Evaluation of Technical Infrastructure for Hybrid Learning

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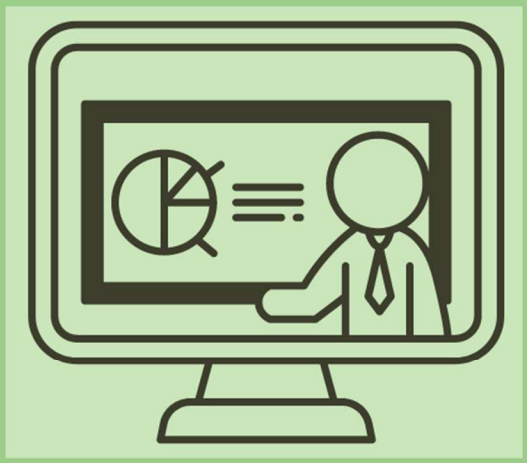

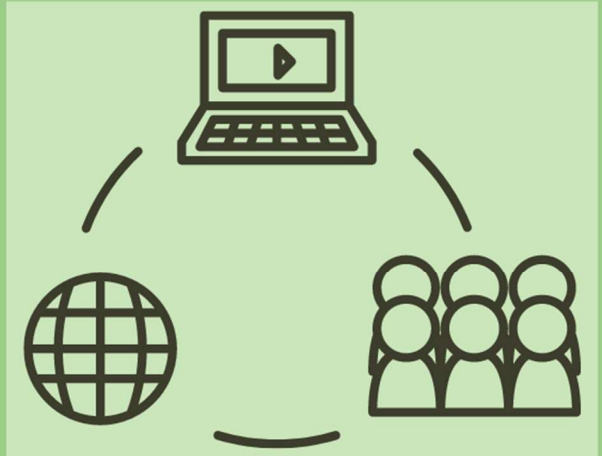

Evaluation of Technical Infrastructure for Hybrid Learning

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

by
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Report Submitted to:

Juan Pablo Martínez Moscoso
Proyecto Instituto Tecnológico Superior “Paul Rivet”

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Worcester Polytechnic Institute

Abstract

Ecuador has great potential for biocommerce and ecotourism, with an immense diversity of ecosystems and environments for its size. Our sponsor, the *Instituto Tecnológico Superior "Paul Rivet,"* will teach the practical elements of working in these industries, with the goal of growing participation in Ecuador. Our project focuses on helping this institute with the development of its hybrid learning program. Students will attend lessons briefly in person, and for the rest of the time, online. We interviewed professors, administrators, and technical experts, visited university campuses, and conducted a survey of potential students. Our sponsor will use our findings and recommendations to inform the development of their hybrid program and to better engage their student population.

Resumen

Ecuador tiene un gran potencial para el biocomercio y el ecoturismo, con una inmensa diversidad de ecosistemas y medioambientes para su tamaño. Este recurso no se ha utilizado en toda su extensión, y el país aún favorece industrias extractivistas como el petróleo o la minería. Nuestro patrocinador quiere remediar esto con la creación del Instituto Tecnológico Superior "Paul Rivet," que enseñará los elementos prácticos del trabajo en biocomercio y ecoturismo. Nuestro proyecto se enfoca en ayudar a este instituto con el desarrollo de su programa de aprendizaje híbrido, donde los estudiantes asistirán a clases presencialmente durante una semana y el resto del tiempo asistirán online. Entrevistamos a profesores y administradores escolares, visitamos universidades y realizamos una encuesta entre estudiantes potenciales. Nuestro patrocinador utilizará nuestros hallazgos y recomendaciones para informar el desarrollo de su programa híbrido e involucrar mejor a su población estudiantil.

Executive Summary

A hybrid learning model is an effective way to increase education accessibility, as it allows for students to do most of their work at home and in their free time. This allows for potential students to get a more in-depth education and improve upon their skills while being able to work simultaneously. Our sponsor hopes to use this system to develop the biocommerce and ecotourism industries, which are currently dramatically underdeveloped in Ecuador. This is

due to workers and companies in these fields only taking advantage of one given resource. For example, some farmers only grow orchids, when they could be taking advantage of other aspects of the environment to grow plants, raise animals, or encourage ecotourism (Martínez, 2024). Ecuador is an extremely biodiverse country, with the Andes mountains in the center, flanked by a tropical rainforest and a rich coastal region. The main issue is that communities stretch across these diverse landscapes and have not always had the opportunity to learn how to best take advantage of these spaces in sustainable ways. Developing a hybrid technical school where students can spend little time on a physical campus and learn from home is ideal to teach biocommerce and ecotourism due to students being spread across the region (Dávila, 2024). For this project, the *Instituto Tecnológico Superior "Paul Rivet"* tasked us to help them understand how to develop this hybrid program.

Biocommerce and ecotourism are growing industries all over the world, and *Instituto Tecnológico Superior "Paul Rivet"* led by Juan Pablo Martínez hopes to have Ecuador, specifically the Azuay Province, be part of this growth. Biocommerce is when any natural element such as plants or animals are sold as a commercial product locally or internationally. Ecuador is known for its orchids, which are a prime commercial export, but lack of training and strict legislation leads to damage in export or from exploitation (Yeager et al., 2020). Ecotourism involves the commercialization of the viewing and interaction with nature or landmarks (Anghel et al., 2008). If the workers in this industry are not properly trained, it can lead to damage to the site from mismanagement or overuse. This is also very dependent on tourists respecting their surroundings, which is an additional issue.

Developing a hybrid technical institute is difficult, as it involves having a deep understanding of not only the technical challenges, but the needs of students and professors. To approach this project, we conducted interviews with professors and technical professionals, surveyed potential students, and collected observational data from site visits. The needs of professors, students and technology were acknowledged as we developed a means to teach the theoretical and practical skills needed for a career in biocommerce and ecotourism. We considered all the given perspectives above and their needs to determine what goes into this form of hybrid education.

Before arriving in Cuenca, we conducted extensive research into how education is conducted within the region (Figure E.1). This gave us a deep understanding of the economic,

social and baseline technical aspects that go into hybrid forms of education. Through this, we learned what resources are economically feasible for students.

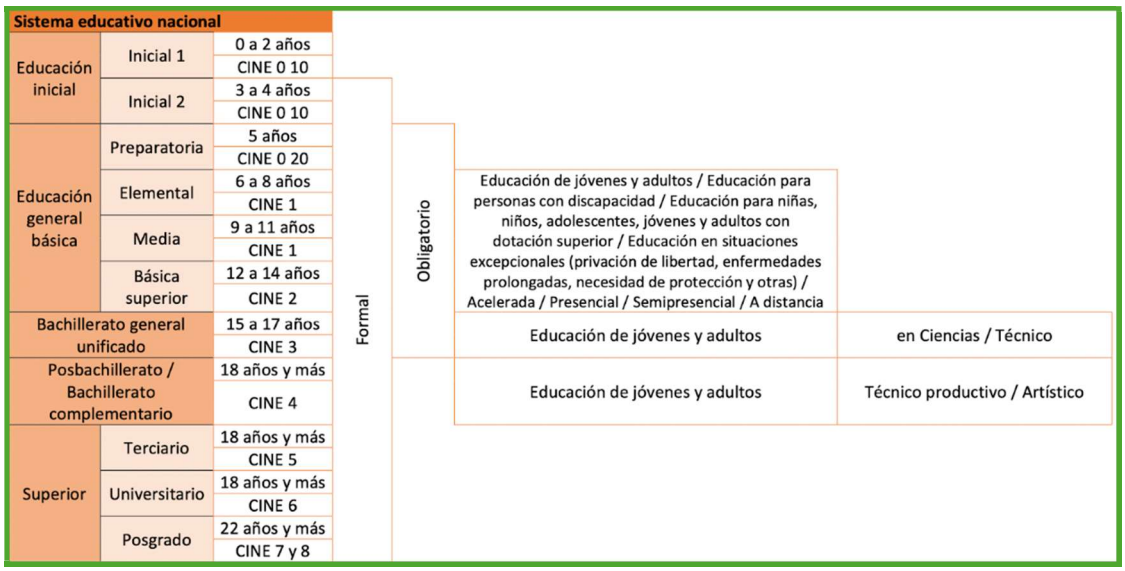

Figure E.1: SITEAL. (2019). Ecuador Perfil Del País. Instituto Internacional de Planeamiento de la Educación. This graph breaks down the structure of the education system.

Once we arrived in Cuenca, we developed a set of specific methods and objectives that met our sponsor's needs. The plan to complete the project included three primary objectives. The first was to determine the technical infrastructure needed to develop a hybrid teaching model for biocommerce and ecotourism. We worked with students and educational professionals to investigate student accessibility to technology and the internet. The second method involved assessing the current technological resources available. This was done by performing interviews with CEDIA, the internet and education services provider for institutes, colleges, and universities in Ecuador, and with ETAPA, the telecommunications provider for the Cuenca region. We also visited a technical learning center and the main campus of the *Universidad Técnica Particular de Loja* (UTPL). For our third objective, we developed a graphic summary of our findings and recommendations and received feedback on it from our contacts. Additionally, we conducted an analysis of the service packages provided by Cuenca to determine the best one for our sponsor.

To produce our manual, we interviewed a list of contacts provided by our sponsor. These interviews were composed of a standard list of questions for each group, with a few additional questions tailored to each individual. They followed a semi-structured format, which elicited more in-depth answers. These interviews were conducted with institute directors, professors, and

technology professionals. The interviews were conducted over Zoom since many interviewees lived outside of the Cuenca region, and it was more manageable with their schedules (Figure E.2). To determine the needs of potential students, we developed a survey which we administered in one *Colegio* called *Unitec Discovery Unidad Educativa Particular.* This survey provided us with limited knowledge of what is accessible to students and their plans beyond *Colegio*, the Ecuadorian equivalent of high school (Figure E.3). Our sample size was sixteen students from a private school, which doesn't properly convey the average student. For this reason, we advised our sponsor to continue to administer the survey in the future to get a clearer picture of the student body. We also conducted a site visit to a UTPL learning center and their campus to collect visual data of what should be implemented in technical institutes.

Figure E.2: This is a photo of a Zoom Meeting our group had with Professors Pozo and Andrade.

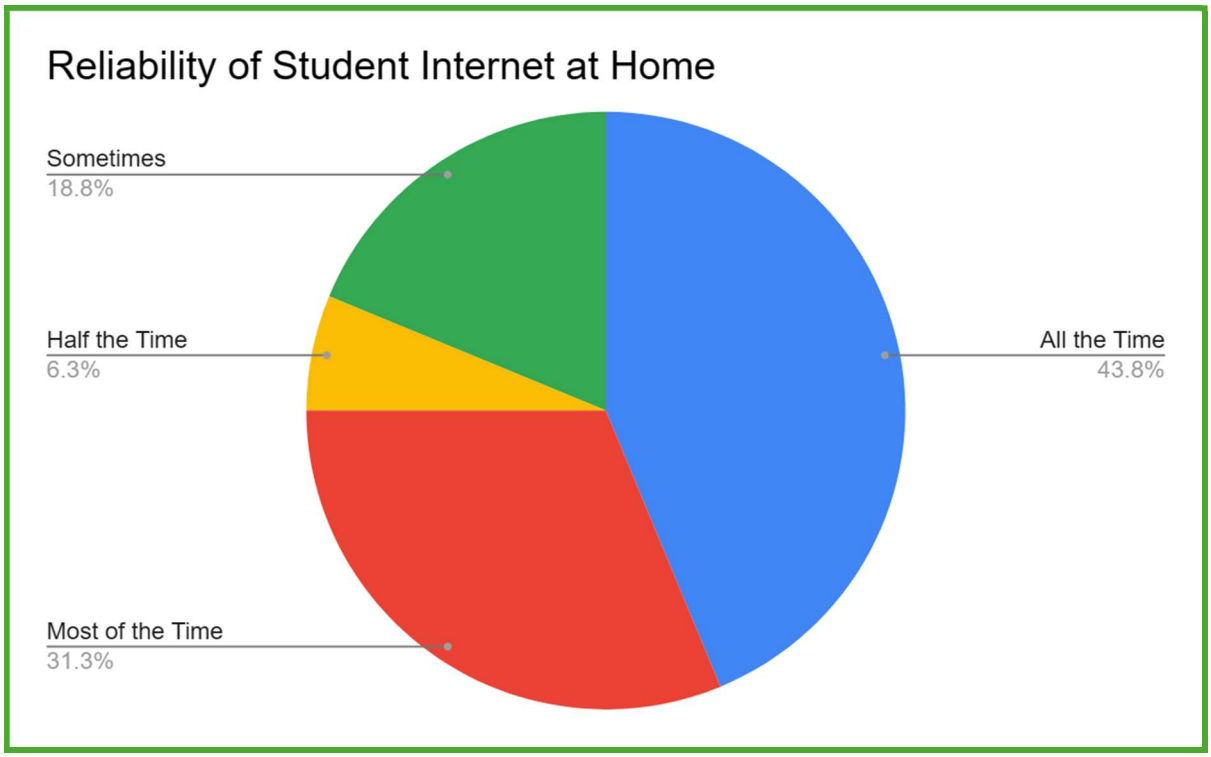

Figure E.3: Reliability of student internet at home based on 16 survey results collected from *Unitec Discovery Unidad Educativa Particular.*

The team took the collected data and went through a process of transcribing, translating, coding, and analyzing. This process allowed us to determine common themes and recommendations from our interviews. The coding provided us with an in-depth assessment of the key components and shortcomings of hybrid learning. This data was developed and described as findings, which provided the basis for an infographic (Figure E.4) that was then provided to the previous interviewees to receive feedback. This feedback was then taken to improve upon the infographic and act as a basis for the final product of the project.

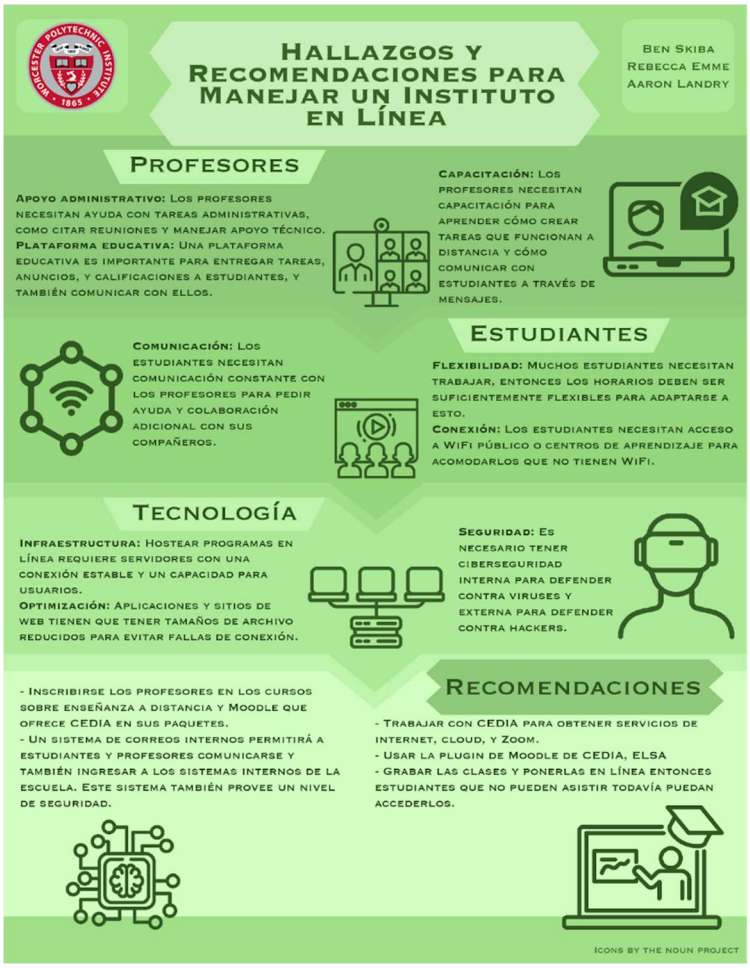

Figure E.4: Infographic summary of our findings and recommendations, used to gain feedback from our interview contacts.

Our final product was a manual with seven key findings and six recommendations to address them and develop a hybrid technical institute. The first recommendation involved an explanation on how to develop virtual and physical infrastructure and why both are important. The second recommendation delves into the security measures that need to be put in place to protect and maintain the Institute. The third recommendation explains the base platform the institute should run classes through and the plug-ins and services that should go with it. The fourth recommendation describes how to develop communication between professors and students and teach ways for professors to keep students accountable and manage their time. The fifth recommendation explains students' accessibility in terms of technology and internet, as well as how to account for this and to provide support. The final recommendation is an explanation on how to implement Altered Reality (AR) technology into this hybrid teaching model. Together,

these recommendations provide guideposts to our sponsor as they develop a hybrid learning model to prepare students to work in biocommerce and ecotourism.

Resumen Ejecutivo

Un modelo de aprendizaje híbrido es una forma eficaz de aumentar la accesibilidad a la educación, ya que permite a los estudiantes realizar la mayor parte de su educación en casa durante su tiempo libre. Esto permite que los estudiantes potenciales obtengan una educación más profunda y mejoren sus habilidades mientras pueden trabajar simultáneamente. Nuestro patrocinador espera utilizar este sistema para desarrollar las industrias de biocomercio y ecoturismo, que actualmente están dramáticamente subdesarrolladas en Ecuador. Esto se debe a que los trabajadores y las empresas de estos campos sólo aprovechan un tipo de recurso. Por ejemplo, algunos agricultores solo cultivan orquídeas, cuando podrían estar aprovechando otros aspectos del medio ambiente para cultivar plantas, criar animales o fomentar el ecoturismo (Martínez, 2024). Ecuador es un país extremadamente biodiverso, con las montañas de los Andes en el centro, flanqueadas por una selva tropical y una rica región costera. El problema principal es que las comunidades se extienden a lo largo de estos diversos paisajes y no siempre han tenido la oportunidad de aprender cómo aprovechar mejor estos espacios de manera sostenible. Desarrollar una escuela técnica híbrida donde los estudiantes puedan pasar poco tiempo en un campus físico y aprender desde casa es ideal para enseñar biocomercio y ecoturismo a estudiantes que están dispersos por toda la región (Dávila, 2024). Para este proyecto, el *Instituto Tecnológico Superior "Paul Rivet"* nos encargó ayudarles a entender cómo desarrollar este programa híbrido.

El biocomercio y el ecoturismo son industrias en crecimiento en todo el mundo, y *el Instituto Tecnológico Superior "Paul Rivet,"* dirigido por Juan Pablo Martínez, espera que Ecuador, específicamente la provincia de Azuay sea parte de este crecimiento. El biocomercio es cuando cualquier elemento natural como plantas o animales se vende como producto comercial a nivel local o internacional. Ecuador es conocido por sus orquídeas, que son una exportación comercial, pero la falta de capacitación y una legislación estricta provocan daños en la exportación o en la explotación (Yeager et al., 2020). El ecoturismo implica la comercialización de la observación y la interacción con la naturaleza o lugares emblemáticos (Anghel et al., 2008). Si los trabajadores de esta industria no están capacitados adecuadamente, puede provocar daños

al sitio debido a una mala gestión o uso excesivo. Esto también depende en gran medida de que los turistas respeten su entorno, lo cual es una cuestión adicional.

Desarrollar un instituto técnico híbrido no es difícil, ya que implica tener un conocimiento profundo no sólo de los desafíos técnicos, sino también de las necesidades de los estudiantes y profesores. Para abordar este proyecto, realizamos entrevistas con profesores y profesionales técnicos, encuestamos a estudiantes potenciales y recopilamos datos de observación de visitas al sitio. Se reconocieron las necesidades de profesores, estudiantes y tecnología a medida que desarrollamos un medio para enseñar las habilidades teóricas y prácticas necesarias para una carrera en biocomercio y ecoturismo. Consideramos todas las perspectivas dadas anteriormente y sus necesidades para determinar qué implica esta forma de educación híbrida.

Antes de llegar a Cuenca, llevamos a cabo una extensa investigación sobre cómo se lleva a cabo la educación en la región (Figura E.1). Esto nos dio una comprensión profunda de los aspectos económicos, sociales y técnicos básicos que intervienen en las formas híbridas de educación. A través de esto, aprendimos las limitaciones de qué recursos son económicamente viables para los estudiantes.

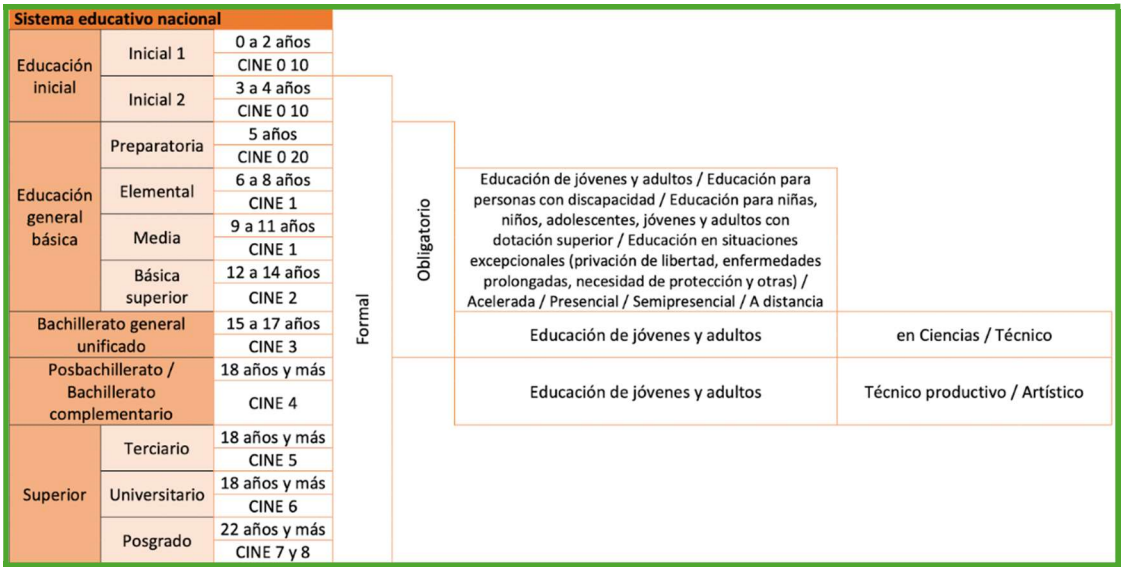

Figura E.1: SITEAL. (2019). Ecuador Perfil Del País. Instituto Internacional de Planeamiento de la Educación. Este gráfico desglosa la estructura del sistema educativo

Una vez que llegamos a Cuenca, desarrollamos un conjunto de métodos y objetivos específicos que satisfacían las necesidades de nuestro patrocinador. El plan para completar el

proyecto incluía tres objetivos principales. El primero fue determinar la infraestructura técnica necesaria para desarrollar un modelo de enseñanza híbrido para el biocomercio y el ecoturismo. Trabajamos con estudiantes y profesionales de la educación para investigar la accesibilidad de los estudiantes a la tecnología e Internet. El segundo método implicó evaluar los recursos tecnológicos disponibles actualmente. Esto se hizo mediante la realización de entrevistas con CEDIA, el proveedor de servicios de educación e internet para institutos, Colegios y universidades de Ecuador, y con ETAPA, el proveedor de telecomunicaciones de la región de Cuenca. También visitamos un centro de aprendizaje técnico y el campus central de la *Universidad Técnica Particular de Loja* (UTPL). Para nuestro tercer objetivo, desarrollamos un resumen gráfico de nuestros hallazgos y recomendaciones y recibimos comentarios al respecto de nuestros contactos. Además, realizamos un análisis de los paquetes de servicios brindados por Cuenca para determinar cuál es el mejor para nuestro patrocinador.

Para crear nuestro manual, entrevistamos una lista de contactos proporcionada por nuestro patrocinador. Estas entrevistas se componían de una lista estándar de preguntas para cada grupo, con algunas preguntas adicionales adaptadas a cada individuo. Siguieron un formato semiestructurado, que provocó respuestas más profundas. Estas entrevistas se realizaron a directores de institutos, profesores y profesionales de tecnología. Las entrevistas se realizaron a través de Zoom ya que muchos de los entrevistados vivían fuera de la región de Cuenca y era más manejable con sus horarios (Figura E.2). Para determinar las necesidades de los estudiantes potenciales, desarrollamos una encuesta que administramos en un Colegio llamado Unitec Discovery Unidad Educativa Particular. Esta encuesta nos proporcionó un conocimiento limitado de lo que es accesible para los estudiantes y sus planes más allá del Colegio (Figura E.3). El tamaño de nuestra muestra fue de dieciséis estudiantes de una escuela privada, lo que no refleja adecuadamente al estudiante promedio. Por esta razón, recomendamos a nuestro patrocinador que continúe administrando la encuesta en el futuro para obtener una imagen más clara del cuerpo estudiantil. También realizamos una visita a un centro de aprendizaje de la UTPL y su campus para recopilar datos visuales de lo que debería implementarse en los institutos técnicos.

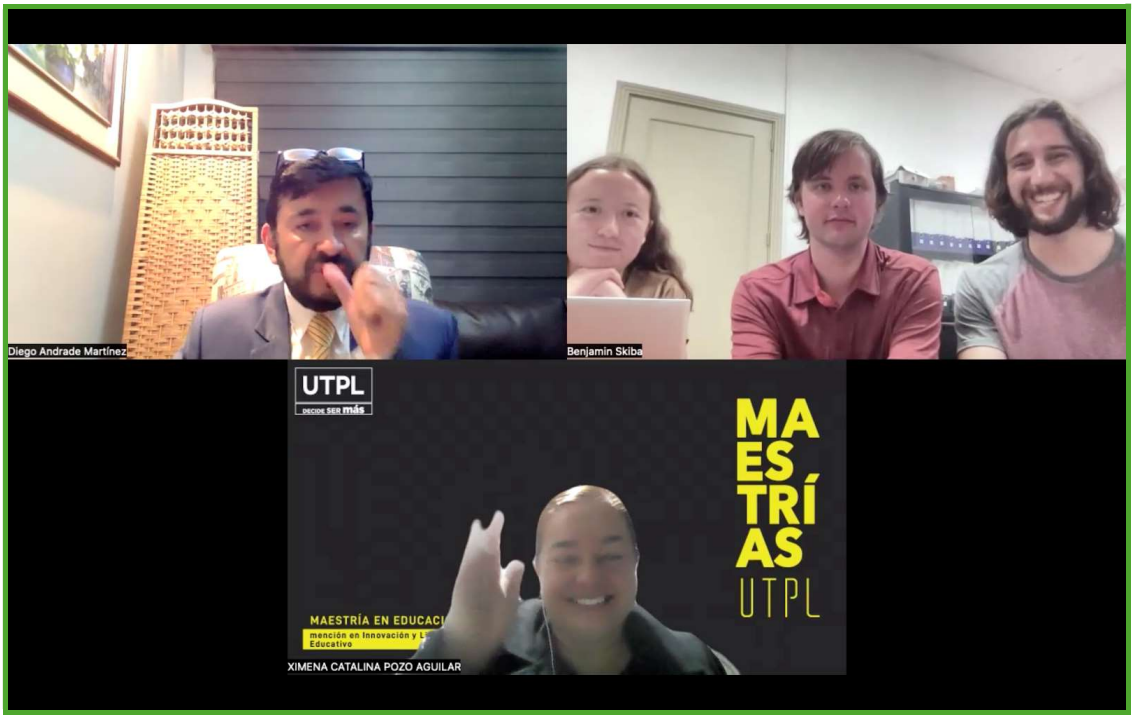

Figura E.2: Esta es una foto de una reunión Zoom que nuestro grupo tuvo con los profesores Pozo y Andrade.

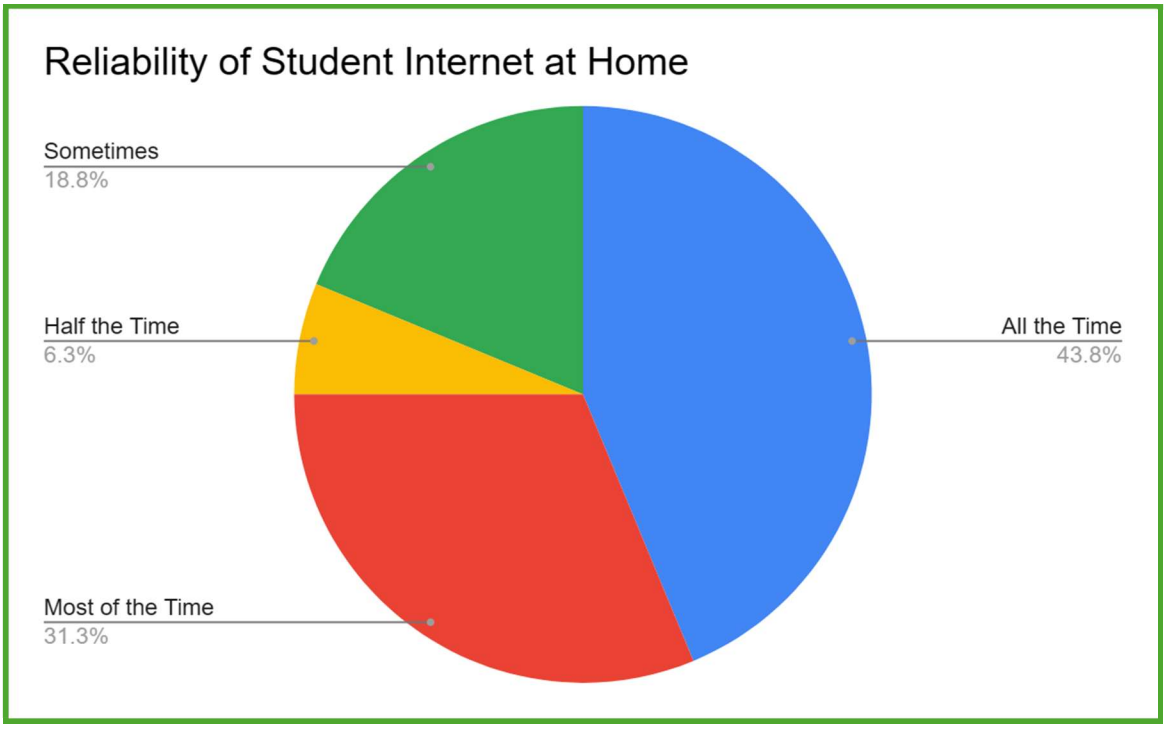

Figura E.3: Confiabilidad de Internet de los estudiantes en el hogar según datos de 16 encuestas recopilados por *Unitec Discovery Unidad Educativa Particular.*

El equipo tomó los datos recopilados y pasó por un proceso de transcripción, traducción, codificación y análisis. Este proceso nos permitió determinar temas comunes y recomendaciones desde nuestras entrevistas. La codificación nos proporcionó una evaluación en profundidad de los componentes clave y las deficiencias del aprendizaje híbrido. Estos datos se desarrollaron y describieron como hallazgos, que proporcionaron la base para una infografía (Figura E.4) que luego se proporcionó a los entrevistados anteriores para recibir retroalimentación. Luego se tomaron estos comentarios para mejorar la infografía y actuar como base para el producto final del proyecto.

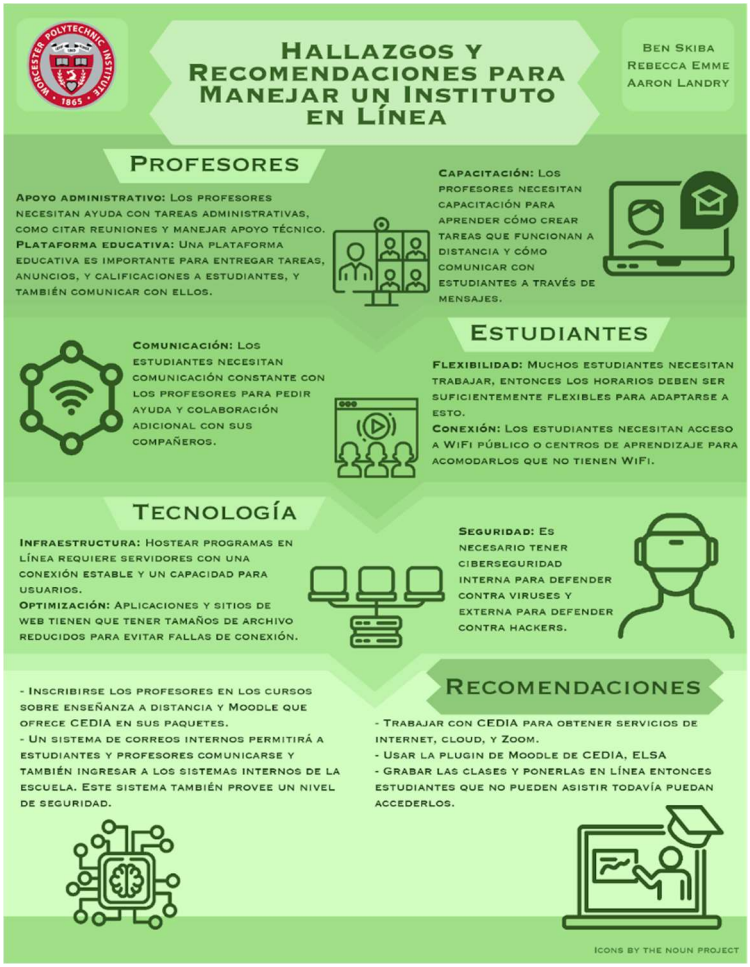

Figura E.4: Resumen infográfico de nuestros hallazgos y recomendaciones, utilizado para obtener comentarios de nuestros contactos de entrevista.

Nuestro producto final fue un manual con siete hallazgos claves y seis recomendaciones para abordarlos y desarrollar un instituto técnico híbrido. La primera recomendación implicó una explicación sobre cómo desarrollar la infraestructura física y virtual y por qué ambos son

importantes. La segunda recomendación profundiza en las medidas de seguridad que es necesario implementar para proteger y mantener el Instituto. La tercera recomendación explica la plataforma base a través de la cual el instituto debería impartir las clases y los complementos y servicios que deberían acompañarla. La cuarta recomendación describe cómo desarrollar la comunicación entre profesores y estudiantes y enseñar formas para que los profesores hagan que los estudiantes sean responsables y administren su tiempo. La quinta recomendación explica la accesibilidad de los estudiantes en términos de tecnología e Internet, y cómo tenerla en cuenta y brindarles apoyo. La recomendación final es una explicación sobre cómo implementar tecnología de Realidad Alterada (RA) en este modelo de enseñanza híbrido. Juntas, estas recomendaciones brindan pautas a nuestro patrocinador a medida que desarrollan un modelo de aprendizaje híbrido para preparar a los estudiantes para trabajar en biocomercio y ecoturismo.

Acknowledgements

This project would not have been possible without the help and contributions of all involved in our project. We would like to say a heartfelt thank you to everyone who assisted our group in developing a manual for the Paul Rivet Greater Technical Institute.

First, we would like to thank our sponsor the *Instituto Tecnológico Superior "Paul Rivet"* and Juan Pablo Martínez, our liaison. Juan Pablo worked with us to set up meetings and provided contacts for individuals we should interview. He aided in scheduling our site visit to Loja; without our sponsor we would not have been able to acquire the data needed to complete our project.

Second, we would like to thank our advisors, Guilherme Chalhoub Dourado and Professors William San Martin and Sarah Strauss, for providing feedback and support for our project since its inception. Our advisors always pushed us to develop the best product possible and always motivated us to work with the mindset of helping others.

Finally, we would like to thank all our interviewees, without whose contributions this project would not have been possible. They provided us with invaluable knowledge and advice and helped us learn about our subject matter. Their contributions propelled our deliverable forward and allowed us to make it as in-depth as possible. We would like to give individual thanks to Angelica Dávila, for giving us a tour of the campus of the *Universidad Técnica Particular de Loja* (UTPL), Stalin Fernando and his team for giving us a presentation on how AR and VR education is run at UTPL, and Cecelia Andrade, for giving us a tour of a Loja learning center. Without everyone involved this project would not have been possible, so thank you to everyone.

Authorship

Section	Research	Writing	Editing
Abstract	N/A	Aaron	Ben
Executive Summary	N/A	Ben	Rebecca and Aaron
1.0	N/A	Rebecca	Aaron
2.0	N/A	Aaron and Rebecca	Ben
2.1	Rebecca	Rebecca	Ben
2.1.1	Rebecca and Aaron	Rebecca	Ben
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2.2.1	Aaron	Aaron	Rebecca
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5.6	N/A	Ben and Aaron	Rebecca
6.0	N/A	Aaron	Rebecca
Appendix A	Ben	Aaron	Rebecca
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Appendix D	N/A	Ben	Rebecca and Aaron

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1.0 Introduction

Countries cannot improve economically unless the methods they use are environmentally sustainable long-term, preserve local policy and social values, and foster participation from local communities. Economic improvement must be made through a broad range of economic output, such that this development can weather one sector's downturns (Barbier, 1987). Ecuador's government, as stated in their *Plan de Creación de Oportunidades* (2021), seeks to develop smaller industries with potential for growth to be less reliant on current dominant industries such as oil. Two industries with great potential in Ecuador are biocommerce and ecotourism. There are vastly different landscapes and a large wealth of biodiversity within Ecuador that provide environments for many plants and animals. Due to this, ecotourism and biocommerce could become dominant industries if more of an investment was put into developing these career paths.

Biocommerce is any commercial activity that utilizes natural resources in trade or research. Thus, protecting and maintaining biodiversity is imperative to the success of this industry (Yeager et al., 2020). It is also imperative to ecotourism, which is the commercialization of naturally occurring landmarks, plants, and animals for tourists. Ecotourism profits aid in protecting the biodiversity of these locations, which promotes research into this wildlife and leads to growth in biocommerce (Anghel et al., 2008). One reason for these industries' relatively small size is due to the lack of educational programs surrounding career development for ecotourism and biocommerce. These fields are highly technical and require specific training in both scientific and business knowledge. There are a lot of laws and regulations which affect the industries. For example, the protection and sale of flora and fauna are governed on both internal and international markets. These rules are complicated and extensive, which makes them very difficult to learn, thus preventing people from participating in biocommerce and ecotourism (Martínez, 2024). Training professionals to be entrepreneurs in the technical and scientific fields will provide these students with the knowledge to create opportunities for themselves using their expertise.

While some programs do exist in Ecuador to train potential employees and leaders in ecotourism and biocommerce, there are not nearly enough relative to the potential opportunities within this sector. Many also lack the time and resources to devote multiple years of their life to receiving an education in these topics without gaining any practical experience. Technical

Institutes provide a unique opportunity in allowing students to gain a professional certificate in a field of their choice in under two years (Chiquito-Chilán et al., 2016). These programs also emphasize gaining hands-on, practical experience over theory to prepare students for the realities of the workforce. Ecuador's *Ley Orgánica de Educación Superior* (2010) mandates that technical institutes place more emphasis on entrepreneurship to promote the development of professionals trained in business.

Despite this opportunity, many students cannot afford to go to school full time in place of working to support themselves and their families. One alternative that satisfies this need is the use of remote and hybrid learning (Dávila, 2024). We define hybrid learning in this report as an education program where students attend class in person for a small period of time and pursue the rest of their education remotely. Our sponsor, the *Instituto Tecnológico Superior "Paul Rivet"* plans to use this education model to attract a specific population of students. The education program at this institute will consist of one week of in-person learning and the rest will be remote. Hybrid education programs can be used to provide opportunities to students who desire further education but need more flexibility.

The goal of this project was to develop a manual of recommendations for technical infrastructure that can support a hybrid education program for classes in ecotourism and biocommerce at a technical institute. We interviewed experts in education and administration and sent out a survey to potential students to determine the needs of these two groups. We also interviewed technology experts and made observations during site visits to assess the current technological infrastructure that exists for such programs. We determined the institute should focus on the needs of professors and students as it develops its technical programs. Our key findings are the importance of managing an online platform that allows the students flexibility and communication. We then created a manual of recommendations and summarized that manual in an infographic. This infographic was sent out to our interviewees so they could provide feedback and we could present the most well-reviewed product to our sponsor. The educators at this institute can then use this manual to build a hybrid learning program to teach students how to be part of the biocommerce and ecotourism industries.

2.0 Background

In this section, we provided background on the goal and objectives of this project, provided context for crucial information, and considered the social and technical dimensions of hybrid and online learning systems to enhance education in the fields of biocommerce and ecotourism. We also summarized the Ecuadorian education system and the role of technical institutes in that system. Additionally, we considered the technology available to educators in Cuenca and the barriers which they must overcome in the creation of a hybrid learning system. Finally, we examined existing cases in Ecuador and beyond which could contribute to our project.

2.1 The Impact of Careers in Biocommerce and Ecotourism

In this section, we provide definitions for biocommerce and ecotourism. We explain how these two industries function in Ecuador and how they benefit the country and its citizens. It is imperative for these two industries to have development models that are sustainable to ensure long-term resource preservation and economic growth. Therefore, these three definitions are essential to the education programs within the fields of biocommerce and ecotourism.

Biocommerce is any commercial activity which takes advantage of natural resources, either to trade those resources or incorporate them in biotechnology research, development, or innovation (Yeager et al., 2020). The natural resources which biocommerce is dependent upon are vulnerable to damage and are often incredibly difficult to repair. Smuggling, poaching, overcollection, and growth from other industries harms wildlife that is in high demand on both legal and illegal markets. This growth includes agriculture spreading to cover more natural land, deforestation to allow mining and lumber collection, and commercial tourism that prioritizes economic growth over protecting its wildlife. Destruction and overconsumption of any given commodity makes it harder for that commodity to be a long-term driver of growth and opportunity (Barbier, 1987).

One example of this is the trade of orchids in Ecuador. The flowers are incredibly valuable throughout the world and are very difficult to grow, which makes them rare. This fact, in addition to high prices, make the flower a perfect target for illegal harvesting and sale. This practice is often done without regard for overcollection or the possibility of habitat loss, even to

the point of endangerment (Yeager et al., 2020). The flowers are also often damaged by shipping practices that fail to ensure their safety, causing yet more unnecessary loss. As a result, the orchid market is heavily regulated, which can make the legal expansion of this industry difficult (Martínez, 2024). Legal markets allow each government they exist in to put regulations on wildlife collection, including plants and flowers. These laws protect the development of different species and overall biodiversity. They also protect the long-term success of the industry. However, these regulations can also become deterrents to involvement in trade in the legal markets. This is because more experience and technical knowledge is needed to work with these laws. When the barrier to entry becomes so high, education is needed to ensure that legal participation in the market is done with full knowledge and understanding of the liabilities associated with that involvement (Martínez, 2024).

Ecotourism is any tourist activity which focuses on commercializing naturally occurring landmarks, plants, or animals without depleting those resources (Villacrés, 2018). It is an industry that allows biocommerce to grow due to the promotion and preservation of biodiversity. The preservation of the culture and nature within these sites protects the people and wildlife that live in the areas. It also allows for-profit commercial activities to continue to grow and attract interest and new customers as the environments evolve and change (Anghel et al., 2008).

Sustainability in ecotourism demands the same care and respect for the local nature and culture from the visiting tourists as it does from the people working at the sites (Barbier, 1987). Ecotourism is a recreational activity, so tourists can take that to mean they can do whatever they want to maximize their enjoyment of the tourist site, without regard for what that site contains. However, sustainable tourism demands that tourists treat their experience as more than just recreation, but as an educational experience. Tourists can learn about foreign cultures and be exposed to biodiversity they have never seen before. To respect this new environment, they should learn and adopt the local life rules while at the site. For instance, tourists should respect community expectations surrounding nutrition and housing and prioritize local accommodations and ingredients. They should also be curious and pay close attention to the site's biodiversity, but not at the expense of damaging any wildlife (Anghel et al., 2008).

Much of Ecuador's tourism focuses on the conservation of the environment and local cultures (Anghel et al., 2008). Ecotourism provides resources needed to care for the land and preserve biodiversity. However, it is also important to ensure that the source of the revenue also

keeps the environment in mind. The local communities in or surrounding these sites can also benefit, but care must be taken to ensure that they do. Tourism can generate income and develop the economy, but the management and people hired to work at the sites need to come from within the community. If this is not done, there is a risk that the money spent by tourists is not distributed to the local population, removing them from the decision and management process (Villacrés, 2018). By placing economic value in the preservation rather than the removal of natural resources, ecotourism incentivizes conservation as an economic engine. This is a practice that needs to be taught, as it requires management, technical, and ecological skills.

2.1.1 Biocommerce and Ecotourism in Ecuador

This section briefly covers the community and natural resources that make Ecuador uniquely equipped to be a hub for biocommerce and ecotourism. These industries' goals are the commercialization and stewardship of its natural resources, which we show to have been consistently underutilized and under protected. Lastly, we explain how Ecuador's limited educational institutions for sustainable biocommerce and ecotourism have been integrated into our project.

The biodiversity in Ecuador is matched by few other nations. Within its borders are environments as varied as highland hills, deep jungle, and long stretches of shoreline. Despite this, Ecuador, like other South American nations, are marginal participants in global biocommerce. This is because the biocommerce industry has increasingly turned toward biotechnology due to the growing amount of research surrounding the microbiome. Developing countries struggle to keep up with technological advances in the biocommerce industry in countries such as the United States as their economy is not as stable (Díaz et al., 2021). This is specifically an issue in Ecuador, as they refuse to take part in global organizations to help these countries. Argentina, Brazil, and Venezuela have all joined The Earth Microbiome Project, and another important initiative that Ecuador could join is the Terragenome Project. The absence of Ecuador from these initiatives only results in the growth of the technological gap within the biocommerce industry that could harm the economic and social development of the country (Díaz et al., 2021).

The same richness of natural wonders which makes Ecuador a potential hotspot for biology research also makes it a destination for tourists looking to see a variety of natural

environments. The Galapagos Islands, hot springs, beaches, and the Andes are all draws for international travel (Tourism in Ecuador, 2024). With the exception of the Galapagos, however, many of these wonders are not easily accessible to tourists. In 2019, before the pandemic warped international tourism, the industry contributed to just under 1% of the country's GDP (Tourism in Ecuador, 2024). An effort to broaden access to less accessible regions could increase the revenues coming into the country and could prove an economic driver in places where growth is needed (Martin et al., 2017).

The natural resources of Ecuador allow biodiversity to flourish, which also promotes rural tourism. Practices of community-based tourism (CBT) have the power to bring jobs and money into rural, poor communities (Martin et al., 2017). When this practice is done right, a community-based model can and does increase the wealth and power of residents. It also decreases poverty and aids in resisting incursions from outsiders who have no interest in long-term preservation (Peaty, 2007). An example of this in Ecuador is the eco-lodge Kapawi, which utilized a CBT operation until ecotourism was a vital part of their economy. Direct employment at the lodge takes up 45% of the local community's total income, and a further 21% of the income comes from handicraft sales (Peaty, 2007). Growing the tourism sector through investment in local communities could create lasting jobs in areas of Ecuador where economic opportunities are sparse. This also ensures that development does not do lasting harm to the environment and provides resources to communities to protect, cultivate, and research local biodiversity to preserve their tourist attractions.

Ecuador has everything it needs to be a hub for sustainable commerce, research, and tourism, which makes use of its abundant natural beauty and biodiversity. The country's failure to take advantage of these resources in places like Cuenca represents a lack of economic efficiency and of opportunity for the local communities, as well as valuable research information. Further education in the subjects of biocommerce and ecotourism is needed to utilize these resources in a sustainable manner. In this project, we addressed this shortcoming through the development of a manual with recommendations to create an effective hybrid education program for these industries. This was to encourage more engagement with these industries to increase their benefit to the people and the country's economy.

2.2 Hurdles Limiting Development

This section explains in detail the barriers that sustainable biocommerce development has faced in Ecuador. We break down the political, social, technological, and historic factors that have impeded this development in the past, including damage done by heavy industry and agriculture. We also study how the influence of the government has shaped this development, as well as some limitations that have hindered the growth and impact of the education system. It is important to understand how history creates the barriers in place that impact decisions in the present day.

2.2.1 Historical Regulatory Barriers

This section examines the role of the Ecuadorian government over its history and its impact on the country's economy, specifically the ecotourism and biocommerce industries. We discuss how the instability of the government has led to corresponding regulatory instability, which harms the growth of new industries. Finally, we examine modern policy initiatives which look to correct these historical failures and see how the goals of our project align with the focus of these modern regimes.

Throughout its history, Ecuador has faced political instability driven by conflict of political, economic, and social interests. As the country's economy grew so did its government, often violently and driven by unrest from trade unions, outsider political parties, and other groups dissatisfied with the leadership. This unstable growth meant that new industries such as petroleum were able to grow unregulated, harming the environment and taking economic advantage of the people (Jiménez, 2021). Foreign companies were accused of failing to abide by regulations, harming the environment, and not paying their taxes (Jiménez, 2021). All of this meant powerful interests, both local and foreign, whose concern did not lie with the stewardship or growth of sustainable industries have been able to drive Ecuador's economy since the early 1800s.

The *Plan de Creación de Oportunidades* (2021) offers a stark contrast to this history. It places emphasis on the need for the growth of sustainable industries and acknowledges the damage which has been dealt to the land by the economy. The nation's regulatory approach as expressed in the plan includes a focus on the implementation of viable policy, prioritizing transparency and legitimacy. It also notes that such policies must have the goal of improving the

business outlook of companies of all sizes; it states explicitly that the growth of the tourism industry in the country must also be a priority.

2.2.2 Economic Barriers

This subsection focuses on a summary of Ecuador's economy today. We discuss the impacts of the three main sectors, agriculture, industry, and services, on Ecuador's development and how those sectors each impact the biodiversity of the country. We then discuss how opportunities can be created for the Ecuadorian people through shifts in these sectors.

The economy of Ecuador is dominated by the service sector (Figure 1). This includes tourism as well as everyday professions such as retail, delivery, transportation, and others. Tourism is only a small part of the service sector, as evidenced by how the sector's size was little impacted by the pandemic (*Ecuador - share of economic sectors in the gross domestic product (GDP) from 2012-2022*, 2024). However, the impacts of the other two sectors on Ecuador's biodiversity, agriculture and industry, merit the most discussion.

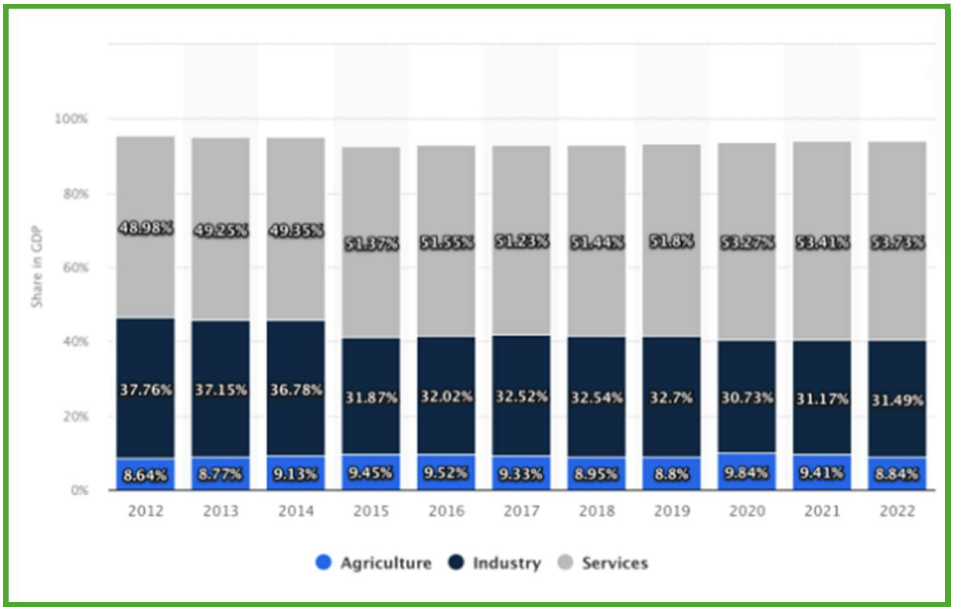

Figure 1: *Ecuador - share of economic sectors in the gross domestic product (GDP) from 2012-2022 (2024).* Statista. Share of Ecuador's GDP taken up by the industry, agriculture, and service sectors.

Mass commercial agriculture represents a threat to the biodiversity and the natural resources of the country. One of the primary dangers faced is deforestation, which is the clearing of native growth for the cultivation of cacao and other crops damages Ecuador's vibrant ecosystems (Cossio et al., 2016). This danger is multiplied when foreign crops such as rice are

introduced; nonative plants can damage ecosystems by consuming too much of a specific resource, such as light or water. The cultivation of only one or two dominant crops transforms a diverse landscape into one where only a few plants can thrive (Cossio et al., 2016). Deforestation and harmful cultivation practices place natural environments in danger, which could provide the basis of new opportunities for the people of Ecuador.

The impact of the industrial sector, composed primarily of mining and oil extraction, is also harmful to native ecosystems. The extraction of minerals from beneath rainforests and mountains contributes to the environmental degradation of the country, destroying valuable ecosystems which might otherwise be used as tourist sites (Secretario Nacional de Planificación, 2021). The destruction of the natural capital of Ecuador by extractive industries such as oil is difficult to repair and impedes the growth of businesses that would profit from the capital. While the importance of heavy industry in the economic development of Ecuador cannot be understated, the transition from an economy focused on extraction to a sustainable one is vitally important (Secretario Nacional de Planificación, 2021). The development of biocommerce, which takes advantage of the natural resources of the country rather than destroying them, could play a role in recuperating the losses from industrial damage.

The impact of Ecuador's economy on the environment has not been positive for much of its history. This damage represents a loss of potential economic engines through sustainable commercialization of natural species and the tourist draw they could provide. Training Ecuadorians with the skills they need to work in sustainable industries is one of many first steps needed to refocus Ecuador's economy in a direction which prioritizes its natural resources.

2.2.3 Limitations in Education and Technology

One difficulty with training Ecuadorians in biocommerce and ecotourism is that the education system does not provide the necessary practical experience that is needed for a successful career. At a university, students must commit full time to their schooling to achieve a degree, typically without gaining much hands-on training (Martínez, 2024). Even if they can afford to spend the time and money to earn a degree, that does not give them the hands-on experience that would make them a valuable employee to hire. This adds to the issue many students face of not having the time and money to pay for school without also working a full-time job to support themselves and their families (Martínez, 2024).

One solution is to better integrate practical training and hybrid learning infrastructure into the education system of Ecuador. This would allow the education to expand past the formal classroom and permit students to learn remotely or on their own schedule. Technology is already used to apply for schools, choose courses, perform research, complete and submit homework assignments, and study. For instance, at the Private Technical University of Loja (2023) the Learning Management System (LMS) Canvas is used to hold live lectures and post recorded lectures. This allows students to view material they may have missed. Homework is also assigned and submitted on Canvas (Dávila et al., 2021). The issue with this implementation is that every student learns in a unique way, but most education systems focus on standardization to make everything equal to each student (Ivanov et al., 2013). This issue is amplified when technology is involved because the chosen systems would need to be used in specific ways to benefit each student's learning styles, but most schools do not have the time or the resources for this. Many educators are taught to instruct their students in a specific way, so when they transition to online learning platforms, they keep the same methods. Since new materials and platforms are being used, these methods are no longer as effective and can result in the students struggling more than they would otherwise (Ivanov et al., 2013).

The curriculum of these schools also needs to be changed when hybrid learning is integrated, which can be difficult to enforce. Another limitation is the students' comfortability level with online platforms. Due to a lack of accessibility, experience, or education some students will be disadvantaged academically if learning is reliant on technology (Ivanov et al., 2013). Potential students could choose not to enter programs purely because they are entirely or partly online and they are afraid of being disadvantaged. This is particularly an issue for low-income students as they do not have the money to purchase reliable and quality technology, so they do not have any way to learn how to use these online platforms (Dávila et al., 2021). Due to these limitations, it is also essential to focus on helping the education system evolve with technological advancements.

2.3 Education in Ecuador

This section provides a brief overview of the education system in Ecuador. We describe the broad system and how young people in Ecuador learn. We develop conclusions from the makeup of Ecuador's student population, and discuss the role of technical institutes, one of

which is our project's sponsor. Finally, we assess how the institutes operate and what their specific purpose is within the wider education system.

2.3.1 Structure of the Educational System

The education system in Ecuador is broken up into five main categories, each with their own subsections, as shown in the graph below (Figure 2). Most students do not reach or go past "*Posbachillerato*," which is analogous to the last years of high school in the United States. This tends to be the highest education most students receive before going into the workforce (Siteal, 2019). Many families lack the resources to send their children to school past the high school level, as they are obligated to go straight to work to support their family. This issue is also amplified by most students being unable to afford being a fulltime student.

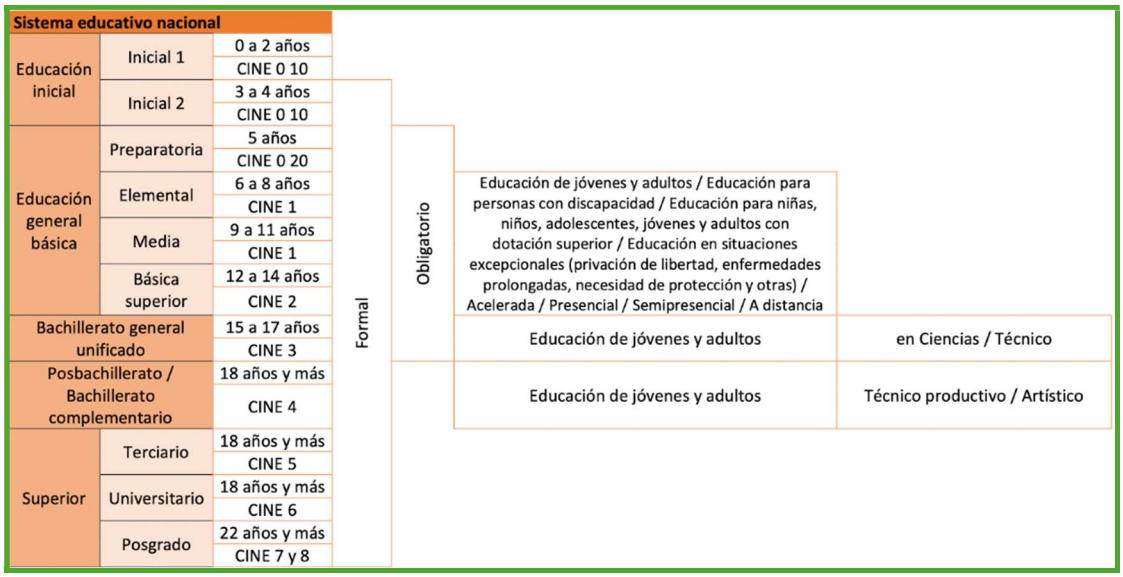

Figure 2: SITEAL. (2019). Ecuador Perfil Del País. Instituto Internacional de Planeamiento de la Educación. The structure of the education system.

For this reason, college and higher education are often not the answer to providing advanced job training or experience to young people. Instead, such materials must be integrated into the pre-university school system. Doing this tends to be challenging, however, considering the economic situations many Ecuadorians face. This is despite many public institutes and colleges being free or low cost. Many people cannot afford to be full time students because of their obligation to provide for themselves and their families (Martínez, 2024).

We also must consider that not every student may have experience with computer tools. These tools are required in hybrid learning, which is the focus of our project. Considering the economic situation of our target audience is important, so speaking with education and industry professionals about the technological needs and costs for students was imperative to our project (Martínez, 2024).

2.3.2 Technical Institutes

Technical institutes are a tertiary education option that students can attend after they graduate high school but are different from pursuing a university degree. Rather than the broad focus of universities, institutes instead focus on one course of study, preparing the student for careers in engineering, business, technology, and science fields (Chiquito-Chilán et al., 2016). The Ecuadorian government has decided to change the productive matrix within their country. This means they are changing how knowledge and talent is developed in individuals (Chiquito-Chilán et al., 2016). This change of focus means there is more emphasis on entrepreneurship in all levels of tertiary education to promote the development of professionals educated in business.

In Ecuador, the *Ley Orgánica de Educación Superior* (2010) determines the standards and regulation of what these institutes teach. These include contributing to scientific and technological innovations and gaining skills that allow students to aid development. Training professionals to be entrepreneurial in technical and scientific fields will provide these students with the knowledge to create opportunities for themselves using their expertise. *Universidad Técnica Particular de Loja* (2023) a good example of this since it has studies in a variety of economic and biology-focused areas. The educational programs are also primarily based in hybrid learning. The school utilizes the company CEDIA to develop an in-depth learning platform on Canvas that allows students to work remotely on their own schedule. CEDIA is the web service provider for institutes and universities in the Cuenca region, and they work closely with these schools to create personalized online programs (Universidad Técnica Particular de Loja, 2023). We have utilized this strategy to develop our own recommendations for a personalized program for our sponsor.

2.3.3 Biocommerce & Ecotourism Models in Ecuador

Biocommerce and ecotourism are two fields where entrepreneurial training promotes economic development. There are several instances of this idea proving to be successful in

Ecuador. The first example of this idea examines the biocommerce of medicinal plants and Guaysa tea in the Jatun Sisa botanical garden in the Amazon Rainforest in Pastaza, Ecuador (Andrés et al., 2021). To determine the extent of the current training and education devoted to the many laws and regulations surrounding the trade of the tea and why these policies were important, a structured survey of ten questions was provided to local producers (Andrés et al., 2021). The surveys revealed that the producers had little or no knowledge about the official processes of biocommerce and why they were needed to support sustainable development and the long-term cultivation of plants. Failure to abide by laws designed to ensure the sustainability of natural resources over the long term is very damaging to those resources. This lack of knowledge also harms the broader environments where they source their products. It also results in smaller, local companies being unable to take an active part in all aspects of the biocommerce industry which leads to unsustainable collection of wildlife in Ecuador from large, foreign companies to meet the demand of the markets (Andrés et al., 2021). Specific educational programs for full-time workers on the purpose and impact of biocommerce laws would allow more local Ecuadorians to enter larger, more profitable markets. It also allows other producers to operate more in the open and make sure that cultivation methods do not damage the supply.

Ecotourism is also growing but would benefit from further development of the current education infrastructure. One example of an Ecuadorian ecotourism development model with relative success is the town of Yunguilla. This rural town, located in the Yunguilla Valley in Cuenca, undertook a large project involving the entire community. Yunguilla is surrounded by cloud forest, which for years had been damaged by the local need for farming fields, wood, and grazing land (Barros, 2021). To stymie this destruction, the Rainforest Alliance, sponsored by the United Nations Development Program, trained large groups within the community in accounting, administration, promotion, and other fields needed to keep tourism flowing smoothly. This plan consisted of using ancestral paths to allow people to experience the forest and present the tourists with an up-close look at the biodiversity within the forest (Barros, 2021). The Rainforest Alliance spent just as much time transforming the Cloud Forest into a preservation site as they spent training the locals how to care for the biodiversity in the forest with the presence of tourists to prevent the degradation of the site and depletion of its resources. The locals that have spent their entire lives around this wildlife will know how to care for them better than foreign investors that prioritize profit (Barros, 2021). Strong organization and

financial management for all areas of the tourism industry must be taught to the community to ensure the environment is not threatened and any opportunities created for local individuals are not lost. Hybrid learning programs allow the people who work in these industries to continue their work while also providing them with the education and knowledge to grow their businesses autonomously.

2.4 Present Infrastructure in Ecuador

This section provides an overview of the technological infrastructure in Cuenca that enables education programs. Specifically, we discuss the internet services provided by ETAPA, the telecommunications provider for Cuenca, and CEDIA, the web services provider for institutes and universities in Ecuador. Finally, we examine effective hybrid learning systems in Ecuador at institutions such as the *Universidad Técnica Particular de Loja* (UTPL). We investigate what makes those programs successful and what can be learned from them.

2.4.1 Existing Technological Infrastructure

As mentioned above, CEDIA, the Ecuadorian Corporation for Research and Academic Development, is the web services provider for universities and institutes in Ecuador (Martínez, 2024). This group provides a variety of web service packages for schools and institutions, including multimedia applications, academic resources such as research databases, and WiFi (CEDIA, 2024). Additionally, this group provides scholarships and funds related to the development of research and innovation technologies in schools and institutes (CEDIA, 2024). We are taking advantage of all that CEDIA has to offer for recommendations to our sponsor.

Additionally, ETAPA, the telecommunications, potable water, sewage, and sanitation company, provides broader internet services to the canton of Cuenca, which includes the villages surrounding the city (ETAPA, 2024). In addition to providing more useful data on internet speeds, working with ETAPA gave us the opportunity to understand the scope of the internet access in many of the rural villages our sponsor is working with (Martínez, 2024). This data was helpful to determine how best to support and interact with students. The data gave us information on whether students have WiFi and/or cellular services, and how we can provide them with those resources if needed. ETAPA and CEDIA were valuable resources for our assessment of the resources of the institute and its students.

2.4.2 Hybrid Learning in Cuenca

Hybrid learning has become an important aspect of modern learning, not only due to the pandemic, but also in terms of accessibility. For many students, access to education is dependent on location and internet access. The portion of Cuenca's population that lives in the mountainous and rural areas have limited access to the internet, according to our sponsor (Martínez, 2024). This poses a challenge to hybrid learning. The cost of developing the technological infrastructure needed to get this education is out of reach for many. This lack of access, in terms of technological needs and technical literacy, reduced interest and potential student investment in higher education as it is too costly or practically unachievable according to our sponsor (Martínez, 2024).

The *Universidad Técnica Particular de Loja* (UTPL) uses a hybrid learning system (Universidad Técnica Particular de Loja, 2023). This system was initially tested in 2021 to determine what forms of hybrid learning that worked best (Dávila, 2021). In this study, a diverse population of test subjects were gathered to test two different iterations of the hybrid system. Participants were presented with modules composed of gamified teaching methods. In the last phase, participants were surveyed to determine what aspects of this program benefitted them (Dávila, 2021). It was concluded that the majority of participants found that they were able to learn effectively and gain new skills through hybrid learning (Dávila, 2021). This system at Loja is a strong frame of reference on how to make a hybrid system that can engage students successfully from a distance. They utilize Zoom and Canvas to teach their classes completely virtually and almost solely asynchronously. This comes with the exception of some on campus activities depending on the major and student accessibility. This allows professors to produce, post and teach their classes from their homes with a more fluid schedule. When analyzing the system and this research we were able to find the strengths in operating a hybrid learning model and what the end goals that are strived for when running this model. This system has been referenced in the process of tailoring a manual to meet the needs of our sponsor to teach potential students in the industries of biocommerce and ecotourism.

2.5 Case Studies in Hands-on and Hybrid Education

In this section, we discuss examples of how biocommerce can be used to promote ecotourism development in Ecuador and abroad. We also analyze the costs and benefits of a hybrid, practical learning approach. The first of these is the previous work of WPI students that focuses on engaging students in hands-on learning. The second is a study which addresses many of the challenges of engaging students online, namely issues with working as a team and economic inequality among students.

The Garden-Based Education Project (Laemmle et al., 2021) is a prior WPI student project in Cuenca from 2021 that focused on teaching methods to better engage students. They used hands-on examples and education to engage students more than with typical classroom-based coursework. Some examples of activities are to build a garden environment on school grounds and to integrate the built environment into subsequent coursework. This project reported that students were able to retain information more easily when they were in dynamic environments rather than staying in the same classroom for extended periods of time (Laemmle et al., 2021). The lessons learned by this IQP were useful as we approached the task of developing our own educational programs.

Applying the hands-on teaching method to a virtual environment is an important challenge. Among the difficulties faced by students who learn virtually are self-regulation and lack of social interaction (Ng, Fang, 2023). These challenges can be addressed with the creation of community web-conferencing centers, where students who live nearby are able to meet and join class as a group (Ng, Fang, 2023). It is also important to consider social inequalities among students, which can be exacerbated during online learning. Making sure that disadvantaged students are able to keep up with coursework is vital for any online program. Learning centers where students are able to access WiFi and other resources are one way to do this (Dávila, 2024).

We shaped our final manual around the lessons learned from these two examples. A focus on physical learning and a hands-on approach engaged the students and better prepared them for their career. Applying the principles of hands-on learning in a virtual environment was a challenge, but the use of working centers where students can gather in smaller groups is one way to remedy this issue. We were also mindful of disparities in the access of students to learning technology which can be exacerbated by the virtual teaching method.

2.6 Review

The breadth of resources within Ecuador's borders is unmatched in the world. These resources provide the country with huge potential for economic development, both through the commercialization of the natural environment and the tourists drawn to visit it. The goal of the *Instituto Technológico Superior "Paul Rivet"* is to begin to utilize these resources by creating accessible education about how to grow businesses in the biocommerce and ecotourism fields. This project has examined the technology-based education systems that are needed to make this possible. We have considered the economic and technical resources of each student, as well as the technology needed by the institute. Our research focused on how those things can accommodate each other to create an education program that works for both students and professors. This institute aims to educate students in the skills they need to find lasting employment in biocommerce and ecotourism to help these industries grow within Ecuador. Our project assisted in this process by providing a manual of recommendations for our sponsor to consider in their development of this program.

3.0 Methods

The final goal of this project was to provide our sponsor, the *Instituto Tecnológico Superior "Paul Rivet,"* with a manual of recommendations for how to teach biocommerce and ecotourism through a hybrid learning model. These recommendations allow the institute to reach more students across Cuenca and the surrounding area. The advice of professors, students, administrators, and technological experts were considered when making these recommendations.

Our project focused on the following three goals, as defined below:

1. Determine the technological infrastructure needed for the implementation of hybrid training for careers in biocommerce, ecotourism, and business. Student accessibility to technology and the internet were two of the primary issues we considered with this.
2. Assess present technical infrastructure available in Cuenca related to internet accessibility and hybrid learning. This includes an assessment of the offerings of CEDIA, the Ecuadorian Corporation for Research and Academic Development, the dominant education services provider in Ecuador.
3. Propose a manual with a feasible and accessible hybrid education program to train students for careers in the biocommerce and ecotourism industries.

We used the following methods to accomplish these goals: semi-structured interviews, observational site visits, surveys and focus groups. We interviewed faculty with experience in hybrid learning as well as directors of *Colegios* [the equivalent to high schools in the United States] to understand the needs of the schools and the students. To gather further information about student needs we ran a survey at one of these *Colegios*. We also spoke with the academic services director of CEDIA to assess which of their packages is best for the school. We then analyzed the CEDIA packages ourselves to find the best option for our sponsor. Along with CEDIA, we interviewed an employee at ETAPA to determine widespread internet access in the region. In addition, we visited the Loja Learning Centers and determined if the services they offer could be applicable as a model for our project. Finally, we received feedback from professors we interviewed on our findings and recommendations utilizing an infographic to ensure that they were considerate of the student's needs.

Each of these methods allowed us to incorporate the voices of students, professors, directors, and technical professionals into our final recommendations, and ensure that their views were integrated into our project.

3.1 Determine Infrastructure Needs

The goal of our data collection was to understand what local stakeholders need to develop and sustain a hybrid learning model to teach biocommerce and ecotourism. We conducted interviews with educators that have experience with a hybrid teaching model. We worked with professors and institute directors to gather information about the resources they need to manage these teaching models. We produced and circulated a survey to assess student interest and determine what forms of technology students have access to and are familiar with. Lastly, we gathered current information on the forms of technical infrastructure used in hybrid learning, as well as sectors to which it can be applied. This data collection was done through interviews, surveys, and research. It allowed us to gain some in-depth insights into what methods and systems work best for hybrid education.

3.1.1 Educator Interviews

We conducted semi-structured interviews to ensure that our questions were properly addressed, while allowing the interviewee to lead the discussion. This tactic was ideal for acquiring genuine and personal responses and developing lasting relationships (Drimie et al., 2022). Our questions and preamble were analyzed and approved by the IRB at Worcester Polytechnic Institute; this ensured our research fell within proper human subject research protocols. This allowed us to acquire consent from our subjects to obtain audio and video recording. During these interviews, we collected in-depth notes in a Google documents file. Alongside these notes, we recorded video and audio of each session using Zoom's recording feature. Doing this we retained any visual data the interviewees provided to us, such as presentations describing their content. The audio was later turned into text through the Mygoodtape transcription program. These transcripts were translated into English through Google Translate, and then edited to ensure accuracy. These interviews were conducted in Spanish, due to the preferences of the interviewees.

We developed open-ended questions that targeted the main points that we need answered for educators (see Appendix B). This allowed us to direct the subject but let the interviewee talk about what they think is important. With this method, we learned their perspective rather than guiding their answers towards any biased opinions. We had a series of key questions that we asked each educator, which were altered to better collect data from each individual. These

different perspectives on similar questions provided insights into what needs to go into developing a virtual education system.

We interviewed local professors and administrators who are part of technical institutes (see Appendix B). We approached faculty and staff at the Quilloac Institute (n.d.), University of Cuenca (n.d.), the Catholic University of Cuenca (2024, April 10th), and Private Technical University of Loja (2023). We approached faculty of these institutes as they were provided to us by our sponsor as contacts who could help us acquire the needed information to conduct our project. These interviews provided insights into how classes surrounding hybrid learning are taught and informed us of any pitfalls we needed to avoid in our work. These interviews also provided us with what the needs of teachers, students and administrators are for this learning model.

These interviews were crucial to see how technical institutes run hybrid classes (see Appendix B). This provided a clear insight into what teaching methods help incoming students understand new topics on the academic level of universities and technical institutes. None of our interviewees teach biocommerce or ecotourism. This did prevent us from learning specifics in those fields, but they provided other insights. The interviewees explained how the hybrid system worked for the topics they taught, which was referenced and used as a base for how we suggested to teach biocommerce and ecotourism.

We analyzed the transcript data through a coding process to find common themes of what hybrid teaching methods are best for our sponsor. We looked through the collected transcriptions and notes from interviews to identify key themes about the online systems, support, and teaching methods needed to create an effective hybrid system (Shackleton et al., 2021). We created nine broad groups that allowed us to reference those specific sections as we looked for usable quotes and key ideas. The coding allowed us to best keep track of the key ideas and those systems, recommendations, and programs which were spoken about multiple times by different contacts.

3.1.2 Student Survey

While interviews provided us with the perspective of educators, we used a survey as a research method to gather data on student opinions (Shackleton et al., 2021). Professors, educators, and students all have different needs relating to technological infrastructure and hybrid learning programs. It was important for us to address the needs of all populations impacted by this institute. We surveyed potential students at the institute, meaning most of them

were 17 years old (Martínez, 2024). The school we ran a survey at is called *Unitec Discovery Unidad Educativa Particular.* We acquired permission from the directors of the school to ensure they understood what was being asked of them and they were willingly consenting to completing the survey. The surveys were distributed by us as physical copies in-person to a class of students (see Appendix C). We also spoke informally with the professor of the class.

The survey contained questions related to the students' accessibility to technology and internet services, their need for support, and their interest in different aspects of the institute. These questions were all multiple-choice with one short response question asking if the student had any further comments (see Appendix C). We chose to run a quantitative survey as we are mainly concerned with predicting specific future needs of the students, especially related to accessibility to technology (Shackleton et al., 2021). The content from this survey was then analyzed to find common themes and topics about what potential students want from an institute they attend. These data points were cross-referenced with the interviews from educators to determine where the two populations align and where they differ, allowing us to incorporate both experiences into our final recommendations.

3.2 Assess Existing Resources

Our second objective was to assess the existing resources in Cuenca our sponsor will rely on. The goal of this data collection was to understand how the institute can best make use of the resources they have, and how they can best use these resources to address student and educator needs. We toured the learning centers operated by UTPL to understand the services that they provide and determine if a similar system is replicable for our sponsor. We also interviewed professionals who work in the telecommunications and internet service fields so we could assess the resources available to both our sponsor and the institute's students. Finally, we toured the UTPL campus to visit their virtual learning lab and the systems they pilot there. These assessments helped us understand both the present resources of the institute and similar hybrid learning systems.

3.2.1 Interviews with Technical Experts

In addition to interviews with educators, we also spoke with technical professionals to understand the resources available to schools and students (see Appendix A). Javier Valdiviezo,

the Chief of Virtual Classwork of CEDIA, provided valuable data concerning this. We asked Sr. Valdiviezo about the packages that CEDIA provides, and the additional resources they could offer to our sponsor (CEDIA, 2024). The packages included access to learning and library databases, as well as resources for research and learning online. This allowed us to provide better recommendations to our sponsor about how to shape their hybrid learning program around the resources that are available to them.

We also spoke to a contact at ETAPA, the telecommunications provider for the canton of Cuenca (ETAPA, 2024). Engineer Guanga was able to provide data on the internet access of different parts of the city. This data helped us understand the internet connection which prospective students have access to, and places they could go if they cannot access it at home (see Appendix A). It was also useful in recommending the potential locations of connection centers to aid rural students in participating in the virtual program. Data from ETAPA helped us plan our program around the access and resources of potential students.

These interviews were both semi-structured, which allowed us to elaborate on certain topics of interest rather than sticking to a protracted script (see Appendix A). Semi-structured interviews are also better at obtaining more in-depth responses (Drimie et al., 2022). After the interviews were complete, we used the same coding system used in the prior interviews to categorize the data and draw out important patterns and key ideas. These interviews gave us key insight into the resources needed by our sponsor to teach classes using a hybrid methodology.

3.2.2 Site Observations

In addition to an assessment of the current resources available through CEDIA and ETAPA, we also visited one of the technical learning centers of UTPL. During this visit, we took photos of the centers as well as descriptive field notes, which are simple analytical descriptions of the environment (Johnson, 2017). These descriptions helped us determine the services these centers offer, as well as how they are rendered to students. Our observations helped us to determine the feasibility of these centers for our institute.

It was important to recall the data gained from our interviews with the CEDIA and ETAPA workers. They were important since they understood the internet strength needed for hybrid programs and how to best manage them. Although UTPL and other institute's programs are virtual, many of their resources are physical. This made site visits crucial as they helped us

determine how best those physical resources could be used to develop hybrid learning infrastructure that works for students, teachers, and administrators.

Additionally, we toured the campus of UTPL, which is about three hours outside of Cuenca. At this campus, they have several labs and other facilities which they make available to their students through a virtual campus program which each student is able to access (Dávila Moreno, 2024).

3.3 Recommend Educational Models

The information gained from objectives 1 and 2 helped us understand which types of technical infrastructure is needed for an education in biocommerce and ecotourism with a hybrid teaching model. We also analyzed all four of the technical benefits packages offered by CEDIA to determine which would benefit the institute the most. The options were *Básico, Intermedio, Avanzado Uno,* and *Avanzado Dos.* The main piece of information we analyzed these packages for was the number of students and professors each package could support. We did this because *El Instituto Tecnológico Superior "Paul Rivet"* plans to enroll around 300 students and 20 professors (Martínez, 2024). Once this information was collected, it was organized into recommendations for a hybrid education program for our sponsor. The final deliverable of this work was a manual that instructs the institute how to manage students, professors, and technology for remote learning. We summarized this information in an infographic with visuals in order to present the manual to professionals that could give us advice. This way they were able to provide feedback on our work. We were also able to collect data to determine which recommendations needed to be improved before the final manual was submitted.

3.3.1 Educator Feedback

The education program at *Instituto Tecnológico Superior "Paul Rivet"* will utilize hybrid learning to allow students to primarily learn remotely. Our recommendations for the program were presented in a manual to our sponsor. To ensure the recommendations were accurate and covered every topic needed to support a technical institute under a hybrid learning format, we created an infographic that summarized our manual using text and images (see Appendix D). This infographic was then sent through WhatsApp to all the directors and professors we had interviewed. They were selected as they are the most well-informed on the content of the manual and can provide in depth feedback. The professors provided comments through a text or texted

document over WhatsApp. The comments were analyzed to pick out common themes in the recommendations about weaknesses, strengths, and what could be improved. We then applied these themes to improve the final manual we presented to our sponsor. Once this analysis was completed, we had a well-reviewed final program to present to the institute to teach potential students about ecotourism and biocommerce in a hybrid learning model.

3.4 Methodological Challenges

In the course of our interviews, we came across several issues, such as getting in contact with interviewees and maintaining a stable connection during virtual interviews. Questions were often changed during the interview to better respond to things which interviewees had already said or abandoned entirely if they no longer seemed appropriate. Interviews were mostly held over zoom to accommodate our interviewees, some of whom lived outside the city or were obliged to meet with us at night. This also resulted in issues with understanding one another due to spotty internet connection or microphone quality. We solved this issue by asking our interviewees to repeat themselves and making sure we were in a location with a stable internet connection. We recorded, transcribed, and translated each interview, which helped with issues of understanding. A final issue we came across was getting in contact and scheduling interviews with some of our interviewees as we did not always receive responses to our messages or did not always attend scheduled meetings.

3.5 Informed Consent and Data Confidentiality

To ethically conduct our research, our team received informed consent from our participants in all three of our research methods. For this project, we informed participants that we were from WPI and doing a research project for our sponsor Juan Pablo Moscoso. We told them our purpose was to investigate hybrid and virtual learning methods at the request of our sponsors, who did not want us to tell them the exact purpose of our research. This was because many of them worked at rival institutions, and he did not want their response to be informed by professional competitive bias. We also asked for their permission when citing and using their responses in our project and explained how they will be used. Before the interview began, we asked for the subject's consent to record the audio and video of the interview using Zooms

recording feature. They were also informed that we would be taking physical notes as the interview proceeded.

Participants of interviews were given the chance to remove personal identifying information from the transcripts. In this case, each participant would have been assigned a unique identifier, which would have been used in analysis and official reports. We only asked that they allow us to record their profession for our research. The audio recordings and transcripts we developed were stored and analyzed to ensure confidentiality. This was done on Google Drive. Upon the completion of the project, all transcribed interviews and data not used in the project were deleted.

3.6 Review

The goal of this project was to create a manual of recommendations to implement technical infrastructure for career training in biocommerce and ecotourism. We incorporated knowledge gained from interviews about both hybrid and virtual learning systems and how they utilized technology. Our final proposal included recommendations to the *Instituto Superior Tecnológico "Paul Rivet"* about how to best support both teachers and students using this system. This allowed the Institute to prepare for potential issues with their program and ensure they had a proper support system for both students and professors. We conducted our research using three methods: semi-structured interviews, a survey, and observational site visits. This information helped us shape what we have learned so that we could help the institute produce future industry leaders and entrepreneurs in biocommerce and ecotourism.

4.0 Findings

In our research, we interviewed professors and administrators from *Colegios* (high schools), technical institutes, and universities. We visited sites operated by the University of Loja which are both centers from which virtual classes are held. Finally, we conducted a survey of students to understand their access to the internet and their familiarity with virtual teaching methods. This data was flawed since we were only able to run our survey at a private school. This school has students that, on average, have access to more resources than the average student in this age range based on survey responses. Due to this, we do not believe our findings from the survey accurately reflect the student population our sponsor wants to target. We also believe many of these students believed Canvas was the same as Canva (an entirely different program), diluting the worth of those responses. This led to further inaccuracy in our survey responses. We believe a few questions provided important data that would not be influenced by the number of resources provided by the school. We included graphs from these findings to support this report.

During our interviews we were able to understand the benefits and drawbacks to a virtual or hybrid system, as well as the ways in which those drawbacks could be mitigated. The most consistent findings were the efficiency of a virtual system in being able to work around the difficult schedules of students who have other responsibilities. The subsequent sections go into detail about our findings as they relate to students, professors, and technology.

4.1 Student Needs

El Instituto Tecnológico Superior "Paul Rivet" is being developed to help students who are pursuing careers in business, biocommerce, and ecotourism. A majority of these potential students plan to work alongside furthering their education (Figure 3). Students that do attend university often do not get enough hands-on experience that most employers in these industries desire. These two problems result in many students not having enough experience or qualifications for the more advanced jobs they wish to obtain. This developing Institute hopes to rectify this issue by offering a hybrid learning program so students can learn on campus temporarily and then transition to a remote program. An imperative aspect when formulating

these programs is determining potential issues and needs relating to students to ensure they obtain the best education possible.

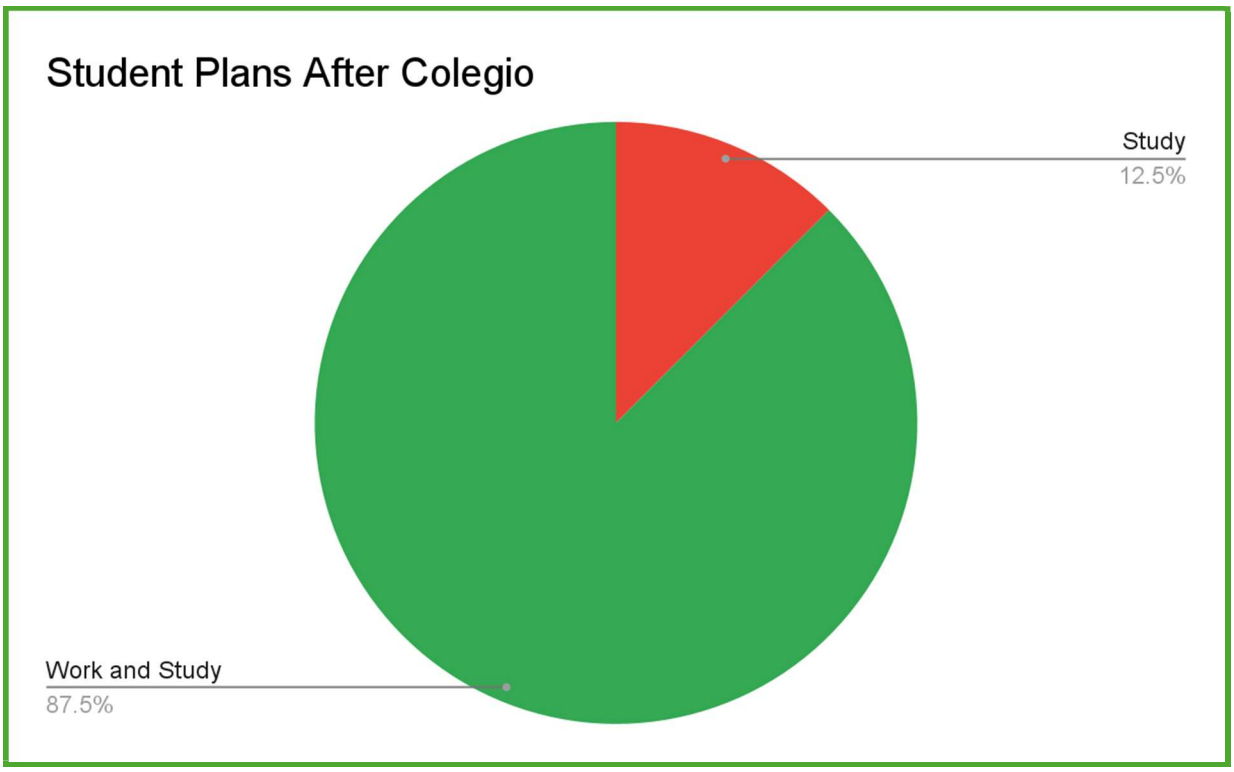

Figure 3: Student plans after *Colegio* based on 16 survey results collected from *Unitec Discovery Unidad Educativa Particular.*

Reliable Connection

The first issue is many potential students do not have access to the required technology for remote learning. Potential students may also live in rural areas where they do not have access to internet or technology support. Some students may not be able to afford the technology needed to complete schoolwork remotely. An issue that all students will face is unreliable power, WiFi, and internet service. Many students do not have consistent WiFi (Figure 4), and all students will be affected by occasional power outages, according to a professor at *Unitec Discovery Unidad Educativa Particular.* The findings relating to solving these issues came from interviews with professors and directors from the *Universidad Técnica Privada de Loja* (UTPL) and ETAPA. ETAPA is the telecommunications provider for Cuenca, and therefore has vital information about WiFi and internet service. Professor Gabriela Inga from UTPL explained part of the solution: “At registration they are given a tablet . . . You get the tablet, but the tablet really isn't

that good quality. Sometimes it crashes, it doesn't load everything. And the network, the internet, no." We learned from this that most schools offer tablets to their students since they are cheaper and easier to operate than computers. However, this only solves the second issue, not the first.

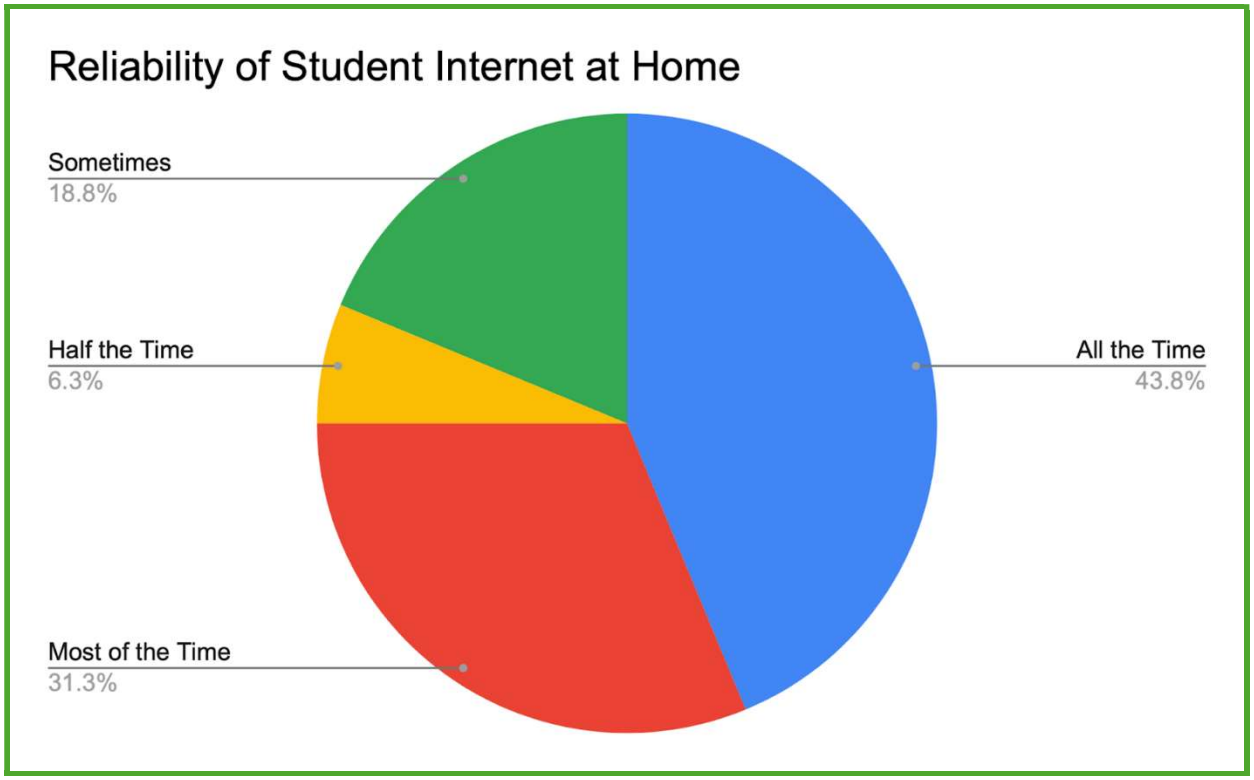

Figure 4: Reliability of student internet at home based on 16 survey results collected from *Unitec Discovery Unidad Educativa Particular.*

We also found that many hybrid learning programs are operated through Canvas. Canvas is a Learning Management System (LMS) that has been curated to fit the needs of the school or institute. Professor Marco Vasquez from UTPL explained how EVA, a Canvas plugin, works: "For each subject, there is a file . . . Schedules, the activities, the announcements that I just told you. It also has an inbox as if it were an email, but institutional." An additional LMS with a similar function is Moodle, which also has a plugin called ELSA. These programs require WiFi to function. However, material from Moodle and Canvas can be downloaded onto a device and accessed remotely without WiFi. Professor Inga explained one method of giving students access to free WiFi: "Now, my university has support centers in every city . . . So, in these support centers there are computers that students can use." However, if the institute does not wish to develop these technical learning centers, they can also recommend locations with free WiFi.

From our interview with Engineer Paolo Guanga from ETAPA, we determined there are many potential WiFi locations that could be utilized as shown in Figure 5 below. He stated ". . . the actions and projects carried out by the local government, the municipality or the mayor's office of Cuenca, precisely through the company ETAPA, where a Wi-Fi network of around 600 has been implemented. Hotspots, in the city of Cuenca. 24 of these 600 are in the rural part . . ." The students can be provided with details surrounding these hotspots, which are located in public places such as historical centers, parks, and cafes, to use them for downloading their work. Depending on the budget for the institute, one of these two methods can be used to overcome any issues related to internet service or WiFi. This would be true as long as students are able to communicate and get support from professors or administrators.

Figure 5: Guanga, 2024. Map of public WiFi hotspots in Cuenca provided by ETAPA.

Flexibility and Communication

The second issue is that many potential students will work alongside pursuing an education (Figure 3). Additionally, students spend a different amount of time on schoolwork depending on their availability levels, which requires flexible school schedules (Figure 6). This means the Institute cannot rely on a strict, consistent schedule of classes and office hours for support because many potential students will have varied work schedules. Professor Inga from UTPL explained how schools can work around this issue using EVA: "The teaching plan is the summary for them, it is their support, because in the teaching plan there is all the subject matter, all the contents that they must start studying . . ." The educational content for each week is

divided up into sections in Canvas, including recorded Zoom lectures. This allows students to learn the information they need by accessing it whenever is convenient for them. If students lack WiFi, the lectures can be downloaded on tablets to be watched remotely, as mentioned in the previous section.

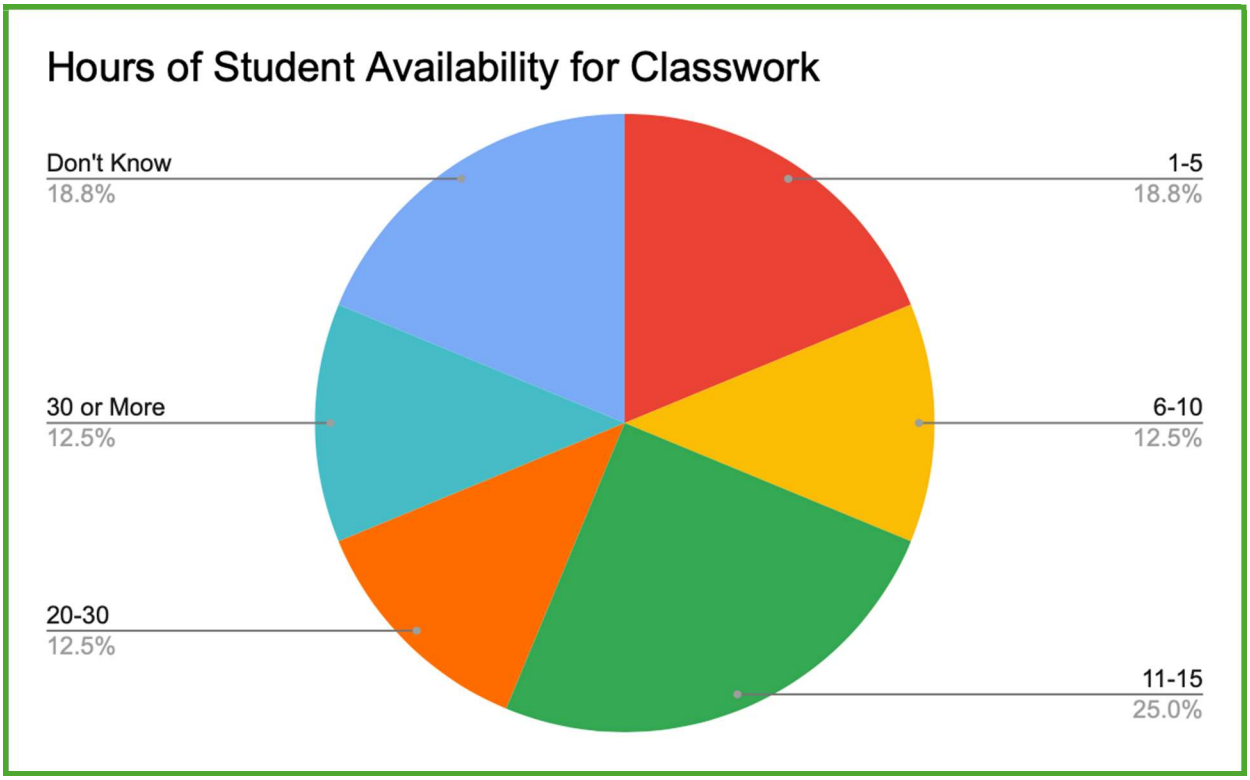

Figure 6: Hours students think they will have available for schoolwork while working based on 16 survey results collected from *Unitec Discovery Unidad Educativa Particular.*

However, this level of independent learning creates its own series of issues. There is no formal accountability for the students since they are not attending a class, so the students must be self-driven to complete their work. Professor Angélica Dávila from UTPL explained how students can do this: "You have to organize your schedule, you have to combine all your activities . . . Teach them to organize their own schedule, so that they can combine their work and their family. Because they are adults . . ." Additionally, students also dislike and are more resistant to group work because they are not spending time in person getting to know their classmates. Professor Inga explained this when she said: ". . . projects, I don't know, a group activity, because normally in distance learning the students are very individualistic . . . they say, no, teacher, I can't contact the other classmate. No, the other partner did not meet." The

professors and administrators from UTPL recommended constant communication between professors and students to encourage asking for help about time management and assignments. Additionally, they form WhatsApp group chats between groups of students to encourage them to work on assignments together and find alternative sources of help. Professors and administrators will need to be flexible with students' needs to make sure that they are able to manage other commitments with their schoolwork.

4.2 Professor Needs

A hybrid learning system is an important tool to reach students who would otherwise be unable to attend school in-person; however this system presents a number of difficulties to the professors, who are obliged to manage teaching through multiple different media. These difficulties arise from the challenges of working online and the technical infrastructure needed to engage and deliver material to students. Aside from the teaching staff, additional personnel are also needed to manage the technical support and the administrative challenges which come from teaching a disparate population of students.

A Powerful Education Platform

Many of the typical methods of teaching are not available in an online space. Professors cannot regularly speak with their students, hand out physical materials, and be certain of attendance. To mitigate this loss, and to best take advantage of the many benefits of distance learning, an effective online learning platform is a necessity. Canvas and Moodle both allow professors to release material to students. Professor Vasquez supported this: “We teachers, week by week, upload announcements, whether academic or informative. So, through it, they also teach themselves.”

These platforms also allow professors to mitigate one of the main difficulties with distance learning: student engagement. Plugins for both sites let professors track logins and determine if a student is not engaging consistently with the material. One such plugin is ELSA, developed by CEDIA based on surveys with teachers throughout Ecuador. In our interview with him, CEDIA Chief of Academic Support Javier Valdiviezo spoke about the functionality of the platform: "ELSA based on Moodle becomes an analytics tool to make decisions for Self-Regulation, Analytics and Active Learning in order to minimize student loss. It monitors

activities, . . . student work times." These analytics allow the professors to track if a student begins to fall behind in their work. Professors can then use the message system embedded in the platform or an internal email system to work with that student and keep them engaged with the program.

A Functional Administrative Staff

In our interviews with professors, it was made clear that they find it difficult to successfully teach without support from administrative staff. Professor Diego Andrade, of UTPL, spoke about this: “The disadvantage for teachers is this. The exaggerated workload, the exaggerated administrative burden. Many times, things that administrators or secretaries should do are left to us.” When there are not enough administrators and secretaries to manage the institute, the professors are forced to do work which distracts them from grading, teaching, and engaging with students. Scheduling meetings, managing enrollments, and tracking down students are all tasks which impede the fundamental work of teaching. This will especially be a problem as the school is starting because teachers will have to adjust to the hybrid system and learn to manage the platform and online lecturing format all at once.

In addition to administrative staff, workers will be needed to manage the technical aspect of the institute. Any plugins or modifications made to a learning platform will require a support staff with technical literacy to manage, as will the necessary physical infrastructure on site at Santana. All of these support staff will be vital to the functioning of the institute, professors who are able to focus their work on teaching will deliver the best education possible to the students.

Professors Must be Taught Specific Distance Learning Techniques

Aside from the material associated with the courses, teachers must develop strategies and plans for virtual learning. Professor Dávila, of UTPL, spoke about the importance of being able to use these tools: “Our challenge is making sure all the professors know how to work with students at a distance… The courses we generate are so they [the professors] know the context of distance education… So, they know how to write an announcement, how to connect with students, and how to develop activities.” Each of these skills is vital in an online environment. Students can often feel isolated, and it is the professor’s job, through announcements to the class and personal communications, to mitigate those feelings and keep them engaged. Activities must also be changed; handouts or lesson plans that work in a physical environment must be adapted

to make use of technical tools and rely less on in-person attendance. For example, more powerful or engaging presentation software can be used in a virtual setting, professors should be trained to use these systems to create lessons that take advantage of the strengths of the program.

All these skills are applied differently in an online classroom than in a physical one, and students will be best able to learn if the teachers themselves are taught how to use the online systems. Professors who give feedback and track student progress will be able to keep them engaged with the material. Professor Andrade, also of Loja, spoke about the importance of consistent training, not simply one course at the beginning: "We are in constant training… training that is super new, about gamification, or using augmented or virtual reality programs." Consistent training ensures that professors are always improving and adapting to new techniques and modern subject matter. Consistent training also exposes professors to technologies, such as the AR and VR systems being developed by UTPL and the *Universidad Católica de Cuenca*, explained in Section 5.6.

4.3 Technology & Infrastructure Needs

To develop a hybrid technical institute, technical infrastructure is vital. The most common of these is using Zoom and an additional educational platform, such as Canvas or Moodle. This is used by many institutes since the pandemic and serves the baseline needs for a hybrid learning model. Institutions such as UCUENCA, Quilloac, and Loja utilize this model, but Loja adds on more integrative systems. They use a digital replica of their campus as shown by Figures 7 and 8 below. Students can join this virtual campus and interact with other students and professors using text and voice chats. Current systems that exist are using videogame tools and concepts to develop classrooms and situations to teach students immersively with a hybrid learning model. Loja's virtual campus is run through Unity, which is a well-established game development engine that can be used to create 3D spaces, characters, and objects. The development team at Loja uses this to make constant iterative changes to improve the quality of the campus and possibilities for a wider range of subjects to be taught. Continuous iteration is a good basis for developing an immersive hybrid learning model.

Figure 7: Loja Site Visit (2024). Taken by Rebecca Emme. Virtual recreation of the Loja campus that students can access on a laptop that runs Windows 10 or newer.

Figure 8: Loja Site Visit, 2024. Taken by Rebecca Emme. UTPL's virtual courtroom for law students to practice legal cases with professors and fellow peers.

When we met with Loja's development team, we learned they are in the process of integrating ChatGPT to help teach English that would be added to the system shown in (Figure 9). Through the use of ChatGPT a student would hear corrections to their speaking in real time without the need for a teacher to be present. This would increase the capacity and accessibility of their English language program. These are just two of many of Loja's attempts to utilize new technologies, such as AI, to improve upon their existing systems. Due to Loja developing a strong technical base to expand into new technological sectors. This method of developing a strong technical base that can grow over time is an ideal way to develop a technical institute. This allows for continuous growth of the program without added difficulty of needing to build a base.

Figure 9: Loja Site Visit, 2024. Taken by Rebecca Emme. UTPL's virtual English teaching program.

Optimization

When Loja was in the process of developing their virtual school and educational model they came across many challenges. The file size of the virtual school was the most glaring issue, as programs of that size are time-consuming to download and take up a lot of memory. This limits the access of students who might not have a powerful enough device as stated by Loja's technical development team during our visit on the 9th of April 2024. Another issue was the processing strain it would put on a computer as it rendered all the assets, which is the name of in-

game objects, and interactive pieces in the program. If a computer's processor is overtaxed it will result in lagging, timing out, and crashing. This is a huge issue for a technology dependent form of teaching, so they developed a system of optimization to resolve both issues. To reduce the file size of the virtual school and its assets, they reduced the number of polygons each model had which decreased the file size. They also simplified textures and removed dynamic lighting to save more storage space. Reducing the lighting also served to reduce in-game rendering which would normally put a lot of strain on a processor. Figure 10 shows this technique: if the lighting were non-simplified, there would be dynamic shadows and lighting coming from the light sources in the space. These techniques reduce the fidelity of the models but saves storage and helps the system run smoother, which was told to us by Loja's technical development team during our visit on the 9th of April 2024.

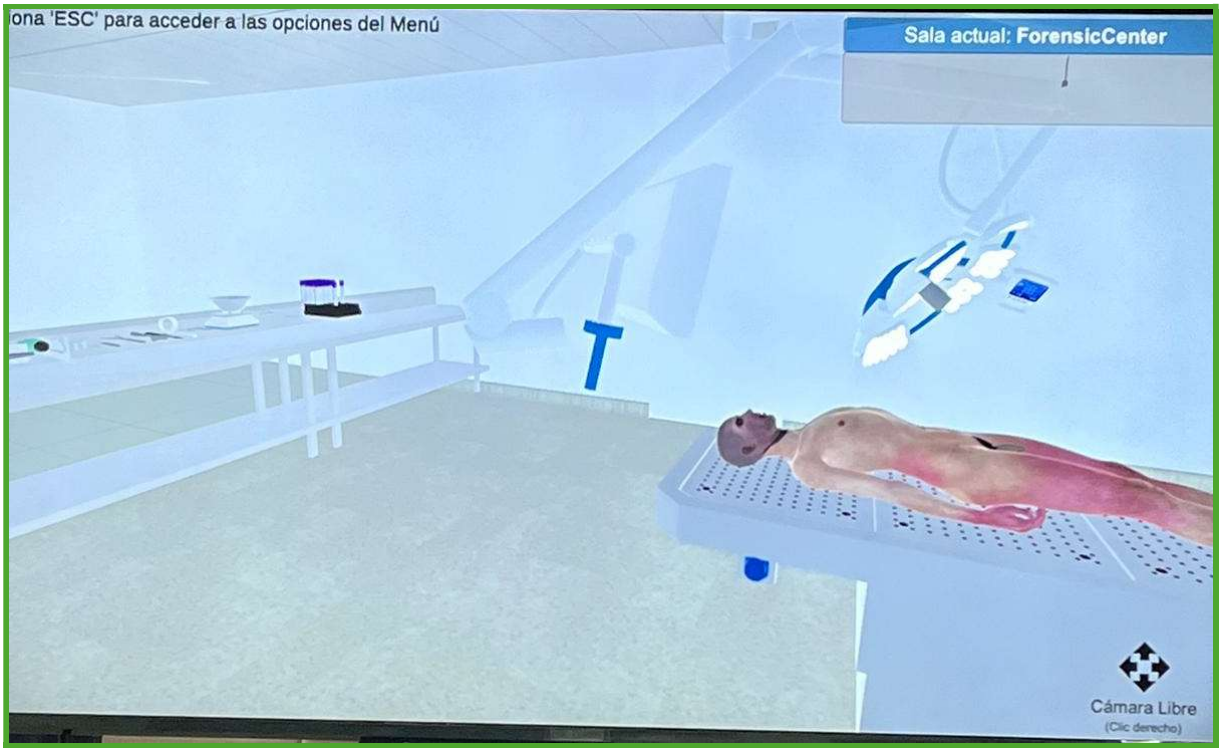

Figure 10: Loja Site Visit, 2024. Taken by Rebecca Emme. The simplified lighting in UTPL's virtual morgue program.

An additional technique that Loja utilized to reduce processor strain was to make it so that the program only rendered objects in the student's direct line of sight. Rendering is the process of a device loading all the visuals and interactable components. This means that whatever the student was not looking at was not being loaded and was not putting unnecessary

strain on the processor. An additional trick was to lock students' cameras during virtual classes which dramatically reduced processor strain (Figure 11). Reducing processor strain also improved students' connectivity by reducing the bandwidth needed to run classes. Bandwidth is the amount of data per second an internet system such as a router, server, or network can handle. Streaming tends to require more bandwidth since it is processing information in real time, rather than being processed and condensed before being made available. Reducing the required bandwidth by reducing the visual data allows the computer to spend less time and energy focusing on generating the visuals. An overloaded processor struggles to keep a stable long distance internet connection, which could lead to students disconnecting and missing class time. This method is something that dramatically improves the quality of virtual learning by making the platform more accessible across more devices.

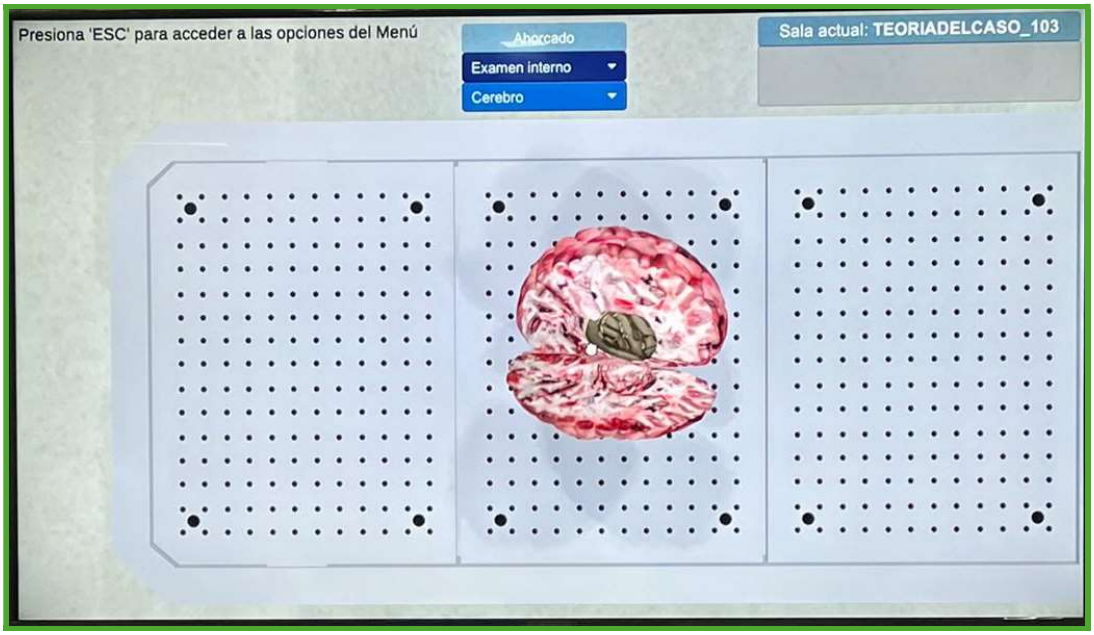

Figure 11: Loja Site Visit, 2024. Taken by Rebecca Emme. A camera locked onto the dissection table of Loja's virtual morgue.

For these optimization fixes to properly function they will need powerful servers and strong internet access. These systems require a large range of computing power and a secure network to run their websites, applications, and archives while collecting and securing the data. Their servers must have the computing capacity to handle influxes of users and data, while keeping connection fluid without dropping computing speed which results in lagging, timing out,

or crashing. Server and network needs are a crucial part of running a hybrid institute, so optimizing those sectors is required for proper function.

Baseline Technical Tools

To run a virtual institute, a base platform of the desired websites and applications must be picked. This section reviews the two systems used by our contacts and what is needed to make them function. They are called Moodle and Canvas, and both are educational websites and applications that allow professors to download and upload materials and modules that allow students to work asynchronously. Loja started with Moodle and transferred to Canvas, while most schools/institutes such as the Quilloac Institute use Moodle.

Canvas as used by Loja has a lot of additional features and optimization compared to the base service provided by the application. Canvas at its core allows for professors to make a calendar where all assignments are presented with the needed information to complete them and a due date. Professors can provide files, make announcements, run quizzes and tests, and provide grades. Students and professors can also communicate through Canvas and participate in text-based class discussions. Zoom can be directly linked as well as echo360 which is a recording software for physical classrooms, important for the periods where students will be in person. All of these tools meet the basic needs of an institute. This system was further improved by Loja who optimized and streamlined this software. An example of this was by allowing for information to be shown in a more efficient manner by dividing into weekly sections that present all of the work for the week (Figure 12). Another improvement was developing a system that allows students to download all the needed materials to work offline as shown in Figure 13, below. These optimizations made it better for virtual learning and general functionality which should be taken into consideration when using this method.

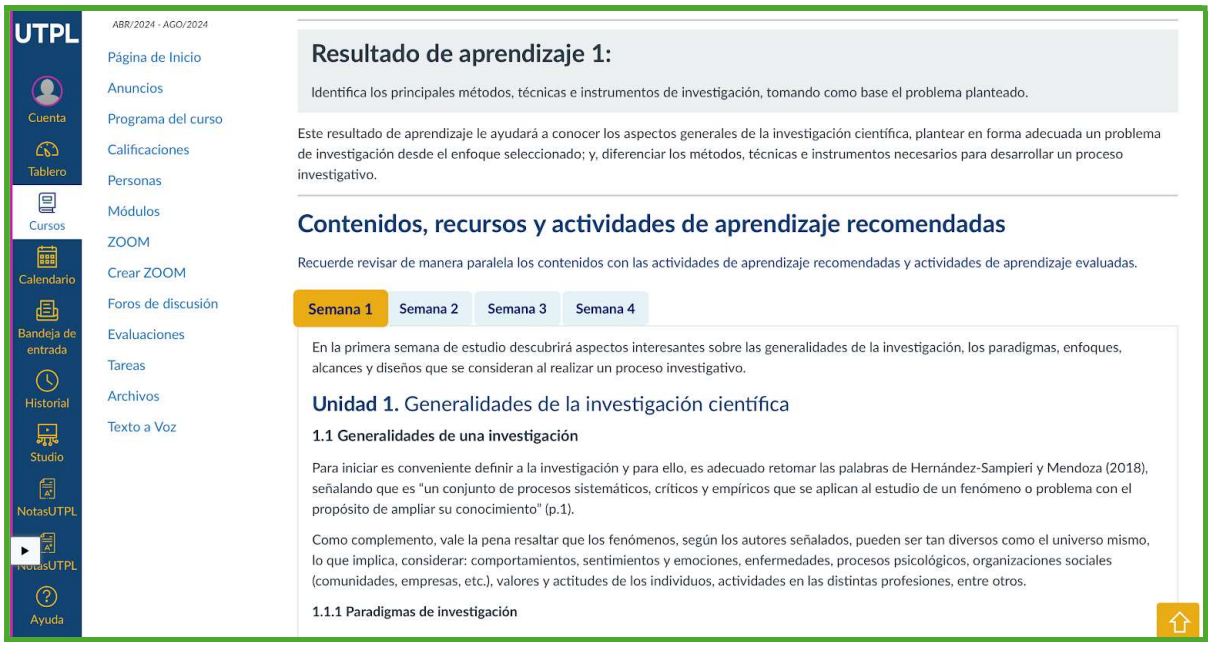

Figure 12: Loja Site Visit, 2024. A Loja canvas page, organized by weeks.

Figure 13: Loja Site Visit, 2024. A Loja canvas page, with the offline course option visible in the bottom right.

Moodle follows a very similar model but prioritizes downloading content rather than just presenting it to students. This being a core aspect of the program makes it the best choice for asynchronous/offline education. Aside from being more accessible to students with a less consistent WiFi connection, it is a free software rather than a paid service. This is often ideal for most institutes, particularly public ones, as it saves on funds while meeting their needs. An

additional bonus of Moodle is that CEDIA provides their plugin, ELSA, in their service packages. ELSA lets professors track students' progress and classwork (Figure 14); it also allows students to keep track of their assignments (Figure 15**)**. Moodle is an efficient system for teaching when paired with CEDIA's analytics system ELSA. This makes an ideal system for hybrid learning.

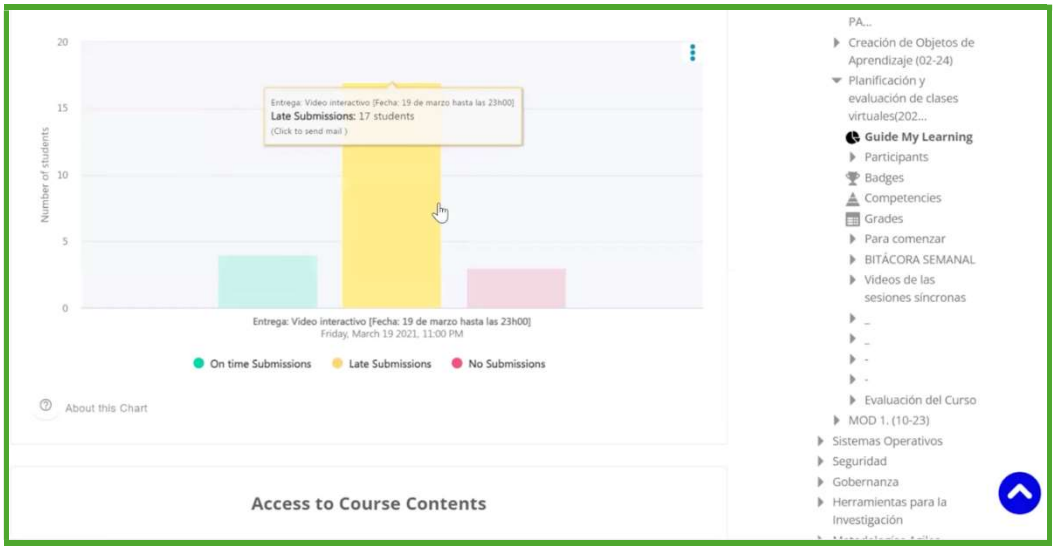

Figure 14: Valdiviezo, 2024. Student's progress on an assignment shown through the ELSA program.

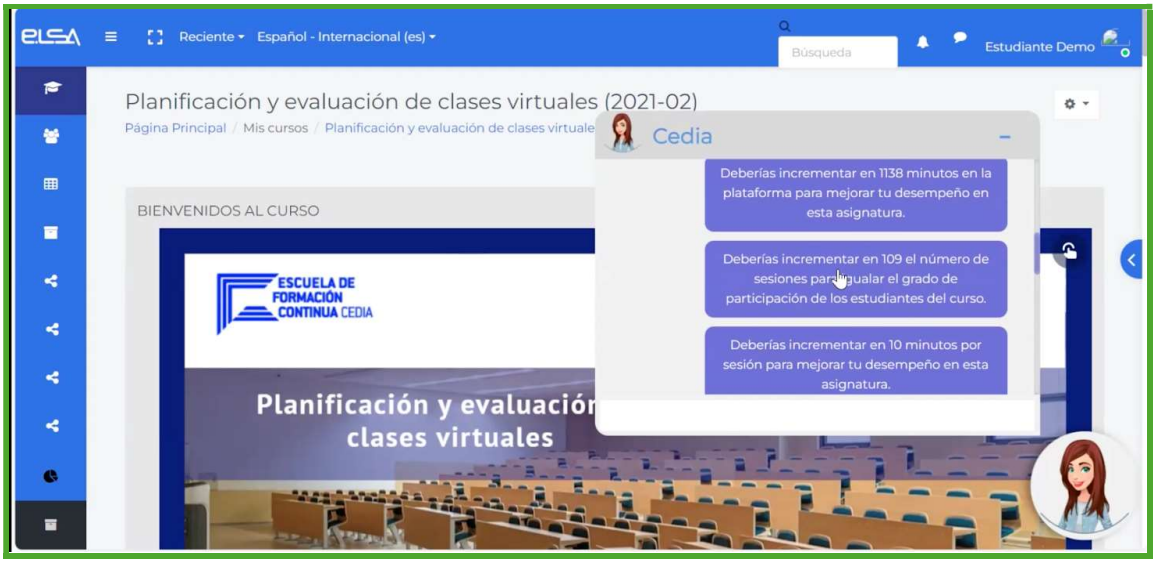

Figure 15: Valdiviezo, 2024. ELSA student notifications, reminding them to keep track of their assignments.

Advanced Technical Tools

Alongside Loja's virtual institute, they have developed systems to teach classes in Virtual Reality (VR) and Altered Reality (AR). The difference between VR and AR is that in VR participants are fully immersed in a digital environment, while in AR participants see the world through a hologram overlay (Figures 16 and 17). This allows professors to perform a VR or AR autopsy and stream it on Microsoft Teams to students so that they can learn with a more tangible example, while only needing to provide goggles to the professor. This gives real world experience from a distance.

These technical systems are professor and student oriented, as professors can control the environment and manage how students interact with the subject matter. Professors and students are also able to talk to one another in real time through a voice or text chat. With these two forms of communication, issues can occur if there is a disruptive student. To solve this, within these virtual teaching rooms professors can mute and remove students as needed, similar to a zoom call. All of this culminates in an immersive and well-developed learning and teaching experience for professors and students alike. These more advanced tools were made possible by Loja's strong technical infrastructure, as it left room for expansion.

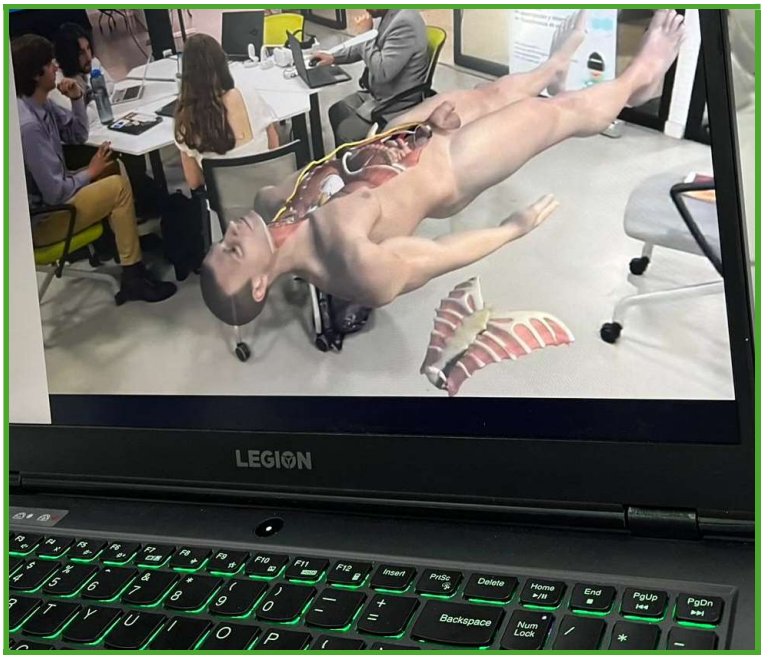

Figure 16: Loja Site Visit, 2024. Taken by Rebecca Emme. A live feed of what an AR headset is showing the wearer.

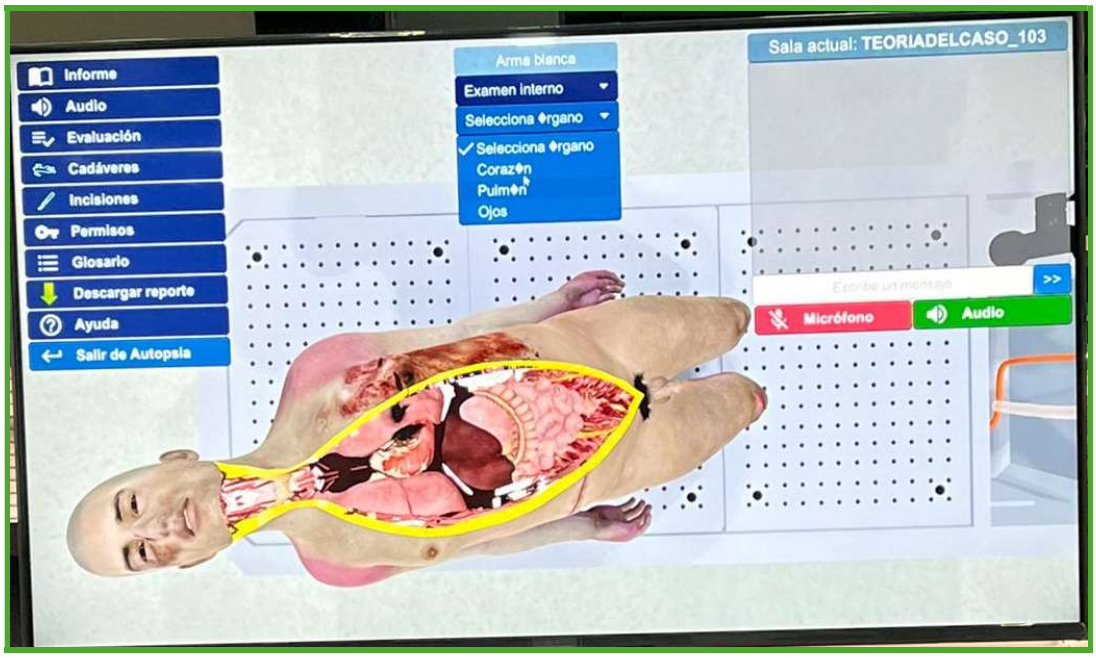

Figure 17: Loja Site Visit, 2024. Taken by Rebecca Emme. A live feed of what a VR headset is showing the wearer.

4.4 Review

Hybrid learning is difficult to manage, with the needs of professors, students, and technical requirements all needing to be accounted for. Through our interviews, site visits, and survey we encountered a number of prominent issues which must be overcome in each of these categories. The institute must account for students who do not have full access to technology and internet in order to take their classes virtually, which would hinder their ability to learn with a hybrid learning model. They must train professors to work with digital systems as well as teach them to engage students through those systems. Without that support students will feel lost and teachers will struggle within the technical systems. Those systems are codependent on strong technical and network infrastructure, without which the institute will not have functioning websites and programs which are necessary for a hybrid learning model. Each of these findings is incorporated into our results and recommendations, and each must be considered in the development of the institute.

5.0 Recommendations

This section contains our recommendations to our sponsor, addressing each of our findings gained from interviews, observational site visits, and a survey. The recommendations provide detail on how technical infrastructure can be developed to support a hybrid learning program at a technical institute. We also address possible shortcomings of these recommendations and what can be done to rectify them.

5.1 Virtual Development

Strong technical infrastructure is necessary for any functional hybrid learning system. These systems must be able to handle the strain of an institute's worth of students, professors and administrators while maintaining educational applications and archives. We recommend developing stable networks with large bandwidth and enough servers to compile and house all of the produced and managed data.

These systems will need a large amount of computing power and a strong and secure network to run their networks such as websites, applications, and archives while collecting and securing the data. To account for the network needs, ETAPA is the service provider for the region, which is then developed for institutes by CEDIA. CEDIA specializes in developing this internet connection for institutes, as well as providing data services and educational technology. CEDIA provides specialized packages depending on the needs of the particular institute. We recommend the *Basico* package, as it will more than account for the estimated student population size of three-hundred students. This package accounts for zero to fifteen hundred students, which also more than accommodates the institute’s goal of doubling in size by its fifth year. To handle the internet needs, we recommend that the institute utilize more than one overlapping network to disperse the load, which was recommended by the IT personnel at UCUENCA. The data management services provided by CEDIA are through cloud data and allows for an institute to utilize a section of their data centers. These data centers are full of server stacks that house and manage data. We recommend taking advantage of this as it will reduce strain on the local servers.

Local servers are still crucial, as they hold and manage all of the Institute's data. The strain will be lessened by the data services provided by CEDIA, but the local servers still must

have the capacity to handle user and data influxes that could slow down runtime and function. For servers to properly run and not overheat, a temperature-controlled room is vital: ample space for the servers and personnel to manage and maintain them is also critical for the system to remain current and functional.

5.2 Security of Virtual & Physical Infrastructure

These servers and networks need to be protected from external influences, such as hackers and malware (destructive external software), that could potentially compromise the efficiency of the institute. The security of physical and virtual infrastructure is crucial to maintaining a technical institute. If the proper security measures are not taken the Institute could be easily crippled by Malware or a hacker who could steal or ransom data by accessing it and threatening to delete it. The best networking option is CEDIA as they have a well-developed cybersecurity sector and significant experience with providing services to institutes.

An effective physical security measure is locking the servers within their controlled room so only the on-campus security and IT teams have access. This, coupled with a development team to make improvements to the systems and programs to make it more secure and updated would make the system not only safer but stronger. This would expand the potential of the institute. Maintaining virtual security is an intensive process, an initial step to acquire security involves creating detailed credentials for users, such as an ID. Creating a school email and password is enough for most students and faculty. The more privileged users such as admins, namely members of the IT team, would have more complex credentials, allowing them to make changes to the school's software. This would allow the institute to limit who is able to access the network to those who are part of the institute. Network security is also an important consideration: keeping the network private and out of public hands is important, as well as maintaining a cybersecurity team. A cybersecurity team would keep watch for security breaches and loopholes in the system. Public access to Wifi and other school networks allows easy entry from outside entities to crucial systems which can then be put in jeopardy and ransomed. An internal cyber security team would be needed as they would be able to locate more in system issues, which general network security as provided by CEDIA would miss.

5.3 Moodle and ELSA

To allow professors to create and upload assignments, we recommend the use of the platform Moodle to administer coursework. This site allows professors to upload assignments and release announcements to students, as well grade assignments. It is used by other institutes, specifically the Quilloac Institute, to manage similar coursework. While the base version is less powerful and less functional than Canvas, CEDIA's packages come with access to ELSA, a plugin which they designed. This program closes the gap between Moodle and Canvas by allowing professors to track student logins, as well as view compiled data on their prior submissions and the time they spend on the site.

Another advantage of working with Moodle is that included in CEDIA's packages are vouchers which can be used to access courses provided by CEDIA for teachers. These courses cover both how to use the specifics of Moodle as well as more general knowledge in how to teach online. There are over a hundred of these courses and the courses will allow the institute to be sure that their professors are qualified and ready to teach both in-person and online.

5.4 Communication and Accountability

Moodle allows for the uploading of announcements, class materials, schedules, and recorded lectures. This allows for the creation of an education program which can be built around students to provide them flexibility. Students will need to form schedules around their classes, work, and personal life to manage their time. Students can access Moodle as their schedule dictates to complete assignments within a required time, and since lectures can be uploaded attendance is not obligatory. These lectures can be recorded ahead of time using Echo360, Google Meets or Zoom, but Zoom is optimal due to its simplicity and easy access through CEDIA. Professors can also hold students accountable by using Moodle to check when students login and submit their assignments. This process allows students to earn an effective education while also managing their personal responsibilities.

Moodle also has built in communication features. This allows professors to engage with their students when offering feedback and assistance. It also provides students with the opportunity to interact with each other when working on group projects or studying together. Student interaction can also be encouraged during the temporary in-person learning sessions. This time lets students form bonds with each other and their professors, so that once learning

becomes remote the program is far less impersonal. They feel comfortable asking questions and meeting with peers from their classes to work on group assignments. The in-person time also lets the students gain hands-on experience since the rest of the learning will be done online. Students can also provide feedback to the institute on how successful each professor is at using these teaching tools to ensure they are receiving the best education possible.

5.5 Student Accessibility

To work on their assignments regularly, students need access to WiFi. Class material such as recorded lectures, books, and homework assignments will be uploaded. This permits students to either view or download it as long as they have access to WiFi. The institute should develop technical learning centers instead of identifying and recommending WiFi hotspots for several reasons. These hotspots will be in public places, and therefore be very loud and distracting to students attempting to study. At night, some sites could also be dangerous or loud, making them difficult places to study for students who have to study at night due to work or family responsibilities. Additionally, students who are commuting from outside of ETAPA's service range could struggle to find WiFi and internet service to access educational material near their homes.

Learning centers are costly, but money can be saved by renting office spaces instead of buying land and building on it. These offices should also be located near bus stops so students would have easy access to them. Technology and educational support can be offered at these sites for the students so they can get help in a safe and focused environment. It also gives a base for administrators to work and provide technical support to teachers and students. Professors would be able to meet with students and plan their classes without distraction in these centers. Students who live far away can come to any one of these sites at the beginning of the week, download the material they need, review it, and ask any questions they may have. They can then return home to their regular work schedules and do everything from there.

This method is only possible, however, if all students at the institute have the physical technology to access online platforms. We recommend that the institute send out a questionnaire to potential students to determine if they need support in this area. The institute can then order the appropriate number of tablets, since they are cheaper than computers, for the number of accepted students that need them. When the institute becomes more successful, more tablets can

be bought. Additionally, the institute should run our provided survey (see Appendix C) to gather data on a more diverse population of potential students. This data can be used to inform the development of student accessibility programs, beyond or in place of our own recommendations.

5.6 Altered Reality

The goal of our sponsor is to include hands-on learning in the curriculum of the institute, though doing this at a distance poses a challenge. Students can't access a physical lab or greenhouse space which they can share with their professor to learn biology or ecology. The solution to this is the use of a VR or AR program. We recommend the institute purchase a small number of headsets to be used by students and professors. When the students are in the distance phase of the program, their professor will be able to visit the institute in-person and use the headset, streaming their point of view to the students like any other virtual lecture. The students will thus become familiar with the AR system and learn more actively. When they return to the school in-person, they will be prepared to use the AR programs to learn in a more hands-on way.

For this program to run, however, there are a number of important considerations. Streaming a virtual world requires that the system render the visual environment as the professor sees it, which places a lot of strain on the network streaming the program and on the device itself. Optimization is the process of managing this load, and there are many steps which can be taken to do so. This can be done by reducing the detail of the assets and not implementing a dynamic lighting system, which accounts for light bouncing within the game. Both changes reduce the detail of the virtual world but also alleviate the strain experienced by the system. Another step towards optimization is using in-view rendering, which is only loading the visuals and content that is only within view of the students or professors. Even with the use of view rendering, we believe that Altered Reality is better suited to the school than Virtual Reality, as the program only creates the pieces of the world which are intractable for the user. Virtual Reality, on the other hand, must load in an entire viewable world, which places much more strain on the system.

When the students visit the school, however, they will be able to apply the things they've learned from watching their professor at a physical lab space or in the same AR program. This use of AR allows the students to learn in a manner more similar to the physical world. For

example, students could access a virtual greenhouse program to work with plants that the institute isn't able to access otherwise.

6.0 Conclusion

Our sponsor, *Instituto Tecnológico Superior "Paul Rivet,"* aims to teach students how to work in the biocommerce and ecotourism industries through education in business, biology, and management. Our research examined how they can do this using a hybrid system, where students attend in-person classes for a week and then spend the rest of their terms online, attending through zoom. We anticipated the needs of students and professors at this institute, and our conclusions will be useful to our sponsor as they begin developing the technology and specifics of their program. We recommended the use of secure technical infrastructure, along with specific programs the institute could use to deliver in-depth, hands-on experience to their students. We focused as well on the needs of the students, who require flexibility and communication from their professors and accessibility to internet service to stay on track while managing their courses. Hopefully, the institute will be able to reach a broad base of students through their classes and increase the access and depth of the field of biocommerce and ecotourism in Ecuador.

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Appendix A: Interviews with Professors/Administrators

These interviews were semi-structured and conducted in either an office or private library cubicle at the University of Cuenca. We first read out the preamble to the subject and then conducted the interview, which was recorded for later transcriptions. Notes were also taken. The notes and audio recording were deleted at the completion of the project, and any material attributed to a subject were first reviewed by them.

English Preamble and Questions:

We are a group of students from the Worcester Polytechnic Institute, in Massachusetts in the USA. We are interviewing professors and administrators to understand your experiences in using virtual schooling. This is a project in collaboration with the Proyecto Instituto Tecnológico Superior "Paul Rivet." Our goal is to provide advice on the technical infrastructure the school should use in their hybrid classes. We would not be able to do this without your insights and experience.

Your participation is totally voluntary, and you can withdraw at any moment. If you prefer, we can include your comments anonymously. However, we would prefer to include your names, as the context will be useful for the readers of our project. You will be given the chance to review any material we attribute to you before its inclusion in our report.

Questions:

1. How much of your teaching is done over zoom?
2. What systems or programs do you regularly use in your teaching?
3. Do you feel you have enough access to technology and the internet, or would you want more?
4. What programs do your students use to effectively learn online?
5. Is there any technology you feel is necessary in your teaching?
6. What could the school do or give you to make your teaching better?
7. What were the problems with remote learning?
8. What were the benefits of remote learning?
9. Do you think your students have enough access to technology or the internet?
10. How is teaching online different from teaching in person?

11. Do you think your students can effectively learn online with their current access to technology?

Spanish Preamble and Questions

Somos un grupo de estudiantes en el Instituto Politécnico de Worcester, en Massachusetts en los Estados Unidos. Estamos realizando entrevistas con profesores y administradores para entender su experiencia con educación virtual. Nuestro objetivo es investigar la mejor manera de enseñar a los estudiantes en una manera virtual. No podemos hacer esto sin su conocimiento en educación.

Su participación es totalmente voluntaria y pueden retirarse en cualquier momento. Si prefiere, podríamos incluir sus comentarios de forma anónima. Sin embargo, preferimos incluir su nombre porque es útil para los lectores entender quién dijo qué, porque sus opiniones y respuestas son importantes. Se tendrán la oportunidad de recursar alguna cita de usted antes de que lo pongamos en el informe.

Preguntas:

1. ¿Qué porcentaje de su enseñanza está hecho en zoom?
2. ¿Usa algunos sistemas o programas regularmente en su enseñanza?
3. ¿Usted siente que tiene tanto acceso a tecnología e internet, o quisiera más?
4. ¿Cuáles tecnologías usan sus estudiantes para aprender en línea?
5. ¿Cuáles son las tecnologías o programas que son absolutamente necesarios para su enseñanza?
6. ¿Qué puede darle la escuela para mejorar su enseñanza?
7. ¿Cuáles son los problemas con el aprendizaje a distancia?
8. ¿Cuáles son los beneficios del aprendizaje a distancia?
9. ¿Piensa usted que sus estudiantes tienen tanto acceso a internet?
10. ¿En qué se diferencia la enseñanza en un aula de la enseñanza mediante zoom?
11. ¿Piensa usted que sus estudiantes pueden aprender eficazmente en línea con su acceso a tecnología actualmente?

Appendix B: Interviews with Technology Experts

These interviews were semi-structured and conducted in either an office or private library cubicle at the University of Cuenca. We first read out the preamble to the subject and then conducted the interview, which was recorded for later transcriptions. Notes were also taken. The notes and audio recording were deleted at the completion of the project, and any material attributed to a subject were first reviewed by them.

English Preamble and Questions:

We are a group of students from the Worcester Polytechnic Institute, in Massachusetts in the USA. We are interviewing technical experts to understand the technology you offer. This is a project in collaboration with the Proyecto Instituto Tecnológico Superior "Paul Rivet." Our goal is to provide advice on the technical infrastructure the school should use in their hybrid classes. We would not be able to do this without your insights and experience.

Your participation is totally voluntary, and you can withdraw at any moment. If you prefer, we can include your comments anonymously. However, we would prefer to include your names, as the context will be useful for the readers of our project. You will be given the chance to review any material we attribute to you before its inclusion in our report.

Questions:

1. What are the different technology packages you offer?
2. Which of the packages do you give to schools, and why?
3. What is the average cost of educational technology packages?
4. Do you have any payment plans for these packages?
5. What are the options for schools who do not have Wifi or cannot afford technology?
6. Do you have any loaning programs for individuals who can't afford purchasing technology?
7. How do you handle updates to your packages?
8. How do you provide technology support?

Spanish Preamble and Questions

Somos un grupo de estudiantes en el Instituto Politécnico de Worcester, en Massachusetts en los Estados Unidos. Estamos realizando entrevistas con expertos en tecnología para entender su experiencia con paquetes de tecnología. Nuestro objetivo es investigar la mejor manera de

enseñar a los estudiantes en una manera virtual. No podemos hacer esto sin su conocimiento en tecnología.

Su participación es totalmente voluntaria y pueden retirarse en cualquier momento. Si prefiere, podríamos incluir sus comentarios de forma anónima. Sin embargo, preferimos incluir su nombre porque es útil para los lectores entender quién dijo qué, porque sus opiniones y respuestas son importantes. Se tendrán la oportunidad de recursar alguna cita de usted antes de que lo pongamos en el informe.

Preguntas:

1. ¿Puede resumir las ofertas y programas de su organización?
2. ¿Qué tipos de sistemas técnicos usted oferta escuelas? ¿Por qué?
3. ¿Que en promedio es la cuesta de paquetes técnicos educacional?
4. ¿Tiene un plan de pagos o préstamo para estos paquetes?
5. ¿Cuáles son las opciones para institutos o escuelas que no tienen WiFi o no pueden gastar un paquete?
6. ¿Tiene programas de préstamo para individuos que no pueden gastar equipos de tecnología?
7. ¿Cómo manejan actualizados sus paquetes?
8. ¿Cómo provee apoyo tecnológico?

Appendix C: Survey with Students

English Preamble and Questions:

This survey is being done as part of a research project run by students of WPI, a university in Massachusetts in the United States. We are researching virtual learning experiences of students of your age group using surveys and interviews. By taking part in this survey, you give consent for us to use your responses. If we quote any responses given in the survey, we will not use your names. You are free to skip any question if you do not wish to provide an answer. We thank you for your time in filling out this survey.

Question 1

At the moment, are you enrolled in a public (fiscal) or private (particular) school?

- Public
- Private

Question 2

After completing *Colegio*, do you plan on:

- Studying
- Working
- Working and Studying

Question 3

If you will be studying after *Colegio,* what are your study plans?

- Attend a university or other higher learning institution
- Attend a technical institute
- Obtain any other non-college degree
- Other:_____

Question 4

If you plan on working while attending school, how many hours do you expect to be available for schoolwork each week?

- 1-5
- 6-10
- 11-15
- 20-25
- 26-30
- 30 or more

Question 5

If you are not planning on attending a university or higher institute, which of the following would make you consider applying? Select all that apply.

- A scholarship
- Virtual classes
- A class schedule which worked around other commitments you might have
- Assistance in accessing the internet or other class resources from your home
- Other:_____

Question 6

Do you have access to internet connection at home?

- Yes
- No

Question 7

If you have access to an internet connection at home, is it reliable?

- All of the time
- Most of the time
- Usually
- Some of the time
- Rarely

Question 8

Have you ever used any online program in your schooling?

- Microsoft Office
- Canvas/EVA
- Zoom
- ELSA
- Others: _____

Question 9

If you answered yes, what platforms did you use and would you use it again?

Platform_____ Ease of Use_____
Platform_____ Ease of Use_____

Question 10

What access to devices do you have at home?

- Each person in my family has a computer, tablet, or other device
- Each person in my family shares one or two computers, tablets, or other devices
- Each person in my family shares one computer, tablet, or other device
- No one in my family has a computer, tablet, or other device
- Other_____

Question 11

What access to cellular connection do you have?

- I have a cell phone/smartphone with consistent cellular connection
- I have a cell phone/smartphone with irregular connection
- I have a cell phone/smartphone but need WiFi to connect to the internet
- I do not have a cell phone/smartphone

Question 12

If you cannot access WiFi at home, are you willing to move to a location close to your home to access the internet to study?

- Yes
- No

Question 13

Do you have any other comments for us?

Spanish Preamble and Questions:

Esta encuesta se realiza como parte de un proyecto de investigación dirigido por estudiantes de WPI, una universidad en Massachusetts en Estados Unidos. Estamos investigando experiencias de aprendizaje virtual de estudiantes de su grupo de edad. Al participar en esta encuesta, usted da su consentimiento para que utilicemos sus respuestas. Si citamos sus respuestas en la encuesta, no utilizaremos sus nombres. Usted es libre de saltarse cualquier pregunta si no desea dar una respuesta. Le agradecemos su tiempo al completar esta encuesta.

Pregunta 1

¿Está asistiendo a un Colegio fiscal o particular?

- Fiscal
- Particular

Pregunta 2

Después del Colegio, planea

- Estudiar
- Trabajar
- Trabajar y Estudiar

Pregunta 3

Si va a estudiar después del Colegio, ¿cuáles son sus planes?

- Asistir una universidad o otro instituto superior
- Asistir a un instituto técnico
- Obtener otro tipo de calificación
- Otro:_____

Pregunta 4

Si planea trabajar mientras estudia, ¿cuántas horas espera estar disponible para tareas escolares cada semana?

- 1-5
- 6-10
- 11-15

- 20-30
- 30 o más
- No sé

Pregunta 5

Si no planea asistir a una universidad o instituto superior, ¿cuáles de las siguientes opciones le haría considerar matricularse? Seleccione todas las que correspondan

- Una beca
- Clases virtuales
- Un horario de clases que se adapte a cualquier otro compromiso que pueda tener
- Ayuda en acceder al internet o a otros materiales de clases desde casa
- Otro:_____

Pregunta 6

¿Tiene acceso al WiFi en su casa?

- Sí
- No

Pregunta 7

Si tiene acceso a WiFi en su casa, ¿qué tan confiable es?

- Funciona todo el tiempo
- Funciona por la mayoría del tiempo
- Funciona la mitad del tiempo
- Funciona algunas veces
- Funciona casi nunca

Pregunta 8

¿Alguna vez ha utilizado algún programa en línea en su educación?

- Microsoft Office
- Google Meets
- Moodle
- Canvas/EVA
- Zoom
- ELSA
- Otros: _____

Pregunta 9

Si respondió que sí, ¿usaría algunas de esas plataformas otra vez?

Plataforma _____ ¿Porque?_____
Plataforma _____ ¿Porque?_____

Pregunta 10

¿Cuántos dispositivos tiene en su casa que pueden acceder el internet?

- Cada persona en mi familia tiene una computadora, tablet, o otro dispositivo

- Cada persona en mi familia comparten una o dos computadoras, tablets, o otros dispositivos
- Cada persona en mi familia comparten una computadora, tablet, o otro dispositivo
- Nadie en mi familia tiene una computadora, tablet, o otro dispositivo
- Otro:_____

Pregunta 11

¿Qué tipo de conexión para su celular tiene en casa?

- Tengo un móvil con conexión de datos consistente
- Tengo un móvil con conexión de datos irregular
- Tengo un móvil pero necesito WiFi para conectar al internet
- No tengo un móvil

Pregunta 12

¿Si no puede acceder a WiFi en casa, ¿está dispuesto a visitar un lugar cercano a su casa para acceder a Internet y estudiar?

- Sí
- No

Pregunta 13

¿Tiene algunos otros comentarios?

_____

Appendix D: Findings and Recommendations Infographic