chemistry and math, one concept was covered during the lecture, but the professor went into depth with several practice problems. One thing that was difficult to prevent through this process was having students fall into the trap of copying from the board without understanding the processes.

Appendix D: Interview Questionnaire for the Informatics Professor

1. ¿Qué te inspiro a seguir una carrera en la enseñanza?

    (What inspired you to pursue a career in education?)

2. ¿Cómo describiría su filosofía de enseñanza y cómo guía su enfoque en el aula?

    (How would you describe your teaching philosophy, and how does it guide your approach in the classroom?)

3. ¿Por qué elegiste tu estilo y método de enseñanza específicos?

    (Why did you choose your specific teaching style and method?)

4. ¿Qué factores influyen sus decisiones al planificar lecciones y actividades para sus estudiantes?

    (What factors influence your decisions when planing lessons and acitivies for your students?)

5. ¿Que desafios encuentra al enseñar informatica y como los aborda?

    (What challenges do you encounter teaching computer science and how do you address them?)

6. ¿De qué manera incorpora aplicaciones del mundo real y la resolución de problemas en su enseñanza de informática?

    (In what ways do you incorporate real-world applications and problem-solving into your computer science instruction?)

7. ¿Cómo mantenerse actualizado sobre nuevas metodologías de enseñanza y desarrollos en el campo de la educación informática?

    (How do you stay updated on new teaching methodologies and developments in the field of computer science education?)

8. ¿Tiene alguna sugerencia para nosotros y nuestro curso de robotica?

    (Do you have any suggestions for us and our robotics course?)

9. ¿Por qué los estudiantes quieren aprender robótica?

    (Why do the students what to learn about robotics?)

Summary of Responses:

The Cerrito School professor of robotics and computer science, decided to pursue a career in education when he discovered his natural passion for teaching, and how much he enjoyed collaborative learning environments. From a young age, he valued knowledge and would often take apart his toys in pursuit of understanding how they worked. He specifically remembers playing with his LEGOs. He enjoyed assembling and disassembling them to understand how things worked. This curiosity about mechanics and design influenced his approach to teaching.

The professor's style of teaching revolves around fostering inclusivity. In our interview, he noted how he avoids hierarchical structures in the classroom and wants to be seen as a peer to the students rather than an authority figure - a philosophy he believes stems from experiencing supportive learning environments when he was growing up.

When planning lessons and activities, the professor prioritizes staying current and adaptable. He often draws from online resources and contemporary tools to enhance what he is teaching, improve its effectiveness, and ensure its applications to the real world. Teaching computer science and robotics at the Cerrito School presents economic challenges due to limited resources. Outdated equipment at the school often hinders practical applications. The professor addresses these limitations by focusing on accessible, simplified approaches using donated software and hardware. This allows him to continue providing students with applicable and valuable knowledge despite the gaps in resources.

As mentioned earlier, he values staying updated on new technology trends. This approach also extends to the teaching methodologies he utilizes. He stays up to date through attending workshops and conferences, actively seeking professional development opportunities to enhance his teaching and the content to be delivered to students.
Regarding the Introduction to Robotics course, the professor did not offer specific suggestions for our student team, but he believes this course has a lot of appeal for the students. The rise of robotics in agriculture-related fields, such as automation in cultivation and irrigation, aligns with Cerrito School student interests and current course work.

Appendix E: Interview Questionnaire for the Mathematics Professor

1. ¿Qué te inspiró a seguir una carrera en la enseñanza?
   (What inspired you to pursue a career in education?)
2. ¿Cómo describiría su filosofía de enseñanza y cómo guía su enfoque en el aula?
   (How would you describe your teaching philosophy, and how does it guide your approach in the classroom?)
3. ¿Por qué elegiste tu estilo y método de enseñanza específicos?
   (Why did you choose your specific teaching style and method?)
4. ¿Qué factores influyen sus decisiones al planificar lecciones y actividades para sus estudiantes?
   (What factors influence your decisions when planning lessons and activities for your students?)
5. ¿Qué desafíos encuentra al enseñar matemáticas y cómo los aborda?
   (What challenges do you encounter teaching math and how do you address them?)
6. ¿De qué manera incorpora aplicaciones del mundo real y la resolución de problemas en su enseñanza de matemática?
   (In what ways do you incorporate real-world applications and problem-solving into your math instruction?)
7. ¿Cómo mantenerse actualizado sobre nuevas metodologías de enseñanza y desarrollos en el campo de la educación matemática?
   (How do you stay updated on new teaching methodologies and developments in the field of math education?)
8. ¿Tiene alguna sugerencia para nosotros y nuestro curso de robotica?
   (Do you have any suggestions for us and our robotics course?)
9. ¿Por qué los estudiantes quieren aprender robótica?
   (Why do the students what to learn about robotics?)

Summary of Responses:

This Doctor of Chemistry soon discovered she had a passion for teaching that led to teaching students' math and chemistry at Cerrito School. She transitioned from tutoring peers, to working in a lab, to educating children in a classroom setting and has now been teaching for 24 years.

The doctor's style of teaching is centered around guiding students towards their own personal objectives. She understands that most of the students in her classes at Cerrito School are not motivated to learn math because they do not see uses for it in real life. Her classes are designed to foster interest in mathematics and develop critical thinking skills, something valuable for students in the future. She chooses shorter classes to encourage focus and facilitate learning, and has developed a teaching style influenced by how she was taught in the past. She also promotes the use of Ministry of Education-provided materials to deepen understanding among the students and provide additional learning.

In planning her lessons, the doctor makes sure to emphasize concept comprehension, followed by analysis. She noted that her most significant challenges include a deficient level of education from students entering her classroom and student disinterest. Despite this, she strives to motivate students through real-world applications of math, putting emphasis on the value of analytical skills.

When asked about suggestions for an Introduction to Robotics course, she suggested linking advanced concepts back to basics, for skill reinforcement. She encouraged our team to incorporate practice problems and again emphasized the importance of student motivation and helped students understand the relevance of what they are learning.

Appendix F: Survey Questionnaire for Adult Faculty Participating in the Course

Q: ¿Cuánto tiempo llevas en Cerrito? ¿Lo disfrutas aquí?
(How long have you been at Cerrito? Do you enjoy it here?)
A: Answers ranged between 3 and 15 years, and they all enjoy the working environment at the Cerrito School.

Q: ¿Qué clases enseñas ahora?
(What classes do you teach now?)
A: Only one of them is currently teaching and he is teaching Agrarian Administration

Q: ¿Qué tipo de cursos ha impartido/disfrutado en el pasado?
(What kind of courses have you taught/enjoyed in the past?)
A: They have all taught some form of Agriculture/Informatics course in the past

Q: ¿Qué sabes de robótica?
(What do you know of robotics?)
A: None of them reported to know very much but were excited about the prospects.

Q: ¿Qué te interesó en participar en este taller?
(What made you intrested in participating in this workshop?)
A: They were all interested in learning something new, plus one added that he was excited to have something where he could use imagination/creativity, and another is particularly interested in the applications of robotics.

Q: ¿Qué sentimientos iniciales aprende robótica?
(What are your initial feelings about learning robotics?)
A: The feelings they all had were curiosity and excitement, but one added that he was unsure of his ability to be able to do it.

Q: ¿Cómo supiste por primera vez sobre los robots?
(How did you first learn about robots?)
A: Two of the teachers learned about robots from their university and the other two learned about robots from the media.

Q: ¿Qué experiencia tienes con cursos de robótica? (1-7) (1 esta no tienes experiencia, 7 esta eres un experto)
(What experience do you have with robotics courses? (1-7) (1 being no experience, 7 being an expert))
A: Three reported a 1, and one reported a 6.

<u>**IF >3**</u>

Q: ¿Cuáles son algunas de las cosas que espera que cubra este curso?
(What are some things that you are expecting this course to cover?)
A: The one who reported the 6 said he would like students to learn about the parts of robots, available technology, and programming.

Q: ¿Qué robots has usado en el pasado?
(What robots have you used in the past?)
A: All but one of the teachers never used robots, and the one who has experience from drones and from playing with his kids toys with them.

Q: ¿Tienes experiencia con el código?
(Do you have experience with coding?)
A: None of the teachers have coding experience.

<u>**IF YES**</u>

Q: ¿Qué lenguajes de codificación has utilizado?
(What coding languages have you used?)
A: None of the teachers received this question.

Q: ¿Crees que este curso será útil y algo que quieras ver en el futuro?
(Do you think this course will be useful, and something that you want to see in the future?)
A: All of the teachers think this course will be useful.

IF YES

Q: Según su conocimiento actual de la robótica, ¿cómo cree que este curso ayudará a los estudiantes a tener más posibilidades de éxito en la vida?
(Based on your current understanding of robotics how do you see this course helping the students have a better chance of success in life?)
A: The teachers all believe that through teaching robotics, this course teaches critical thinking skills, which will help students with problem solving in their futures. They al also said that this class would give students working in a team and problem solving as a team. Finally, one of them said that he is excited for students to get exposure to systems thinking through this class, which can give a competitive edge in the job market.

IF NO

Q: ¿Por qué?
(Why?)
A: None of the teachers received this question.

Appendix G: Student Focus Groups Questionnaire

Engagement Questions

1. ¿Qué te entusiasmó inicialmente acerca de la posibilidad de tener un programa de robótica en la escuela?
   (What initially excited you about possibly having a robotics program at school?)
2. ¿Cómo describirías tu interés en la robótica antes del curso?
   (How would you describe your interest in robotics prior to the course?)
3. ¿Cuales eran sus expectativas del curso?
   (What were your expectations from the course?)

Exploration Questions

1. ¿Qué temas o actividades específicos del curso de robótica le han parecido más interesantes o atractivos hasta ahora?
   (What specific topics or activities in the robotics course have you found most interesting or engaging so far?)
2. ¿Que aspectos del curso de robótica te han desafiado más y cómo los has superado?
   (What aspects of the robotics course have challenged you, and how have you overcome these challenges?)
3. ¿Te gusta el balance de teoría y actividades en el curso? Prefieres más actividades prácticas o más teoría en las presentaciones?
   (Do you like the balance of theory and hands-on activities? Do you prefer more active activities or more theory based lectures?)
4. ¿Ha notado alguna diferencia en sus habilidades de resolución de problemas o de pensamiento crítico desde que comenzó el curso de robótica?
   (Have you noticed any differences in your problem-solving skills or critical thinking abilities since starting the robotics course?)
5. ¿De qué manera la colaboración con tus compañeros en el curso ha influido en tu experiencia de aprendizaje?
   (In what ways has collaborating with your peers in the course influenced your learning experience?)

Exit Questions

1. 1.¿Reflexionando de lo que aprendieron en el curso, que sugerencias tienen para mejorar el aprendizaje del material?

   (Reflecting on what you have learned in the course, what suggestions do you have for improving the learning experience?)

2. ¿Como crees que a contribuido el curso a su comprensión de la ciencia, la tecnología, la ingeniería, y las matemáticas?

   (How do you think the course has contributed to your understanding of science, technology, engineering, and math?)

3. ¿Hay áreas o temas en particular que le gustaría explorar más a fondo en lo que queda del curso?

   (Are there any areas or topics you would like to explore in the remaining duration of the course?)

Focus Groups Summary:

Overall, during the discussions, students shared their experiences and concerns regarding the course we had begun implementing. A common theme that emerged was nervousness and apprehension about the course due to the lack of prior programming knowledge. This let us know the importance of making sure that the classroom learning environment would be supportive, allowing students to feel confident about this new subject. In terms of course structure and delivery, students said they preferred more hands-on activities rather than theory-based classes. They acknowledged, however, the need for a balance between the two,in order to be able to grasp the concepts effectively. The students also expressed their struggles with the language barrier they had to face while programming, as some of the programming concepts in the robotics field continue to be expressed only in English. They stated that they felt that not understanding English hindered their ability to fully engage with the course. This being their biggest obstacle, some students were still determined to overcome it and independently try to understand the coding concepts.

Appendix H: Reference and Recommendations Sheet

Notas útiles

Palabras de Robótica

- **Entradas**: Entradas son valores que se introducen en una función. La entrada pasará a través de la función y dará como resultado una salida. Estos valores son definidos por el programador. Algunas funciones no requieren entradas.
- **Variables**: Las variables son definidas por la persona que programa. Estas son cosas que contienen un valor que puede ser manipulado y utilizado.
- **Funciones**: Las funciones pueden ser definidas por el programador. Se utilizan cuando un proceso se repite muchas veces dentro de un programa.
- **Booleano**: La lógica booleana es similar a la matemática normal pero booleana sólo tiene dos valores: verdadero y falso. Los operadores booleanos que se utilizan para modificar valores son [o, no, y]. Aquí tienes un repaso de booleanos: https://www.ibm.com/docs/es/db2/11.5?topic=list-boolean-values
- **Declaraciones if y else**: Se utilizan para verificar condiciones usando booleanos. Si la condición es verdadera, entonces ejecutará el código dentro.
    - **If**: Si
    - **Else if**: Si no
    - **Else**: De lo contrario
- **Sensor de distancia**: Este sensor mide la distancia utilizando sonido ultrasónico similar a los murciélagos.
- **Seguidor de línea**: El seguidor de línea mide cuánta luz infrarroja se refleja en una superficie para encontrar superficies que sean negras/oscuras.

Recomendaciones

- Cuando comience una clase, asegúrese de que los estudiantes sepan qué esperar para el día. Esto mantiene organizada la clase. Lo mismo debe hacerse al final de la clase, resumiendo lo que se ha hecho, así como mencionando brevemente lo que se cubrirá en la próxima clase.
- Cuando los estudiantes hagan una pregunta, recomendamos que el profesor la repita para toda la clase y la responda para que todos la escuchen, para evitar que varias personas se detengan en el mismo punto.
- Una forma de ayudar a reducir la confusión y responder preguntas es hacer demostraciones con código XRP utilizando la computadora portátil que se está utilizando para presentar.
- Para mantener un ritmo sólido para el curso, creamos planes de clase con tiempo asignado a cada sección. Recomendamos que los profesores se adhieran a estas asignaciones lo mejor que puedan para evitar que la clase se retrase..
- También es importante que todos los estudiantes estén trabajando en el mismo tema en cualquier momento dado. Los estudiantes pueden desanimarse si ven a otros en la clase avanzando y ellos no lo están.
- También es importante que los estudiantes no estén inactivos durante mucho tiempo durante la clase. Creemos que su tiempo de inactividad se debió a la barrera del idioma con los bloques de código, ya que todos los bloques están escritos en inglés. Asegúrese de entregar los folletos de la hoja de referencia o brinde acceso a la versión en línea para que los estudiantes la utilicen.