Gamification in a public school environment through a continuous improvement mobile application

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Master's Dissertation

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Abstract

This master's thesis investigates implementing and evaluating a gamified mobile application intended to improve the educational experience of students, teachers, and operational assistants at Escola Básica e Secundária de Campo. The application's primary goals were to increase students' motivation, improve their behavior in and out of the classroom, and boost their overall school performance. The application facilitated the administration and monitoring of an interclass competition in ninth grade, in which students earned points based on performance indicators and weekly classroom conduct. The application provided a calendar for test registration, real-time point tracking, classification tables, and opportunities to earn bonus points for exemplary conduct and participation in school tournaments.

The study utilized a Decision Support System (DSS) component within the application, which continuously monitored and recorded various quantitative and qualitative indicators of the class, such as student conduct, points gained from evaluation assessments, and upcoming class events. The DSS assessed the performance of each class over the weeks, allowing teachers to identify deviations that could indicate problem areas, such as declining grades related to class behavior. The teacher could proactively intervene to address these deviations and solve any potential problems.

The project's results demonstrated its efficacy in enhancing the participants' educational experience. Both students and teachers/operational assistants gave the application solid Net Promoter Scores (19 and 27, respectively), indicating a positive reception. Post-implementation surveys revealed increased student motivation and behavior improvement, with fewer students indicating low motivation. Teachers and operational assistants observed improvements in student behavior, indicating a positive impact on the learning environment. Students developed individually and collectively due to the competition and point system, which nurtured peer support and teamwork. Preliminary evidence suggested an improvement in academic performance, however, additional long-term research is recommended for conclusive proof.

The study also identified a few obstacles, such as technical difficulties in some classes and variable compliance rates among teachers. These findings emphasize the significance of addressing these issues in future initiatives by providing a more robust technological infrastructure, enhancing accessibility, and incentivizing teachers' consistent platform usage.

In conclusion, this research demonstrates a successful implementation of a mobile application for continuous improvement in a public school. The results suggest that the application showed great potential in enhancing the educational experience, motivation, behavior, and possibly academic performance. This study offers valuable insights and recommendations for future initiatives that will build upon this foundation and produce more effective and enriching educational experiences.

Resumo

Esta tese de mestrado investiga a implementação e avaliação de uma aplicação móvel gamificada destinada a melhorar a experiência educativa de alunos, professores e assistentes operacionais da Escola Básica e Secundária de Campo. Os principais objectivos da aplicação foram: aumentar a motivação dos alunos, melhorar o seu comportamento dentro e fora da sala de aula e melhorar o seu desempenho escolar. A aplicação facilitou a gestão e o acompanhamento de um concurso inter-turmas no nono ano, no qual os alunos ganharam pontos com base em indicadores de desempenho e no comportamento semanal na sala de aula. A aplicação forneceu também um calendário para o registo dos testes, o acompanhamento dos pontos em tempo real, tabelas de classificação e oportunidades para ganhar pontos de bónus por conduta exemplar e participação em torneios escolares.

O estudo utilizou uma componente de Sistema de Apoio à Decisão (SAD) dentro da aplicação, que monitorizava e registava continuamente vários indicadores quantitativos e qualitativos da turma, como a conduta dos alunos, os pontos ganhos com os elementos de avaliação e os próximos eventos da turma. O SAD avaliou o desempenho de cada turma ao longo das semanas, permitindo aos professores identificar desvios que poderiam indicar áreas problemáticas, como a diminuição das notas relativas ao comportamento da turma. O professor pode, assim, intervir proativamente para abordar estes desvios e resolver quaisquer problemas potenciais.

Os resultados do projeto demonstraram a sua eficácia na melhoria da experiência educativa dos participantes. Tanto os alunos como os professores/assistentes operacionais atribuíram à aplicação sólidos Net Promoter Scores (19 e 27, respetivamente), indicando uma receção positiva. Os inquéritos pós-implementação revelaram um aumento da motivação dos alunos e uma melhoria do seu comportamento, com menos alunos a indicarem pouca motivação. Os professores e as assistentes operacionais observaram melhorias no comportamento dos alunos, o que indica um impacto positivo no ambiente de aprendizagem. Os alunos desenvolveram-se individual e coletivamente devido à competição e ao sistema de pontos, que fomentou o apoio dos colegas e o trabalho de equipa. As evidências preliminares sugerem uma melhoria no desempenho académico, no entanto, recomenda-se uma investigação adicional a longo prazo para uma prova conclusiva.

O estudo também identificou alguns obstáculos, tais como dificuldades técnicas e alguma variabilidade no cumprimento da submissão dos registos pelos professores. Estas questões devem ser melhoradas em iniciativas futuras, fornecendo uma infraestrutura tecnológica mais robusta, melhorando a acessibilidade e incentivando a utilização consistente da plataforma pelos professores.

Em conclusão, esta investigação demonstra uma implementação bem-sucedida de uma aplicação móvel para melhoria contínua numa escola pública. Os resultados sugerem que a aplicação mostrou um grande potencial para melhorar a experiência educativa, a motivação, o comportamento e, possivelmente, o desempenho académico. Este estudo oferece informações e recomendações valiosas para iniciativas futuras que se baseiem nesta base e produzam experiências educativas mais eficazes e enriquecedoras.

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To my friends who have been my greatest source of happiness these past few months. I wish you all the best and apologize for the times I couldn't be there. I promise to make it up to you.

"The most beautiful things in the world are dictated by madness and written by reason"

André Gide

Contents

Acronyms and Symbols

AEC	Agrupamento de Escolas de Campo
AM	Agile Methodology
DSS	Decision Support System
ESBC	Escola Básica e Secundário de Campo
ITS	Intelligent Tutoring Systems
KI	Kaizen Institute
NPS	Net Promoter Score
OA	Operational Assistant
PDCA	Plan-Do-Check-Act
SETA	Security, Education, Training, and Awareness
SPC	School Principal Coordinator
SSP	School Strategic Plan

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Chapter 1

Introduction

This master's thesis was written for the Masters's degree in Industrial Engineering and Management of Faculdade de Engenharia da Universidade do Porto. The Introduction chapter of this dissertation serves as a roadmap, providing clarity and direction to the research endeavor. It was meticulously structured into five sub-chapters: Project Description, Project Motivation, Main Objectives, Methodology, and Document Structure.

1.1 Project Description

The Project Description served as the starting point, providing a general overview of the project and setting the context. This project resulted from a pro bono project established between a school group (Agrupamento de Escolas de Campo) and the Kaizen Institute (KI).

Agrupamento de Escolas de Campo, located in Valongo, Porto, is a public school group that harbors five elementary schools (Escola Básica Azenha, Escola Básica Balselhas, Escola Básica Moirais, Escola Básica Outeiro, and Escola Básica Retorta) and one main school, Escola Básica e Secundária de Campo (EBSC), that contains elementary, middle, and high school students.

This pilot project was developed in the 9th grade at EBSC and counted with the contributions of all 140 9th grade students from 6 different classes (9ºA, 9ºB, 9ºC, 9ºD, 9ºE, and 9ºF), their 26 professors distributed across 12 different lectured subjects, and 2 school operational assistants (OA) who are allocated to the pavilion where the classes take place.

To continuously improve the organization, the concept of "gamification" was introduced in this school pilot, through a mobile application that allows inter-class competitions in which teachers, students, and staff are involved to achieve the best results. The project had a strong programming component and intended to establish a culture of continuous improvement in the organization. The school ensured the collection of any necessary data and arranged weekly in-person meetings with a School Principal Coordinator (SPC) to assess the project's evolution and provide improvement feedback.

This project is in total syntony with the Kaizen Institute's continuous improvement culture. KI's continuous improvement culture promotes sustained development and organized issue solutions in new scenarios. Despite showing several advantages for both people and companies, this ideology has yet to be implemented to its full potential in a school environment. The first steps were given in other schools in the Porto area in the past, where the Kaizen philosophy was implemented in a classroom setting. The best example of this was the work developed in Escola Básica do Falcão by the Kaizen Institute, in which the Lean and Kaizen methodologies enabled teachers and students to work together to tackle recurrent problems in a structured manner (Pimenta, 2022).

The KI continued to collaborate with schools to establish similar projects. One of those schools was Agrupamento de Escolas de Campo (AEC) which was developed:

- Lean problem-solving approaches in a classroom setting and teachers' weekly team meetings, improving the alignment between both entities (teachers and students);
- Tools using *Microsoft Excel* and *Microsoft Teams* to create a better structure for meetings in the third cycle, increasing their productivity while reducing the total meeting time.

After describing the project, it was mandatory to answer the crucial question of 'why' the project is of significance (the Project's Motivation), which delineates the impetus behind the research.

1.2 Project's Motivation

After the Kaizen Institute started applying continuous improvement methodologies at ESBC, student engagement rates were identified as one of the main opportunities for improvement at the school. From this emerged the need to reflect on the subject of student engagement and to develop mechanisms to improve this aspect.

Student engagement is the degree of commitment, enthusiasm, and drive a student show in their academic work and learning environment. Alexander Astin's work from the 1980s is where this idea first appeared, and it has subsequently received much attention in education. Higher levels of student engagement have been linked to better academic achievement, lower dropout rates, and increased social and emotional well-being, according to several international studies (Moreira et al., 2018).

According to research conducted in Portugal, school support for learning increases student engagement, which boosts academic success. Academic performance, however, moderates the effect of school assistance on engagement, so students who perform better academically are likely to be more engaged regardless of the quantity of help offered by the school. This shows that involvement is influenced by both internal and external factors, such as earlier academic success (Moreira et al., 2018).

Unfortunately, cases of student demotivation are increasingly common in Portugal. According to a 2022 collaborative study by the World Health Organization (WHO) called "Health Behaviour

in School-aged Children" (HSBC), Portugal is one of the countries where most students report having a poor relationship with education. A third of young people don't like going to school, a percentage that has been increasing in recent years, study data indicate (Guedes et al., 2023).

According to the data revealed in this study, carried out every four years in 51 countries, the percentage of teenagers in Portugal who said they liked school was 87% in 1998. It dropped significantly throughout the years, reaching a value of 70.4% in 2018 and 69.7% in 2022, as shown in Figure 1.1. The decline is so steep that Portugal is now among the five countries that have the least liking for school.

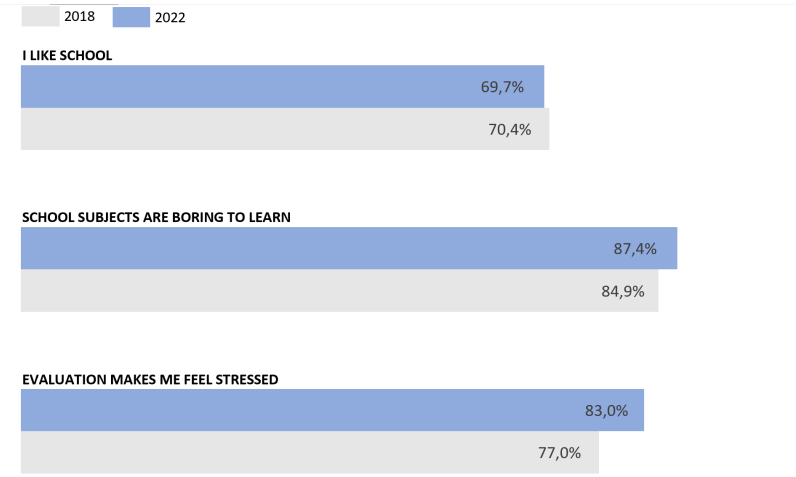

Figure 1.1: Portuguese student's relationship with school according to HSBC/WHO

The same figure showcases that among the main difficulties felt by the students is the subject matter, which is considered to be "boring" (87.4%). Reference to stress caused by assessments has also increased: 77% mentioned it in the last survey, and it's now 83%.

To ensure a sustainable improvement in students' motivational indices, there is a need for initiatives that aim to increase student engagement and cultivate a competitive and motivating learning environment.

1.3 Main Objectives

This project's primary objective was to enhance the educational experience of those who directly collaborate or work with the institution: students, teachers, and operational assistants. In addition to this goal, it emphasized the need of increasing students' motivation levels, their behavior in and out of the classroom, and their school performance. To this end, the spirit of helping each other within the class was considered a priority, with the best-performing students mentoring the worst-performing students to ensure a positive evolution of the school grades of these students. The improvement is to be measured through the:

- Increased Net Promoter Score (NPS) of the students involved;
- Increased NPS of the Professors involved;
- Increased NPS of the involved staff;
- Improved student behavior in and out of the classroom;
- Increased motivation of students with poorer academic results to increase academic performance.

Net Promoter Score (NPS) is a commonly employed metric for measuring consumer loyalty and satisfaction. It is predicated on a single question: "On a scale of 0 to 10, how likely are you to recommend our company/product/service to a friend or colleague?" The respondents are then classified into three groups: Promoters (scores 9 to 10), Passives (scores 7 to 8), and Detractors (scores 0 to 6). Subtracting the percentage of Detractors from the percentage of Promoters yields the Net Promoter Score. The final score can range from -100 (if all customers are Detractors) to +100 (if all customers are Promoters). In general, high NPS is regarded as an indication of customer satisfaction and loyalty.

The effectiveness of the project was assessed using two different *Microsoft Forms* that were designed specifically for this purpose, one catered to students and the other for teachers and operational assistants. These surveys were used at two critical points during the project. Initially, at the start of the project, these *Forms* served to capture the current state diagnostic, giving a clear understanding of the baseline motivational indices of these vital stakeholders. Following this, the same *Forms* were used after the project, this time to evaluate the impact of the developed continuous improvement mobile application on these motivational indices and the NPS.

To summarize, the project's goals are not only to enhance the educational experience of all involved but also to create a supportive and collaborative learning environment. The drive to improve the NPS of students, teachers, and staff, as well as student behavior and motivation were clear indicators of these objectives. These goals were monitored and assessed using specific tools, such as surveys, and at strategic points during the project to provide a comprehensive view of the project's effectiveness.

In the next sub-chapter, 'Methodology', it was described the specific methods employed to achieve these objectives: from how the project was structured all the way through the different techniques used in the development and implementation phases of the mobile application and the main conclusions and results extracted in the process.

1.4 Methodology

The project lasted 18 weeks and was divided into two major phases, both structured according to the A3 problem-solving and Agile methods: a first phase called the Planning Phase includes the

current state diagnostic and the assessment of the major implementation risks of the app; a second phase entitled the Do, Check, Act phase that consists of the development and implementation stage of the application, as well as the follow-up actions that acted as stimulants of the app improvement in terms of its design and functionalities.

The Planning phase started with the formal description of the project's format: school years involved, teaching and non-teaching staff involved, primary goals, frequency of meetings, and main mechanisms for feedback exchange.

Then, with the help of the SPC, the current state of the school was outlined (with particular emphasis on the main problems affecting the project participants), the ideal state to be achieved, and the most relevant risks and challenges for the pilot implementation. According to the agile project management methodology, the project was developed in an 18-week project schedule organized into sprints.

After the project was meticulously outlined, it was possible to begin the solution design stage, titled the "Do, Check, Act" phase. This stage was subdivided into two that contain multiple synergies: the definition of the application's functionalities and the possible free software options capable of satisfying these requirements in the required time frame.

To monitor the effectiveness of the project, two *Microsoft Forms* were developed and sent to all participants in the pilot: one for teachers and operational assistants and another for the 9th-grade students, measuring their levels of satisfaction and engagement with the school. The same Forms were then sent at the end of the project to assess the evolution of these parameters after the implementation of the application. The increase in student behavior and academic results can also be measured through the application since the teachers' input instances of summative assessment and social evaluation.

1.5 Document Structure

This dissertation is divided into six chapters. The first chapter introduces the dissertation project, highlighting the motivation behind it, the scope of the pilot, the methodology followed, and the main objectives to be achieved.

In the second chapter, a theoretical introduction is made through a specific and relevant literature review of the dissertation.

The third and fourth chapters portray the Planning and the Do, Check, Act phases. The first 11 weeks of the project started with the definition of the project's requirements and ended with the beginning of the implementation of the application in the field. The remaining seven weeks of the project were dedicated to the second phase, which consisted of an iterative process of improving the design and functionality of the application and extracting the results.

In chapter five, these results are presented, with a reflection on them being made in chapter six, alongside proposals for future research opportunities.

Chapter 2

Literature Review

This chapter provided a comprehensive literature review that informed the project and served as the conceptual basis for the methodologies and strategies implemented. It started with a reflection on the Kaizen Methodology, its origins, and its contrast with Lean methodologies, emphasizing the philosophy of continuous improvement.

Then, it was examined the Lean Transformation management strategy, including the Plan-Do-Check-Act (PDCA) cycle and its practical applications, as well as the A3 problem-solving technique. The focus then shifted to one of the dissertation's central topics, Decision Support Systems (DSS), Agile Methodology, and the application of gamification in education. The origins and applications of DSS were then analyzed particularly its educational applications. The contribution of the Agile Methodology to project structure was also highlighted. In a subsequent subchapter, the critical interaction between student and teacher engagement was examined as well as its effect on academic performance.

The chapter concluded with a discussion on the application of gamification in education, outlining its effective implementation in a variety of contexts.

2.1 Kaizen Methodology

Kaizen is the Japanese word for "continuous improvement." Improvement is implied to engage employees and managers and to require relatively little financial investment. According to the kaizen principle, we should constantly strive to improve all aspects of our lives, whether they be professional, social, or personal (Imai, 2012).

This is the same management paradigm that Toyota has created over the last 60 years, where daily improvement is the norm. Soon after the Second World War, Toyota began to apply kaizen. There are numerous accounts of Japan's significant efforts to improve its economic competitiveness following World War II, particularly in light of Germany's and the United States' high levels of productivity. Toyota wanted to contribute to the expansion of the Japanese auto industry. After more than 60 years of kaizen, Toyota is currently the market leader in the automotive sector

worldwide. The inventive ideas of Taiichi Ohno at Toyota, who created a new method of organizing production and logistics known as the "Toyota Production System (TPS), also known as "Lean Transformation," which is based on the creation of a flow of materials and information, can be seen as being influenced by kaizen (Coimbra, 2013).

Although kaizen and lean are frequently confused and viewed as one, it is important to recognize that they are two separate concepts. The fundamental distinction between the kaizen concept and lean transformation is that the latter takes a larger, more thorough approach to ongoing development. The lean transformation aims to establish a completely new way of conducting business, whereas kaizen is concentrated on making tiny, incremental changes to certain processes or tasks. It entails reevaluating the entire value chain, from raw materials to completed goods, and looking for methods to reduce waste and boost effectiveness at every stage (Ortiz, 2010).

2.2 Lean Transformation

Lean transformation is a management strategy that strives to increase a company's operational effectiveness and efficiency by using several guidelines, instruments, and methods intended to promote a continuous improvement culture. Scientific studies in this area show that, of all the possible frameworks to be used, those that focus on bottom-up approaches tend to be more successful. When implementing lean, a top-down strategy alone is insufficient to change the culture of an organization. On the other hand, a bottom-up strategy is just as crucial to the success and sustainability of a lean transformation program or the establishment of a learning organization, in general, (Chay et al., 2015).

One of the problem-solving methodologies most associated with lean transformation is the Plan-Do-Check-Act (PDCA) cycle. This cycle, which is sometimes referred to as the Deming cycle, is a crucial element in the lean transformation process and possesses four steps: Plan (identify a problem and design a solution), Do (implement the solution), Check (measure the outcomes), and Act (standardize the solution or make further changes). The PDCA cycle was first introduced by Imai (1986) to emphasize the prevention of error recurrence by establishing standards and the ongoing modification of those standards (Imai, 1986).
Another important instrument in the lean transformation process is the A3 problem-solving technique. It is a methodical strategy for solving problems that entails presenting data on a single sheet of A3 paper. With the aid of this method, the issue can be more clearly defined, the source of it can be found, remedies can be developed, evaluated, and an implementation plan can be made (Sobek II and Smalley, 2011). The A3 methodology is a well-known tool in lean organizations to promote continuous improvement since it helps teams work together and communicate effectively. Several developments of the original A3 thinking approach template have been made throughout the years to assist decision-making in a lean environment (Mohd Saad et al., 2013b).

2.2.1 PDCA

By the 1960's the PDCA cycle in Japan had evolved into an improvement cycle and a management tool (Imai, 2012). Decades later, applications of the PDCA cycle have expanded into many areas that impact a project of this nature. Two of them are project management and education environment.

Due to its success in regulating dynamic project targets, the PDCA cycle management paradigm has been widely used in engineering project management. The PDCA method is frequently used to achieve project management control in challenging and protracted projects since it is a classic example of dynamic control principles. In the industry, PDCA is well-respected for its capacity to advance rational and standardized project management techniques as a result (Zhang and Li, 2006). The PDCA cycle approach can actively contribute to increasing project management standards and practices by being used in engineering project management. This approach aids in ensuring that project management stays dynamic and that the management of project targets remains its central concern. As PDCA has been widely embraced in engineering project management on both a domestic and international level, it has emerged as a key tool for advancing rational and standardized project management procedures (Ren et al., 2015).

Even though there is no register of a kaizen digital application applied in a school environment, the concept of continuous improvement is no stranger to the education realm. The PDCA Cycle of Continuous Quality Improvement offered a methodical way to gradually advance toward the objective to address the issue of imparting the skills, knowledge, and other abilities regarded as appropriate for graduates who are prepared to start their professional careers (Knight and Allen, 2012). Previous research also demonstrated that the PDCA Cycle requires a commitment and "continuous conversations with as many stakeholders as possible", in a constant and standardized manner (of Teachers of English and of Writing Program Administrators, 2008). Other authors maintain that those stakeholders should only include professionals and academics (Joshi, 2009).

Another strong example of how the PDCA principle can be applied in a learning setting, not only to obtain good, standardized results but also as a cultural changer, is the application of the PDCA cycle to Security, Education, Training, and Awareness (SETA) programs (de Casanove et al., 2022). A SETA program increases awareness of information systems security and plays a crucial role in achieving a strategic equilibrium between the prevention and response paradigms. It aims to change people's behavior toward safety, which necessitates altering their security culture (Silic and Lowry, 2020). To do this, the program should instill intrinsic motivation in participants, to raise security awareness (Siponen, 2000).

The Deming wheel, often referred to as the continuous improvement wheel, is an idea that exemplifies William Edwards Deming's PDCA principle, which attempts to enhance and optimize goods, procedures, or services while minimizing losses. The PDCA method entails repeatedly going through Plan-Do-Check-Act and moving up the process-improvement incline toward the targeted result. Deming's illustration, figure also features a wedge that stands in for the quality

system created by earlier improvement efforts and keeps the process from going backward (Moen, 2009).

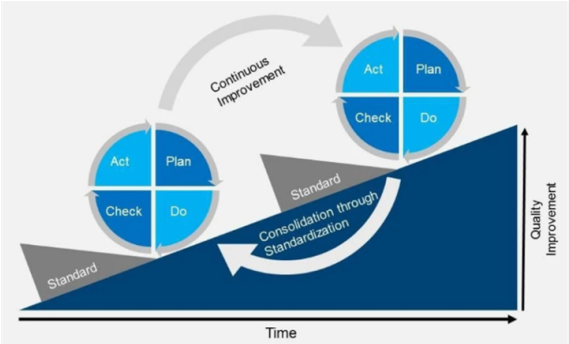

Figure 2.1: PDCA Process Chart Continuous Improvement Cycle.
Adapted from "Moen, R., and Norman, C., The History of the PDCA Cycle, 2009."

By reducing the likelihood of failure and avoiding making the same mistakes twice, we may use this technique to create more effective SETA programs. By incorporating the PDCA principle into SETA projects, we can establish policies, encourage a security culture, and stop the program from regressing by drawing on our expertise from earlier improvement processes. Therefore, a SETA program created to foster intrinsic motivation is more likely to be effective over the long run (de Casanove et al., 2022).

A parallel can be drawn between these mentioned programs and the dissertation project since its main objective is improving the participants' motivation and involvement rates.

2.2.2 A3 Problem-Solving Method

The A3 Problem-Solving Methodology is a structured approach to problem-solving that requires the creation of a one-page document (known as an A3) that concisely and visually depicts the problem, analysis, and proposed solution(s). It is composed of the following 9 steps:

1. **Problem Identification:** This initial step involves identifying and clearly defining the problem that needs to be solved.

2. **Problem Clarification:** Here, the problem is analyzed in detail, breaking it down into smaller, manageable parts. It involves understanding why the problem is a problem, who it impacts, and how it impacts the process or system.

3. **Target Setting:** In this step, the desired outcome or goal is set. What does success look like? What are the measurable outcomes we hope to achieve by solving the problem?

4. **Root Cause Analysis:** Here, the aim is to identify the underlying cause(s) of the problem. This often involves asking "Why?" multiple times until the root cause is revealed.

5. **Countermeasure Proposal:** Based on the root cause, potential solutions are proposed. These are ideas or actions that can directly address and resolve the root cause identified in the previous step.
6. **Countermeasure Implementation:** Here, the proposed solution(s) are implemented. It's important to track and document the implementation process, noting any adjustments or changes made along the way.
7. **Effects Confirmation:** This step involves assessing the results of the solution. Did it solve the problem? Are there any unforeseen consequences or new problems that arose as a result of the solution?
8. **Standardization:** If the countermeasure was effective, the new process or solution becomes the new standard. This often involves updating documentation, training, or systems to reflect the new method or process.
9. **Follow-up Plan:** Finally, a plan for monitoring and follow-up is developed to ensure that the solution continues to be effective over time. It often involves scheduling future evaluations or audits.

Each step of the A3 methodology is designed to encourage clear thinking, structured analysis, and effective communication. The ultimate goal is continuous improvement and organizational learning (Sobek II and Smalley, 2011). Toyota created the A3 approach to standardize problem-solving across the organization (Schwagerman and Ulmer, 2013). In recent years, the methodology has gained popularity outside of the automotive industry and has been implemented in numerous contexts, such as healthcare, education, and product development (Buckley et al., 2021; Loyd et al., 2010; Mohd Saad et al., 2013a; Saad et al., 2013; Schwagerman and Ulmer, 2013).

In a healthcare context, a scientific study compared the effects of design thinking and A3 problem-solving on resident attitudes toward system change and illustrated the A3 methodology (Buckley et al., 2021). In this investigation, the A3 method was utilized to structure problem-solving efforts aimed at enhancing the patient discharge procedure. The A3 document served as a visual aid that assisted in aligning stakeholders around the problem and potential solutions, resulting in increased acceptance and implementation of the proposed changes.

Similarly, Loyd et al. (2010) described the incorporation of A3 thinking as an academic communication standard for engineering undergraduates. In this investigation, student reports on their senior design projects followed the A3 format, which enabled them to communicate the problem, analyze it, and propose solutions to stakeholders, including faculty and industry partners, plainly and concisely.

As demonstrated in Mohd Saad et al. (2013a) and Saad et al. (2013), the A3 approach has also been utilized in product development to facilitate problem-solving efforts in lean product and process development. The A3 document served as a visual aid for identifying and prioritizing problems, analyzing fundamental causes, and implementing solutions.

In conclusion, the A3 Problem-Solving Methodology can be a useful instrument for structuring a project and developing a software application. The A3 document can convey the problem, analysis, and proposed solution(s) to stakeholders, such as developers, educators, and students, clearly and concisely. In addition, the A3 methodology is complemented by the PDCA tool, which can be used to improve the A3 document's proposed solutions perpetually.

2.3 Decision Support Systems

2.3.1 Origin and Main Applications

Decision Support Systems (DSS) are computer-based systems designed to assist users in decision-making processes by providing timely and accurate data. The origins of DSS can be traced back to the 1960s when computers were first utilized for data analysis and decision support (Turban, 1995). Over time, DSS has evolved, leading to the development of a wide range of decision-making strategies and tools applicable to various business disciplines.

One significant advantage of DSS is its ability to swiftly and accurately process large amounts of data, providing decision-makers with up-to-date information. This feature is particularly valuable in sectors that demand prompt decision-making, such as healthcare, banking, and transportation (Turban, 1995). By leveraging DSS, organizations can access current data, enabling more informed decision-making. Additionally, DSS can automate decision-making processes, reducing the reliance on direct human involvement and minimizing the likelihood of errors.

Another benefit of DSS is its capability to integrate data from diverse sources, including databases, spreadsheets, and other applications. By integrating data from multiple systems, decision-makers can gain a deeper understanding of complex systems and identify patterns and trends that may not be immediately apparent (Fick and Sprague, 2013). This comprehensive data integration enhances decision-making processes and facilitates more accurate assessments of complex situations.

However, the implementation of DSS is not without challenges. One significant hurdle is the integration of DSS into existing processes and systems. This integration may require substantial investments in hardware, software, and personnel, as well as modifications to existing workflows and business processes (Turban, 1995). Organizations must carefully consider the compatibility and integration aspects when implementing DSS to ensure a smooth transition and maximize the system's effectiveness.

Another potential disadvantage of DSS is the risk of complexity, which can make the system challenging to use and interpret. Decision-makers may struggle to understand the information presented by DSS, leading to incorrect or insufficient conclusions (Fick and Sprague, 2013). To address this challenge, careful attention must be given to the design and usability of DSS interfaces, ensuring that they are intuitive and user-friendly, and provide clear and meaningful insights to support decision-making processes.

In summary, DSS offers numerous advantages in decision-making processes by providing timely and accurate data, automating tasks, and facilitating data integration. However, challenges exist in terms of integration into existing systems and the potential complexity of the system. By understanding these advantages and challenges, organizations can make informed decisions when implementing DSS, considering factors such as investment requirements, system compatibility, and user interface design (Turban, 1995; Fick and Sprague, 2013).

2.3.2 In the Educational Sector

The educational sector has witnessed the application of Decision Support Systems to enhance various aspects of teaching, learning, and administration. By leveraging DSS in educational settings, educators and administrators can make data-driven decisions, improve instructional strategies, and provide personalized support to students.

One of the key areas where DSS has been applied in education is in the development of intelligent tutoring systems (ITS). These systems utilize DSS techniques to provide personalized instruction tailored to individual students' needs, preferences, and learning styles. By analyzing data on student performance and behavior, ITS can offer targeted interventions, adaptive learning paths, and real-time feedback to enhance student engagement and academic success (Liang et al., 2005).

In addition to ITS, DSS has also been instrumental in supporting decision-making processes related to resource allocation, curriculum development, and school management. By integrating data from various sources, such as student information systems and assessment results, DSS can assist administrators in optimizing resource allocation, identifying areas of improvement in the curriculum, and enhancing school performance (Burstein et al., 2008; Fick and Sprague, 2013).

The design of user interfaces plays a critical role in the successful implementation of Decision Support Systems in the educational sector. Intuitive and user-friendly interfaces are essential for ensuring the usability and effectiveness of DSS tools. Effective interface design enables teachers and administrators to access and interpret data, facilitating their decision-making processes easily. By following interface design principles outlined in the relevant literature, DSS applications in education can provide a seamless and engaging user experience (Dong and Srinivasan, 2012).

Moreover, the use of DSS in guidance and counseling services is beneficial for students in making informed decisions about their educational and career paths. For example, a case study presented by Cil et al. (2014) demonstrates the implementation of a DSS that provided personalized guidance, considering students' interests, abilities, and goals. This resulted in improved decision outcomes and increased student satisfaction (Cil et al., 2014).

In conclusion, the application of DSS in the educational sector offers numerous advantages, including personalized instruction through intelligent tutoring systems, support for decision-making processes related to resource allocation and curriculum development, and user-friendly interfaces

that enhance usability. The integration of DSS principles can also empower teachers and operational assistants, enhance decision-making processes, and promote student growth and success (Burstein et al., 2008; Fick and Sprague, 2013; Liang et al., 2005).

2.4 Agile Methodology

The Agile Methodology (AM) for Project Management and Software Development has gained significant popularity and recognition over the years. This iterative and flexible approach to managing projects and developing software has revolutionized how organizations tackle complex tasks. The origins of the AM can be traced back to the early 2000s, with the publication of the Agile Manifesto. This manifesto, formulated by a group of software development practitioners, emphasized the importance of collaboration, flexibility, and responsiveness in project management and software development processes (Whiteley et al., 2021). The Agile Methodology evolved as a response to the limitations of traditional waterfall approaches, which often led to rigid and slow-paced development cycles.

Since its inception, the AM has found wide-ranging applications beyond software development. It has been successfully implemented in sectors such as manufacturing, healthcare, finance, and education, to name a few. For instance, the combination of Lean and Agile methodologies, along with the integration of Industry 4.0 technologies, has been shown to bring competitive advantages to manufacturing processes (Ding et al., 2023). The Agile Methodology allows organizations to adapt quickly to changing market demands, improve efficiency, and enhance customer satisfaction.

2.4.1 In Software Development

The AM for Software Development emphasizes flexibility, collaboration, and iterative development to deliver high-quality software solutions. Within Agile Software Development, different methodologies and trends have emerged, such as *Scrum*, *Kanban*, and *Extreme Programming (XP)*, each with its own set of principles and practices. These methodologies offer distinct approaches to managing projects and teams.

Scrum is characterized by its time-boxed iterations called sprints, where development work is planned, executed, and reviewed in short cycles as illustrated in Figure 2.2. Kanban, on the other hand, focuses on visualizing work and limiting work in progress to improve flow and efficiency. Extreme Programming (XP) emphasizes continuous feedback, test-driven development, and close collaboration between developers and stakeholders, as seen in Figure 2.3 (Al-Saqqa et al., 2020).

One of the primary advantages of the AM is its ability to adapt to changing requirements and uncertainties in software development projects. By embracing iterative and incremental development, Agile allows for frequent feedback and continuous improvement throughout the development process (Jiang and Eberlein, 2009). This flexibility enhances customer satisfaction and reduces the risk of delivering a final product that does not meet the stakeholders' expectations. Furthermore,

Agile promotes collaboration and effective communication among team members, fostering a culture of shared responsibility and knowledge sharing (Al-Saqqa et al., 2020). Such collaborative practices lead to increased productivity, higher-quality software, and improved team morale.

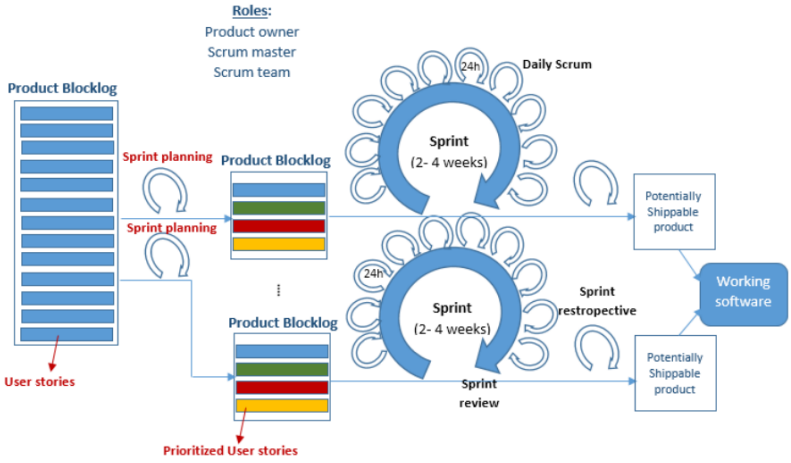

Figure 2.2: Scrum method life cycle.

"Al-Saqqa, Sawalha, and AbdelNabi, Agile software development: Methodologies and trends, 2020"

One trend that stands out in the last few years is the development of mobile applications using this methodology. Several reviews and analyses provided by scientific papers explore the mobile application development processes using Agile methodologies. They delve into the challenges faced in mobile application development due to the dynamic nature of mobile platforms and user expectations, highlighting the need for adaptability and responsiveness to meet evolving requirements and deliver high-quality mobile applications. By adopting AM, developers can effectively address these challenges and ensure the success of mobile app projects (Flora and Chande, 2013).

An article by Spataru (2010) that focused on the Agile development methods tailored specifically for mobile applications highlighted the significance of user involvement and early delivery in mobile app development, while also emphasizing the importance of engaging users throughout the development process to gather feedback and ensure the app aligns with their needs and preferences. Through the implementation of Agile practices such as user story mapping, cross-functional teams, and continuous integration, developers can streamline the development process, improve collaboration, and deliver mobile applications that meet user expectations (Spataru, 2010).

The benefits of adopting the AM for mobile app development is further explored in the literature: these include a reduced time to market, improved user satisfaction, and effective handling of evolving requirements. It also highlights the importance of flexibility, collaboration, and iterative development in delivering successful mobile applications. By embracing Agile principles and practices, organizations can enhance their mobile app development processes and achieve better outcomes in terms of both project success and user satisfaction (Flora et al., 2014).

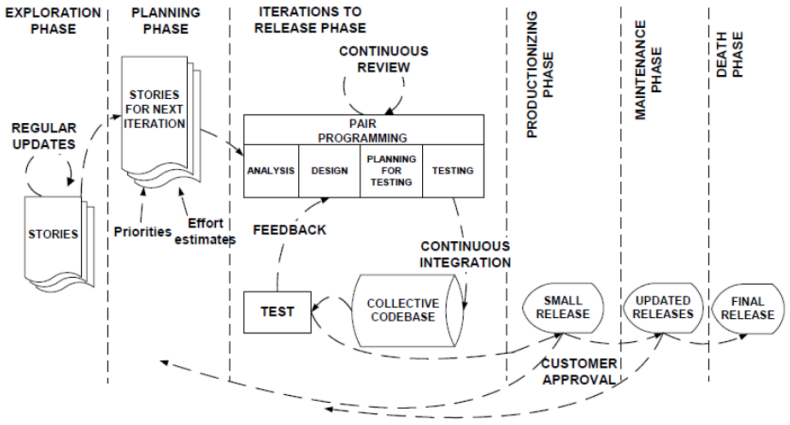

Figure 2.3: Extreme Programming method life cycle.

Adapted from "Anwer et al., Comparative Analysis of Two Popular Agile Process Models: Extreme Programming and Scrum, 2017."

The Agile methodology's adaptability, user involvement, and iterative development approach align well with the objectives of educational institutions. By incorporating Agile principles, such as iterative development, rapid feedback loops, and frequent releases, teachers can use a gamified mobile application that fosters student engagement, motivates learning, and facilitates decision-making. The use of Agile methodologies in mobile application development within the educational sector proves to be a promising approach for enhancing student experiences and promoting interactive learning environments (Flora and Chande, 2013; Spataru, 2010).

2.4.2 In Project Management

Agile Methodology for Project Management is a flexible and iterative approach to project execution that prioritizes adaptability, collaboration, and continuous improvement. It provides project managers with a framework that promotes efficient communication, rapid decision-making, and the ability to respond to changing requirements, ensuring successful project implementation.

The influence of Agile Methodology, particularly *Scrum*, on software project management is extensively explored in literature. The research highlights the numerous benefits of adopting Agile principles, including iterative development and frequent stakeholder communication. *Scrum*, a popular Agile framework, provides a structured approach to project management by dividing the project into iterations called sprints. During these sprints, cross-functional teams collaborate to deliver incremental pieces of software that are ready for review and feedback. (Hayat et al., 2019).

One of the key elements of *Scrum* is the emphasis on stakeholder communication. Frequent and transparent communication channels are established to ensure that all stakeholders, including clients, end-users, and the development team, are continuously engaged throughout the project. This open line of communication enables stakeholders to provide feedback, express their evolving needs, and align their expectations with the project's progress. By actively involving stakeholders,

project managers can gather valuable insights that contribute to the overall success of the software project (Hoda et al., 2008).

In terms of project planning, Agile methodologies like *Scrum* provides an iterative and adaptive approach. Rather than relying on traditional long-term planning, Agile projects employ shorter planning cycles called iterations or sprints that typically last from one to four weeks and involve selecting a set of prioritized requirements to be developed and delivered within that time frame. This iterative planning approach allows project teams to respond to changing requirements and market dynamics while maintaining a focus on delivering value in smaller increments. It ensures that project priorities can be adjusted based on the feedback received during each sprint, resulting in a more adaptable and customer-centric approach to project planning. It also deals with another one of the notable challenges in project management, which is scope creep, which refers to the continuous expansion of project requirements beyond the originally defined scope. Traditional project management approaches often struggle to handle scope creep effectively, leading to schedule delays, budget overruns, and decreased customer satisfaction. However, Agile methodologies offer a solution to address this issue. The research showcases that Agile projects implement iterative development cycles, allowing for incremental delivery of software features. By breaking the project into manageable iterations, project managers can control the scope and prioritize the most valuable requirements for each iteration. This approach enables them to respond to changing requirements in a controlled manner, preventing scope creep and ensuring that the project remains focused on delivering value to the stakeholders (Coram and Bohner, 2005).

The use of Agile Methodology for Project Management is crucial in the development of a gamified mobile application for interclass competition like this dissertation project. The selected articles highlight the benefits of Agile methodologies, including iterative development, stakeholder collaboration, and adaptability to changing requirements. By leveraging Agile principles and practices, like the employment of shorter planning cycles, project managers can effectively navigate the dynamic educational environment and ensure the successful implementation of the mobile application. The integration of gamification elements can foster student engagement and support decision-making processes, potentially enhancing the overall educational experience.

2.5 Student and Teacher Engagement

As previously stated, Alexander Astin's work in the 1980s brought the concept of student engagement to reality. Through this research, robust correlations have been established between student participation in a subset of "educationally purposeful activities" and positive outcomes of student success and development, such as satisfaction, persistence, academic achievement, and social engagement. (Astin, 1984).

While most of the literature since there explored the benefits of student engagement, a striking absence registered when addressing this subject was the student voice in the literature on student engagement. Instead, literature was written about students for managers, policymakers, researchers,

funders, or teachers, with occasional briefing guides for student leaders, by other managers, policymakers, researchers, or teachers (Trowler, 2010).

Also, student involvement and teacher engagement have been proven to be closely connected. According to Cardwell (2011) research, there is a strong positive association between student and teacher involvement. More engaged teachers typically foster a more positive and encouraging learning atmosphere, which in turn encourages student involvement. Additionally, a study by Cinches et al. (2017) suggests a connection between teacher effectiveness and engagement, with more effective teachers typically having more engaged students.

According to Veiga et al. (2010), to increase student engagement, schools should diversify their teaching strategies and tailor them to the needs and preferences of individual students. This strategy can help to increase student motivation and engagement by fostering a more individualized learning environment. Additionally, professional development and support initiatives can improve teacher engagement (Cinches et al., 2017).

Overall, student and teacher engagement has a significant correlation with academic performance. Various studies, such as those mentioned previously have provided evidence of this connection. However, it is important to note that engagement cannot be solely attributed to the individual; the school environment and support play a crucial role as well.

A potential approach to enhance engagement is by incorporating gamification elements into classroom activities, such as assignments and assessments. As shown by the study conducted by Armier et al. (2016), game elements such as points, badges, and leaderboards can increase student engagement and motivation. This approach could also be applied to teacher engagement, by creating a system that rewards and recognizes effective teaching practices.

With this research it became clear that schools could potentially increase both student and teacher engagement, leading to better academic performance and a more positive school environment through initiatives that integrated gamified elements. The research also demonstrated how the student's voice tends to be ignored when the subject of student engagement is discussed and how it could be a demotivating factor for students.

2.6 Gamification in Education

Gamification in education is using game elements and game mechanics to improve student engagement, motivation, and learning outcomes. The idea is inspired by intrinsically motivating elements of games, such as competition, rewards, and challenges. Gamification transforms the learning experience into an interactive and immersive journey by introducing elements such as points, badges, leaderboards, and progress monitoring. The goal of gamification in education is to make learning enjoyable, boost student motivation, and promote a deeper understanding of educational content. (Kiryakova et al., 2014).

Extensive research conducted by Swacha (2021) provided a perceptive analysis of the current state of gamification in education. By analyzing numerous academic articles and research papers from *Google Scholar*, *Scopus*, and *Web of Science*, the study cast light on several trends and findings in this field. The survey identified the increasing interest and research activity surrounding gamification in education as a prominent trend. Researchers from a variety of educational contexts and disciplines have acknowledged gamification's potential to enhance the learning experience. This trend demonstrates the relevance and applicability of gamification as an educational subject of study (Swacha, 2021).

Regarding gamification's applications, the survey emphasized its positive effects on student motivation, engagement, and knowledge retention. Gamification has demonstrated promise across a broad spectrum of subjects and age groups, incorporating a variety of educational contexts. For instance, in STEM (Science, Technology, Engineering, and Mathematics) subjects, gamified approaches have proven effective in fostering problem-solving skills and conceptual comprehension. Gamification techniques have also increased student engagement and proficiency in language acquisition and have positively affected knowledge acquisition and skill development in younger age groups. Furthermore, the survey revealed that the favorable effects of gamification extend beyond traditional academic subjects. In health education, gamified interventions have effectively promoted healthy behavior and disease prevention (Swacha, 2021).

Gamification learning experiences have also been tested in Portuguese education. Ferreira et al. (2019) investigated the effects of gamification in higher education by focusing on implementing gamified elements, such as leaderboards and progress tracking, in a university course. The researchers observed that gamified learning experiences promoted higher engagement, motivation, and academic achievement levels among students. Traditional teaching methods can be transformed by incorporating gamification, creating interactive and personalized learning environments in Portuguese universities (Ferreira et al., 2019).

The dynamic and collaborative nature of these gamified environments can also promote social interaction among students, further enhancing their engagement levels. Therefore, the appropriate design and implementation of gamified learning experiences can substantially increase student engagement, thus facilitating effective learning (Ferreira et al., 2019)

Integrating gamification with Industry 4.0 technologies is also possible. To realize the full potential of gamification, Almeida and Simoes (2019) highlighted the importance of well-designed game mechanics and alignment with educational objectives. By incorporating gamified elements, teachers can nurture active learning, improve problem-solving skills, and encourage student collaboration. The authors stress the significance of educators in Portugal adopting gamification to adapt to the changing educational landscape and equipping students with the skills necessary to thrive in the digital age (Almeida and Simoes, 2019).

Chapter 3

Planning Phase

The Planning Phase chapter started by describing the problem at hand through the project's scope, the current state diagnostic, the ideal state design, the project's chronogram, and the most significant implementation risks. This approach emphasizes identifying and addressing challenges and requirements before proposing practical solutions.

3.1 Project Scope

This sub-chapter specified the intended audience, the school setting, and the technological limitations of the project.

The mobile application was designed as a comprehensive solution aimed at monitoring and managing the interclass competition of the 9th grade. The project aimed at creating an engaging and supportive learning environment for students, while providing valuable tools and insights for teachers and class directors.

In terms of scope, this initiative targeted the 9th grade at Escola Básica e Secundária de Campo. There are six classes in ninth grade (9ºA, 9ºB, 9ºC, 9ºD, 9ºE, and 9ºF).

The 9th grade was chosen for this pilot project since the motivational indices of this grade are perceived to be very low by the school board of administration, the SPC, and the department head of the Family Support Office. It is also the end of a school cycle (a third cycle that goes from the 7th grade to the 9th grade), in which students are in an age group where they can easily use the mobile application (mainly between 14 and 16 years old), amicably compete with each other and carry valuable feedback to the following years in future editions of the competition if they occur.

Each class has one allotted class director and one period devoted to addressing pending matters regarding the class. The remaining teaching time is divided among 12 subjects; 11 of these subjects are taught year-round, including Physics-Chemistry, Natural Sciences, Portuguese, English, French, Visual Education, Physical Education, Catholic Religious Moral Education, Information Technology and Education (alternated with Citizenship), Mathematics, and the Complement to Artistic Education. History is currently taught to 9ºD, 9ºE, and 9ºF, while Geography is taught to

9ºA, 9ºB, and 9ºC. The 12th subject alternates between History and Geography every semester. Contributing to the initiative were 26 teachers, 140 students, and 2 operational assistants. Because they are assigned to the corridor where ninth-grade classes typically meet, the operational assistants were chosen based on their increased interaction with ninth-grade students.

In terms of constraints, it was defined from the beginning that the mobile application must be developed for both iOS and Android platforms. The app should be able to provide real-time data updates, requiring internet connectivity for that effect. All the development, design, and testing responsibilities of the application were assigned to the Kaizen Institute, which should provide a no-cost software solution for the app that ensures school data privacy and security regulations.

3.2 Current State Diagnostic

This sub-chapter provided a comprehensive analysis of the school's existing challenges, expanding on the Project Scope. Before implementing solutions to improve the school, it is crucial to outline and understand its current state (as seen in Figure A.1 from Appendix A). This step is fundamental in the A3 problem-solving methodology, which emphasizes thorough analysis and identification of problems before proposing solutions. Outlining the current state allowed for a comprehensive understanding of the challenges and areas that required improvement, helping to identify the root causes of the issues and providing a baseline against which progress could be measured.

In a designated meeting with the SPC, several points emerged regarding the current state of the school. The main prominent issue that arose from the meeting was the lack of motivation among students to learn the subjects taught. This indicated a potential disconnection between the curriculum and student engagement. This was evidenced by the surveys conducted through the *Microsoft Forms* platform, where, of the 89 responses submitted by the 9th-grade students, 5 said they are rarely motivated to learn at school, 12 said they are usually not motivated to learn at school, and 31 said they are only sometimes motivated to learn at school. Only 46% of the students said they were regularly motivated to learn about the various subjects taught as shown in Figure 3.1.

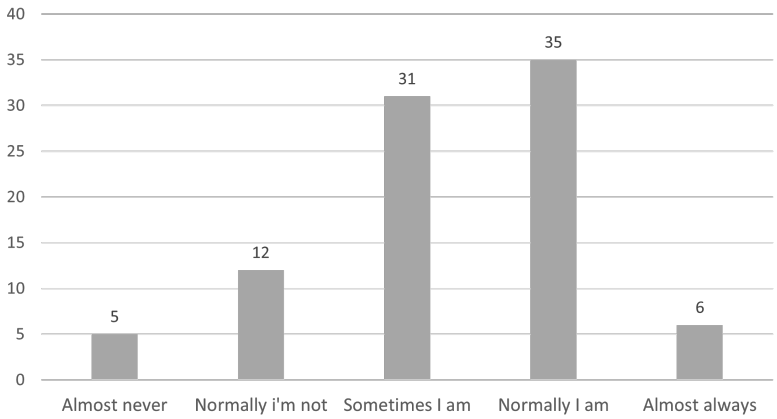

Figure 3.1: Escola de Campo student answers regarding their motivation levels in school

When asked about students' motivation to learn, teachers were even more negative: only 2 out of 25 responses (8%) said that students were regularly motivated to learn at school as shown in Figure 3.2.

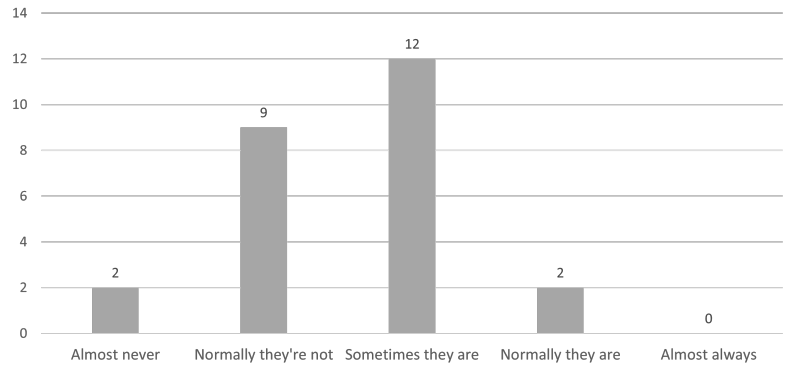

Figure 3.2: Escola de Campo teacher answers regarding their student's motivation levels in school

From these surveys it was deemed essential to explore innovative teaching methods and instructional strategies that made the learning experience more interactive, relevant, and meaningful. By fostering a student-centered approach and incorporating elements of gamification, technology, and real-world applications, teachers could inspire students and ignite their curiosity to participate actively in the learning process.

Another issue identified was the lack of sensitivity towards students with special educational needs. This suggested that the school may not have adequate support systems to address these students' unique requirements.

The meeting also identified a failure to perform some learning tasks both in the classroom environment and outside of school, with some students displaying a lack of autonomy. This highlighted the need to promote self-directed learning and develop students' independent problem-solving and study skills. Additionally, the classroom environment itself required improvement. Issues such as disruptive behavior, a reported lack of integration among some of the students in the 9th grade, and limited commitment and involvement from those students contributed to an unsupportive learning atmosphere. Creating a positive and inclusive classroom culture that fostered respect, collaboration, and shared responsibility was deemed crucial.

Conflicts between students also needed to be mitigated. Although these conflicts may be occasional, they can have a significant impact on students, teachers, operational assistants, and parents. It is important to address these conflicts promptly and proactively by implementing conflict resolution strategies, and by fostering a sense of belonging and community within the school.

From the analysis conducted in this sub-chapter, it was possible to identify the school's main challenge the low student motivation. Other problems, such as a lack of support for students with special educational requirements, limited autonomy, as well as an imperfect classroom environment also were highlighted. With these problems in mind, an ideal state design was drawn in the

next sub-chapter, with the intent of targeting all of these issues.

3.3 Ideal State Design

This sub-chapter described the desired features and functionalities of the mobile application, aligning them with the identified obstacles and requirements. Here is an outline of the features and functionalities that were agreed the application should possess:

- **User-Oriented Design:** The application should have an intuitive and user-friendly interface, ensuring ease of use for students, teachers, and operational assistants. By providing clear and intuitive interfaces, the application enables users to quickly understand how to interact with its features, promoting engagement and active participation in the interclass competition. A visually appealing and interactive design not only grabs users' attention but also fosters sustained motivation and interest in tracking progress and earning points. Furthermore, a user-friendly design increases adoption rates as it encourages users to embrace and regularly utilize the application. A well-designed user interface contributes to positive user experiences, leading to increased user satisfaction and loyalty. In addition to ease of use and adoption, a user-friendly design ensures accessibility across various devices, such as smartphones, tablets, and computers. This flexibility allows users to access the application from their preferred devices, promoting inclusivity and convenience;
- **Leaderboard and Point Attribution:** The application should include a leaderboard that displays the ranking and accumulated points of each 9th-grade class. This feature allows students to track their class's performance in real-time, fostering healthy competition and motivation. At the same time, the application should also enable teachers, class directors, and operational assistants to assign points based on behavior indicators. This can include tracking and recording both in-class and out-of-class behavior that directly affects the work of operational assistants and class directors since it provides a comprehensive view of students' conduct and allows for a holistic assessment of their engagement and behavior throughout the week;
- **Test and Performance Tracking:** The application needed to include a calendar or scheduling feature where teachers could register upcoming tests and assignments. Students should be able to view their future tests and opportunities to earn points, promoting better preparation and time management. Test performance indicators should be established in the app to monitor student academic progress, and they should be aligned with the goals defined in the school's internal regulation;
- **Meritorious Point Attribution:** The application also needed a mechanism to award extra points to classes based on meritorious behavior, and participation in school tournaments, or other competitions. This would encourage students to engage in extracurricular activities, foster collaboration, and demonstrate desirable behaviors beyond academic performance;

- **Decision Support System (DSS):** The application needed to incorporate a DSS component that captured and analyzed various quantitative and qualitative indicators, such as test scores, behavior grades, and other relevant parameters. By collecting this data, the DSS should be able to create comprehensive reports and visualizations that would provide a holistic view of the class's performance and behavior trends over time. It needed to compare the class's performance against previous data, identifying deviations and trends. This would allow class directors to identify areas of improvement and track progress in real-time. Additionally, the DSS is needed also to facilitate effective communication between teachers and class directors. It would allow teachers to share relevant data, observations, and insights with the class director, providing a comprehensive picture of the class's performance. This collaborative approach would enable teachers and class directors to work together in defining and implementing appropriate interventions and strategies to support the class's needs. Finally, the DSS could assist class directors to monitor the effectiveness of interventions and procedures implemented to improve class performance. By continuously tracking indicators and comparing them with previous data, class directors could assess the impact of their actions and make data-informed decisions for ongoing improvement. This iterative process should help refine teaching methods and behavior management strategies;

- **Student Engagement and Feedback:** The application needed to provide a platform for students to suggest improvements for the application itself and recommend behaviors worthy of point attribution. This would empower students to have a voice in shaping the learning environment and enhances their sense of ownership and engagement while at the same time, it would facilitate effective communication between students, teachers, and class directors. It could include features such as messaging or discussion boards where teachers could provide feedback and students could seek clarification on assignments or performance;

- **Gamification Elements:** The application needed to incorporate gamification elements as a way to make the learning experience more interactive and motivating. This could include visual progress indicators, badges, or rewards that recognized classes' achievements and milestones, further enhancing their motivation and engagement.

These characteristics were agreed upon due to their potential to cater to the identified challenges and needs, improve user engagement, foster healthy competition, encourage meritorious behavior, provide holistic insights into class performance, and make the learning experience more enjoyable and rewarding. With these design requirements in place, the focus transitioned to creating the Project Chronogram. This chronogram would map out the timeline of the application's inception, development, and implementation, providing a comprehensive overview of the project timeline until the end of the school calendar year. It also allowed the evaluation of the efficiency of the project execution and the understanding of the steps taken toward the application's implementation.

3.4 Project Chronogram

This sub-chapter introduced the concept of organizing the project into one-week segments for effective project management. The agreement that the project would be organized into sprints of one week was made with the school board management and the SPC, due to the numerous advantages previously mentioned. This methodology provided a clear and focused timeframe for planning, enabled iterative development and feedback loops, allowed for adaptability to changing needs, facilitated progress tracking and expectation management, enhanced time management and resource utilization, and promoted motivation and a sense of achievement.

The main milestones defined in the Project Chronogram (Figure B.1 from Appendix B) were:

- **Pre-project current state measurement survey launch:** Main goal of assessing motivation levels of all participants (students, teachers, and operational assistants) pre-start of the project to determine the effectiveness of the app in those parameters by the end - *Week 20/02-26/02*;
- **Presentation of initial mockups:** Objective of providing a base for discussion between the developing team and the School Principal Coordinator to establish more concrete and imaginative functionalities in the application – *Week 06/03-12/03*;
- **Project presentation meetings:** To inform all the participants of the nature of the project and what contribution is expected from them in the following weeks – *Week 17/04-23/04*;
- **Presentation of the first application prototype:** The critical goal of creating the mobile application with the key core functionalities and a user-friendly design using already the definitive software option – *Week 17/04-23/04*;
- **Mobile Application Live:** To ensure that all students, teachers, and operational assistants have the application on their mobiles and re-inform them of the competition rules and criteria – *Day 24/04;*
- **Addition of gamification elements:** To create a more dynamic user experience for the students to up their engagement levels (includes quizzes related to the subject matter taught, extra points awarded, among others) – *Week 15/05-21-05*;
- **Student application feedback survey launch:** To proactively detect a possible lack of motivation that may result from a discrepancy of points gained between classes or other problems regarding the app – *Week 22/05-28/05*;
- **Award presentation and wrap-up ceremony:** To reward the winning class with a predefined prize and a small celebration ceremony – *Week 12/06-16/06*;
- **Post-project application effect measurement survey launch:** To determine how effective the project was in terms of fulfilling its predefined goals – *Week 12/06-16/06*.

These milestones were set with the objective to ensure the project's efficient progression, timely feedback, and the active involvement of all stakeholders, contributing to the project's success. The next sub-chapter presented the potential major risks associated with the implementation of the mobile application.

3.5 Major Risks of Implementation

Several risks associated with the implementation of a mobile application of this character were considered. The possibility of competition between class directors was a major cause for concern. The introduction of a competitive element through the mobile application could lead to increased rivalry and conflicts among class directors, thereby disrupting collaboration and equity and leading to a lack of objectivity in decision-making and an unhealthy work environment.

Additionally, the complexity of the application's capabilities was a factor. Students, teachers, class directors, and operational assistants could be dissuaded from using all of the application's features if its interface became overly complicated. Excessive complexity may result in confusion and discontent, reducing participation and impeding the achievement of project objectives.

Measuring the effectiveness and impact of the mobile application throughout the project was another obstacle. A rigorous evaluation framework was required to evaluate the application's impact on student performance, conduct, and engagement. Without the appropriate metrics and evaluation methods, assessing the application's influence and making data-driven decisions about future enhancements may be challenging.

The prospective lack of student interest in the school's conclusion prize posed a significant threat. The competition might not have generated the intended level of motivation if students did not perceive the prize as valuable, attainable, or aligned with their interests and aspirations. This lack of motivation could undermine the application's intended purpose and diminish its impact on student engagement and performance.

New technical obstacles and complications could also emerge. Compatibility issues with different devices and operating systems, software defects, data synchronization problems, and server downtime could negatively impact the user experience. These technical issues could reduce engagement, frustrate users, and impede the successful implementation of the application.

Change resistance was an additional significant concern. Teachers, class directors, operational assistants, and even students could resist using the mobile application for various reasons, such as unfamiliarity with the technology, skepticism regarding its efficacy, and concerns of increased burden.

Collecting and storing student information posed inherent data privacy and security risks. Inadequate data protection measures, unauthorized access, or protocol violations could compromise the data's confidentiality and damage the school's reputation. Implementing stringent data privacy and security measures was crucial for the project's success.

Users who lack adequate training and support may pose a substantial threat. If users were not adequately trained on how to use the application's features or could not receive prompt help, frustration, decreased engagement, and suboptimal application usage could result in frustration.

The successful implementation of the mobile application could have been endangered by resource limitations such as a limited budget (zero costs), an inadequate technical infrastructure (the absence of a *Microsoft Account* for all students prevented the app from being developed using *Microsoft PowerApps*, for example), and insufficient personnel (to support the app). The application's effectiveness, scalability, and long-term viability could have been in menace due to inadequate development, maintenance, and support resources.

This mobile application implementation poses several risks that must be carefully managed. These risks included competition between class directors, complexity in application functionalities, difficulty in measuring efficacy, lack of student motivation, technical issues, resistance to change, data privacy concerns, inadequate training and support, and resource constraints.

Chapter 4

Do, Check, Act Phase

The Do, Check, Act Phase provided a comprehensive roadmap for the project through various critical discussions and analyses. It started with a discussion risk mitigation strategies to ensure that the potential risks identified in the preceding chapter are adequately addressed. Next, it addressed the essential features and requirements the application should include providing its success, and establishing definitive criteria for its efficacy. Following this, a comparative analysis of four prominent no-code platforms was made - Adalo, Bubble, PowerApps, and GlideApps - assessing their strengths and weaknesses to determine the most suitable platform for the project. The chapter concluded with a comprehensive description of the final product, highlighting the functionalities included, the design aesthetics adhered to, and how the app correlates with the initial vision and objectives. This chapter emphasizes doing, verifying, and acting to improve and refine the application development process iteratively.

4.1 Risk Mitigation Strategy

Based on the risks outlined in the previous chapter, it was possible to establish a risk mitigation strategy. The first measure to take is to adopt the Agile Methodology (AM), by establishing regular feedback sessions during sprint reviews and retrospectives that should provide an opportunity to address any emerging issues and concerns from teachers and students. The iterative nature of Agile allowed for open communication and encouraged all stakeholders to share their ideas, experiences, and problems. This would translate into class directors actively sharing effective practices, challenges, and solutions, thus fostering a collaborative rather than competitive environment, which reduced the potential for unhealthy competition. The organization of the project in one-week sprints also ensured that the focus was on delivering small, manageable increments of functionality. This approach allowed frequent user feedback and validation. By incorporating user feedback during each sprint, it's ensured that the application's functionalities are user-friendly and straightforward, mitigating the risk of excessive complexity.

By incorporating regular feedback loops and weekly feedback sessions, it was also possible to identify training and support needs from students and teachers early on and act accordingly. This

feedback-driven approach allowed for timely training and supported resources to ensure users had the necessary skills and assistance to utilize the application effectively.

The iterative nature of Agile allowed for frequent testing and validation, which reduced the risk of technical issues going unnoticed until the later stages of the project. Through continuous integration and testing during each sprint, it was possible to identify and address compatibility issues, software flaws, and data synchronization problems early on. This proactive approach helped ensure a smoother and more successful mobile application implementation.

The PDCA cycle provided a framework for continuous evaluation and improvement. By implementing a feedback loop within each sprint, the project team could gather data and assess the effectiveness of the application's impact on student performance, conduct, and engagement. This data could be used to refine and adjust the application's functionalities and features, ensuring its effectiveness throughout the project.

4.2 Application Functionalities Requirements

Feedback from the SPC was invaluable in defining the core app functionalities and refining them in one-week sprints. The SPC feedback helped to identify gaps in functionality, usability issues, or areas for enhancement, all of which were incorporated into the plan for the next sprint. This iterative feedback and refinement process was crucial for developing an application that effectively meets the needs of its users.

The first application requirement structured with the SPC was the development of a mobile application with an intuitive and user-friendly interface. It was critical that users find the application intuitive and user-friendly since it's the foundation for all other functionalities and should be one of the first things developed.

Next, the leaderboard functionality was prioritized. This feature should provide a visual representation of the accumulated points and ranking of each 9th-grade class, which was meant to help students to perform better.

The behavior tracking and point attribution system was another requirement defined that should allow teachers, class directors, and operational assistants to assign points based on student performance and behavior. This system should directly feed the leaderboard functionality and play a crucial role in the gamification element of the app.

A calendar or scheduling feature was also deemed necessary for registering upcoming tests and assignments, allowing students and teachers to plan their study and teaching strategies, respectively. The creation of such a system should allow the introduction of various types of events that would create the need for reminders and notifications through the app to students and teachers, adding complexity to the feature.

The Decision Support System (DSS) component was considered a key feature for data analysis, performance comparison, and early warning alerts due to the valuable insights offered to teachers

and directors through the monitoring of the performance and conduct of classes. This feature should be showcased through a dashboard involving multiple data sources and analysis methods and was expected initially to take more than a week to build and refine.

Additional points should be awarded based on meritorious behavior and participation in events and introduced in the application in the final week of the competition. This functionality should play a significant role in motivating students to go the extra mile in their studies and behavior and increases the dynamism of the competition.

A student engagement and feedback platform should also be created to allow students to offer suggestions and recommendations for the app, with the intent to foster a sense of community by allowing for direct user input into the app's further development. It should be a valuable source of ideas for future improvements either in terms of design or functionalities.

Other gamification elements, such as quizzes and achievements, should be introduced in the application in a later stage to enhance motivation and engagement by making the learning experience more enjoyable. Allowing students to share their achievements, badges, or scores on social media was also discussed as a way to increase engagement and competition among students.

Finally, the app should also incorporate a feature for communication and collaboration. This functionality would foster efficient interaction among students, teachers, class directors, and operational assistants. However, considering the intricate nature of implementing real-time communication capabilities, the SPC classified this feature as optional.

4.3 Software Possibilities for App Development

After establishing the application requirements, it was necessary to study all viable software possibilities for the development of the app. The main decision to make was to choose between a no-code platform like Adalo, Bubble, PowerApps, or GlideApps or a traditional coding software option.

No-code platforms cater specifically to users with minimal understanding of coding or software development understanding. These platforms offer intuitive interfaces and pre-built components that simplify application development, even for users with little to no technical experience. This is a stark contrast to traditional coding software options such as *Android Studio*, *Xcode*, or *Visual Studio*te a strong proficiency in programming languages like *Java*, *Swift*, or *C#*.

Secondly, the simplicity of the application design requisites aligns perfectly with the capabilities of no-code platforms. Though the app requires a range of functionalities, is not overly complex, a scenario that no-code platforms handle adeptly. The concept of coding from scratch introduces an element of unnecessary complexity and extends development times, an aspect that no-code platforms conveniently circumvent.

Additionally, the licensing requirements for traditional coding software may introduce cost concerns. Software like *Microsoft's Visual Studio*, a popular integrated development environment for coding applications, requires a license that can add significantly to development costs. On the contrary, no-code platforms often operate on a freemium model, where the basic functionality is offered for free, with premium features available through a paid subscription.

The short development timeframe, a crucial consideration in the project, also leans in favor of no-code platforms. A six-week window for developing the first application prototype called for quick development times, a feature inherent in no-code platforms. These platforms expedite development by providing pre-made components, instant code generation, and immediate testing and deployment capabilities. The manual coding, debugging, and testing process typical of traditional coding software would likely overrun the six-week development period.

Lastly, no-code platforms excel in facilitating iterative development and maintenance. Their visual interface simplifies the process of making changes and updates, allowing the developer to see in real-time the impact of these modifications on the layout and functionality. Coding platforms, while offering greater control and the ability to handle more significant, more complex applications, could be overkill for a mobile application of this nature.

Given these considerations, it became clear that no-code platforms offer a superior choice for this project. Their alignment with the developing team's coding abilities, capability to handle the required functionalities, cost-effectiveness, swift development times, and facilitation of iterative development all add up to make them the most appropriate choice. The reduced development time, lower costs, and the ability to easily make updates and modifications also speak to the agility and flexibility of these platforms, a feature that traditional coding platforms struggle to match. Therefore, based on the nature of the mobile application and its specific requirements, a no-code platform emerged as the most effective and efficient option, with four options being considered prior hand: *Adalo*, *Bubble*, *Microsoft PowerApps* and *GlideApps*.

4.3.1 Adalo

Adalo is a platform that simplifies app creation, often compared to assembling a slide deck. Its key advantage lies in its component marketplace, which accelerates the development process significantly. Boasting a modern, user-friendly interface, *Adalo* excels in creating native mobile apps compatible with both Android and iOS platforms. Additionally, *Adalo* supports push notifications, proving beneficial for user engagement and immediate updates.

On the downside, while *Adalo* offers numerous components, it may lack flexibility when it comes to customizing these elements. Users have also reported slower app performance with *Adalo*, particularly with a large user base or complex data structure. As for push notifications, *Adalo* does support them but cannot schedule notifications in advance.

Regarding cost, *Adalo* offers a limited functionality free plan, with paid plans starting from $50 per month and up to $200 per month. These plans remove *Adalo* branding, provide priority support, and increase the number of updates per month.

4.3.2 Bubble

Bubble is a visual programming platform designed for the creation of web applicsupportsllows for extensive customization of the application's user interface and facilitates complex application development. Its extensive plugin marketplace and support for third-party integrations increase the flexibility and functionality of applications. *Bubble* also supports the transmission of emails, which can serve a similar purpose for user engagement as push notifications.

Due to its extensive functionality and adaptability, *Bubble* has a steeper learning curve than other platforms. Although it is possible to create mobile apps, the process is not as straightforward as it is on other platforms dedicated to the effect. *Bubble* does not inherently support push notifications for notifications and instead relies on third-party integrations or email for similar functionality.

In terms of pricing, *Bubble* offers a complimentary tier with limited functionality. Paid plans range in price from $25 per month to $475 per month for professional plans. These strategies provide expanded capacity, quicker response times, and priority support.

4.3.3 Microsoft PowerApps

Microsoft PowerApps is a no-code service that allows users to create business applications that function on multiple devices without coding expertise. It is distinguished by its seamless integration with a vast array of *Microsoft* and third-party services. These integrations include *Microsoft 365*, *Dynamics 365*, and *Azure* services, which expand the functional scope of applications. Push notifications are also supported by *PowerApps*, contributing substantially to user engagement and real-time updates.

However, the *PowerApps* learning curve can be severe, particularly when implementing more complex functionality. The user interface may not be as intuitive as other platforms, which could hurt the development process for those without technical expertise despite the platform's ability to create diverse applications. Although *PowerApps* supports push notifications, configuring them is somewhat complicated and cannot be scheduled.

As for pricing, *Microsoft PowerApps* provides a free plan with limited usage. Paid programs start at $10 user/app/month and can go as high as $40 user/month for access to more comprehensive features. These programs include features such as premium connectors, an on-premises data gateway, and policy enforcement.

4.3.4 GlideApps

GlideApps is a no-code platform for building mobile apps, particularly good for creating apps with a straightforward purpose and intuitive user interface. That is the software's most significant

advantage, as even people without a technical background can use it easily. It supports real-time data updates, meaning the app reflects these changes as soon as the underlying data changes. Another advantage is quickly prototyping and iterating on your application design. *GlideApps* also supports push notifications, which can be very useful for user engagement and real-time updates.

However, *GlideApps* may be restrictive for apps that require sophisticated features or logic. In addition, although *GlideApps* supports push notifications, it is difficult to set up specific notification triggers, and notifications cannot be scheduled. Building a highly pleasing user-design interface may also be challenging as the layout customization options are limited.

In terms of costs, *GlideApps* has a free version, but it includes *Glide* branding and has limitations to the number of users. Their paid plans vary from $25 per month per app to $799, with the number of additional features added increasing accordingly. These features include removing *Glide* branding, allowing more data updates per month, and providing immediate customer support.

4.3.5 Final Balance

All platforms have strengths and weaknesses as summarised in Table 4.1.

Table 4.1: Strengths and Weaknesses of No-Code Software Platforms

	STRENGTHS	WEAKNESSES
ADALO	• COMPONENT MARKETPLACE • USER-FRIENDLY INTERFACE COMPATIBLE WITH BOTH ANDROID AND IOS PLATFORMS	• LACKS FLEXIBILITY IN CUSTOMIZATION • SLOWER APP PERFORMANCE • CANNOT SCHEDULE NOTIFICATIONS IN ADVANCE
BUBBLE	• EXTENSIVE USER INTERFACE CUSTOMIZATION • FACILITATES COMPLEX APPLICATION DEVELOPMENT	• SEVERE LEARNING CURVE • DOES NOT INHERENTLY SUPPORT PUSH NOTIFICATIONS
POWERAPPS	• SEAMLESS INTEGRATION WITH MICROSOFT AND THIRD-PARTY SERVICES • SUPPORTS PUSH NOTIFICATIONS	• SEVERE LEARNING CURVE • USER INTERFACE IS NOT AS INTUITIVE • CANNOT SCHEDULE NOTIFICATIONS IN ADVANCE
GLIDEAPPS	• VERY EASY TO USE • ALLOWS FOR THE CREATION OF QUICK PROTOTYPES AND ITERATIONS ON THE INTERFACE DESIGN • SUPPORTS PUSH NOTIFICATIONS	• RESTRICTIVE FOR SOPHISTICATED FEATURES OR LOGIC • DIFFICULT TO SET UP SPECIFIC NOTIFICATION TRIGGERS

GlideApps and *Adalo* have the benefit of being extremely user-friendly and offering free tiers, but they may be limited for more complex applications. *PowerApps* is effective and integrates well with other *Microsoft* products, but it lacks a free tier and can be difficult to master. *Bubble* supports complex applications but not mobile app development natively. Due to its user-friendliness, multiple app integrations, and the availability of a free tier package, which prevented the school from incurring additional costs with the project, *GlideApps* emerged as the superior option when considering the functional requirements. Following this decision, the next step was to construct the final app design and functionalities based on the ideal state requirements established in the chapter 3.

4.4 Final Application Design and Functionalities

Before defining the final application design and functionalities, it was necessary to scheme the application's process flow. Figure 4.1 illustrates a visual representation of the cyclical and sequential process that users, including students, teachers, and operational assistants, followed when using the mobile application during the competition.

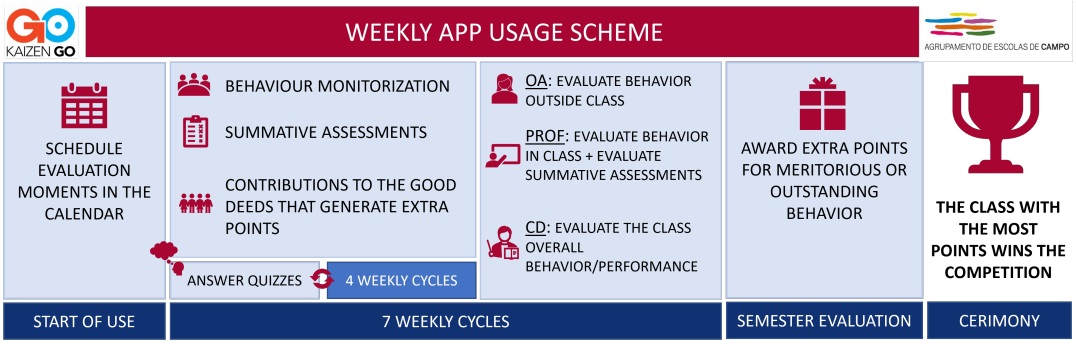

Figure 4.1: Weekly and Semester-End User Interaction Cycle in KAIZEN GO

4.4.1 User Interface Design

The user interface played a crucial role in creating an engaging and intuitive experience for students, ensuring their adherence to the application and fostering a positive learning environment. Several components were introduced in the app to ensure that the user interface design was user-friendly and aesthetically pleasing, as can be seen in Figure 4.2. The referenced design elements used to improve the user interface were:

A) **Vibrant Color Scheme:** Orange was used as the primary color of the mobile application's interface to produce a visually enticing and energizing design, due to how vibrant of a color it is. The color selection throughout the app was consistent with the school's logo and color patterns and had the goal of eliciting a feeling of enthusiasm;

B) **School-Themed Images:** A decision was also made to include images associated with the school environment (class team photo and school logo) to foster a sense of familiarity and belonging among students. Throughout the app's multiple screens was also possible to find animated images related to the school subject. These visual representations were meant to cultivate a connection between the user and the application, making it more engaging;

C) **Eye-Catching Titles:** The use of bold and/or larger font sizes for essential titles and headings was meant to attract the user's attention to the most pertinent menu items. This ensured that crucial details, such as upcoming events, the most recent updates, and important announcements, were readily discernible. Clear and prominent titles aided users in swiftly locating the information they seek, which promoted effective navigation and boosted student engagement;

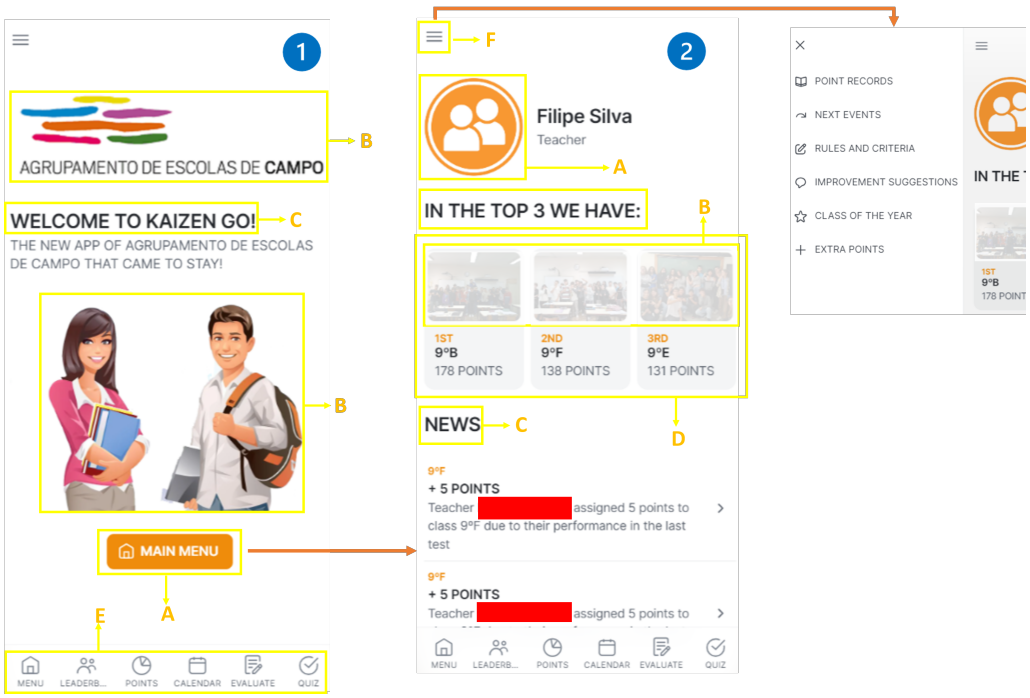

Figure 4.2: Initial Navigation Screen (1) and Main Menu Screen (2) with referenced design elements (A to F)

D) **Latest Events and Rankings:** A list of "what's new" was displayed in the app on the primary menu, such as the most recent events that earned points for the classes, to generate excitement and keep students informed of ongoing activities. In addition, the top three classes were displayed on the leaderboard on the main menu to foster a competitive spirit and encourage students to aspire for improved academic performance and conduct;

E) **Tab Navigation:** Various sections at the bottom part of every screen of the application facilitated navigation and significantly enhanced the user experience. These categories include sections such as Menu, Leaderboard, Points, Calendar, Evaluation, and Quiz that are frequently accessed.

F) **Left-Menu Navigation:** Other sections of the application were introduced in a left-menu navigation component to avoid placing an excessive number of tabs on each screen. This component was for accessing screens that were periodically updated and therefore didn't need to be in the set of E tabs indicated above. These screens were: history of points earned, upcoming events, rules and criteria of the competition, suggested improvements of the application, class of the year conduct behaviors, and rules for extra points earned.

G) **Mobile Application Logo and Name:** In the iterative application development meetings the name and a prototype of the application's logo were also outlined. It was established that the name needed to be catchy and straightforward, making it easy to recall, which could significantly impact the application's popularity and usage. In terms of the logo design,

it also needed to be versatile to look good in different sizes, whether it was displayed on a phone's home screen, a website, or marketing materials. The name of the mobile application was defined as "KAIZEN GO," and its logo can be seen in Figure 4.3.

Figure 4.3: KAIZEN GO Logo

The key components of the design strategy were grounded in creating an engaging and user-friendly interface to foster an effective learning environment. Among the various elements, the vibrant color scheme, school-themed imagery, eye-catching titles, regular updates on events and rankings, and an intuitive navigation system, all contributed to enhancing the user experience. These aspects were carefully incorporated to resonate with the students, stimulate their engagement, and contribute to their learning experience. Moreover, the chosen name, "KAIZEN GO," and the logo of the application, echo simplicity, versatility, and memorability, thereby aiding in the popularity and usability of the application.

In the next chapter, the focus transitioned to one of the main features of this application that fosters student engagement and competition - the leaderboard functionality.

4.4.2 Leaderboard Functionality

The leaderboard was designed as a real-time classification system that displayed each 9th-grade class's current scores and relative positions. All classes were represented by their class photographs, as can be seen in Figure 4.4, making the leaderboard relatable to the students.

The leaderboard design was strategic and deliberate, with the class picture serving as a visual identifier, fostering a sense of belonging and class unity among students. The first-place class was highlighted, and its image was displayed in a larger dimension than the others. This was done to recognize their accomplishments and served as an inspiration for other classes to increase their efforts to ascend on the leaderboard. It was essentially a dynamic, visual representation of the progress that fostered a game-like atmosphere that motivated students. Regular revisions to the leaderboard ensured that the competition remained engaging and that students perceived a direct correlation between their efforts and the position of their class in the ranking.

In addition, the leaderboard provided teachers, class directors, and operational assistants with a concise overview of class performance. It assisted in identifying classes that were underperforming and needed additional support, as well as those that were excelling and could be challenged further. Consequently, the leaderboard was a crucial component of the mobile application, as it served multiple functions, including student motivation and teaching aid.

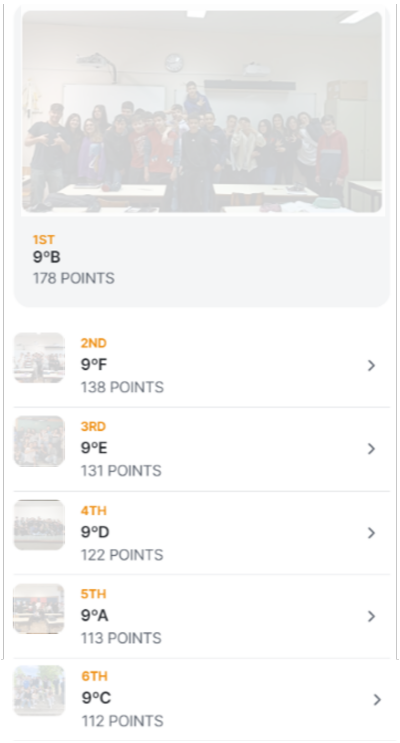

Figure 4.4: Leaderboard representing the scores and relative positions of all 9th grade classes

4.4.3 Behavior Tracking and Point Attribution System

The scoring system embedded in the application was meticulously designed to assess students' performance and drive their engagement holistically. It took into account not just the students' academic prowess (the interface of the summative evaluation can be seen in Figure C.3 from Appendix C), but also their social skills and attitudes of merit and excellence. This multifaceted assessment approach aims to reward overall student development and promote a well-rounded educational experience aligned with the goals identified in the school's Educational Project:

a) **ACADEMIC SKILLS**

- At each moment of summative assessment, the class can earn a maximum of *15 points*:
  - *5 points* awarded, if all students obtain a positive classification;
  - *5 points* awarded, if 40% of the students in the class obtain a classification equal to or higher than 4 (on a grading scale from 1 to 5);
  - *5 points* awarded, if the average marks of the class are higher than the average of the element of summative assessment immediately before.

b) **SOCIAL SKILLS**

- A maximum of *15 points* can be awarded each week to the class resulting from the assessment of the behavior and attitudes of the class:

  - Each teacher grades the behavior of the class on a scale of 1 to 5. Reverts to the class score the average of the teachers' ratings (*between 1 and 5 points*);
  - Each operational assistant grades the behavior of the class on a scale of 1 to 5. Reverts to the class score the average of the OAs ratings (*between 1 and 5 points*);
  - Each class director rates the behavior and attitudes of the class on a scale of 1 to 5, which reverts to the class score (*between 1 and 5 points*).

c) **ATTITUDES AND BEHAVIORS OF MERIT AND EXCELLENCE**

- Meritorious actions practiced individually and collectively will be rewarded through an extra score assigned by the Educational Team at the end of the semester:
  - Class or students of the same who have won an internal or external competition, tournament, or other grouping activity will earn *5 points* per activity;
  - Class or part of it has developed an activity or project with an impact on the school will earn *10 points* per activity;
  - Class or part of it has shown an outstanding attitude, by their effort, dedication, commitment, humanistic, philanthropic, and solidarity spirit, sense of justice and citizenship exercise stand out in one or more of the categories listed below will earn *10 points* per activity. The categories defined were:
    i) Develop exemplary initiatives of intervention in the educational community (at school and in the local community);
    ii) Reveal a great spirit of sacrifice, bravery, courage, or self-sacrifice on behalf of others (in the class, school, and local community)
    iii) Promote and encourage heritage conservation;
    iv) Contribute to the promotion and prestige of their school and their grouping;
    v) Promote inclusive education through actions and activities in the class, school, and local community;
    vi) Show exemplary attitudes in overcoming school difficulties caused by prolonged absence due to illness or other reasons.

This feature was, therefore, more than a scoring system; it also served as a comprehensive tool for fostering all-around development. By balancing academic achievement with behavioral metrics and recognition of meritorious actions, the scoring system promoted a holistic learning environment where students are encouraged to excel not just in academics but also as responsible, socially-conscious citizens. It incentivized continuous improvement, respectful behavior, and collaboration, ultimately aiming to enrich the overall educational journey of every student.

This functionality is directly linked with the Calendar feature: having access to all upcoming assessments allowed students to effectively manage their time, which influenced their academic performance and the subsequent points earned. Moreover, the option to filter by subject helped students to focus on underperforming subjects, thereby improving their class's overall score.

4.4.4 Calendar/Scheduling Feature

This feature provided an overview of all upcoming assessment elements for each course, streamlining educational planning and coordination. It allowed students to see all assessment elements for their class and filter them by subject, offering them a personalized learning plan (as can be seen in Figure C.1 from Appendix C). Teachers and class directors could view all assessments across all their classes and filter them by a specific class. The versatility of this feature was also demonstrated through the ability to add and edit individual events, which promoted an organized and personalized learning and teaching environment.

This functionality, while fundamentally practical, also carried strategic implications for the entire learning process since it played a pivotal role in shaping the academic progression of the students and supported the scoring system defined within the application, as previously mentioned.

For teachers, the feature acts as a management tool that allows for an organized, high-level view of assessments across all classes. Doing so facilitates smooth planning and execution of teaching strategies, helping students achieve their academic goals and improve their classes score.

4.4.5 DSS Component

The DSS functionality played a crucial role in enabling teachers and class directors to make data-driven decisions. It offered a comprehensive overview of the class's development over time by displaying the weekly evolution of their score and position (as illustrated in Figure C.2 from Appendix C). The ability to visualize the point distribution within each week and the sources of these points provides valuable insight into students' performance. By analyzing the weight of each scoring component, teachers and class directors could determine the areas in which their students excelled and those in which they needed development, whether in summative assessments or behavioral aspects, as seen in Figure 4.5.

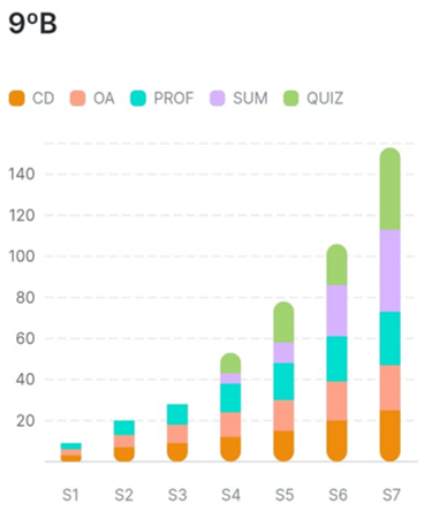

Figure 4.5: Class 9ºB Point Distribution

This feature was especially beneficial for numerous reasons. Teachers could better understand the class's learning curve and adjust their teaching strategies accordingly by tracking the evolution of scores over time. Second, the capacity to analyze point sources enabled teachers to recognize patterns and correlations. For example, if a significant portion of points were consistently derived from behavioral records, teachers could infer that students exhibited commendable conduct but needed to improve academically.

With an in-depth comprehension of how the DSS functionality assisted teachers in optimizing their teaching approach and student performance, it became evident that feedback was a crucial component of this process. Not only did feedback assess the efficacy of implemented strategies, but it also revealed opportunities for advancement.

4.4.6 User Engagement and Feedback Platform

A key feature of the mobile application was its strategic use of push notifications, which proved instrumental in sustaining participants' motivation and engagement. These (at least) weekly notifications were developed using *GlideApp's* existing integration. They had multiple responsibilities, including notifying students of changes to the leaderboard, introducing new features, declaring quiz results, and providing visibility on class accomplishments.

Not only were these notifications sent to students, but also to teachers, class directors, and operational assistants. Teachers and class directors were reminded to record grades for classroom behavior and to update summative assessment scores. In addition, they were prompted to add assessment moments to the application's calendar, allowing students to anticipate opportunities to earn points and prepare accordingly.

In addition, teachers received weekly emails through *Microsoft Outlook*, which, despite not being directly incorporated into the application, served as an essential communication tool. These emails contained a summary of submissions, quiz results, and a schedule of the week's most important tasks. Teachers actively utilized this tool because it enabled them to report improvement opportunities and address any questions or concerns.

Lastly, the app included a straightforward interface that allowed all users to report areas for improvement and ask inquiries about the app. In addition to fostering a sense of ownership and active participation among users, this feature ensured that the application was constantly evolving and improving to satisfy their needs.

The characteristics above highlight the significance of proactive communication and user participation in any application of this type. The application fostered a sense of competition and motivation by providing regular updates, eliciting user feedback, and providing visibility into the class's progress. It kept users informed of their responsibilities and available opportunities. In addition, this active feedback channel enabled the application to be continuously enhanced, ensuring that it remained a practical and beneficial resource for all project participants.

4.4.7 More Gamification Elements

Despite the condensed competition timeframe, another gamification element was introduced to the mobile application during the contest: quizzes. These quizzes comprised one or two questions pertinent to the students' subjects, allowing the class to earn points and adding a dynamic, interactive element to the application.

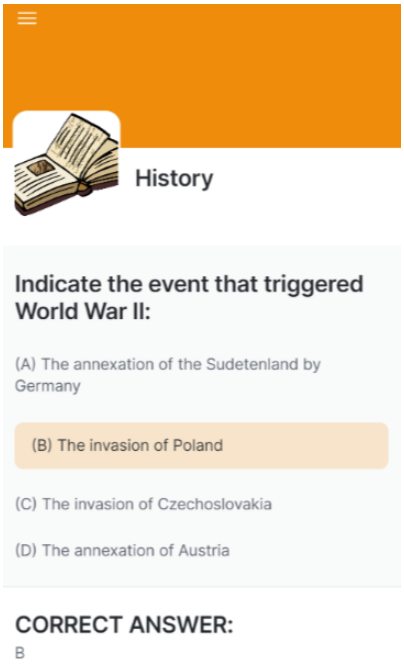

Figure 4.6: History Quiz

Every class that saw full participation from all its students in a quiz was awarded 5 points. The class with the highest ratio of correct answers to eligible students each week was deemed the winner and awarded an additional 5 points. The questions were sourced from teachers via email upon request. They spanned eight subjects: French, English (as seen in Figure C.4 from Appendix C), Mathematics, Portuguese, Physics/Chemistry, History (as seen in Figure 4.6), Geography, and Visual Education. Over the four weeks, new quizzes were introduced each week in a rolling manner, starting with Physics/Chemistry and Visual Education, then progressing to History and Geography, French and English, and finally Portuguese and Maths. Ultimately, 9ºB emerged as the quiz victors, amassing 40 points.

In summary, the incorporation of quizzes as a gamification element in the mobile application served to invigorate and enrich the user experience while simultaneously promoting academic learning and competition. This feature provided an additional avenue for point acquisition, stimulated engagement, and encouraged active student participation. It exemplifies how the strategic integration of gamification elements in an application can be a powerful tool for fostering motivation, increasing knowledge retention, and enhancing overall user experience.

Chapter 5

Results

In this section it was examined three subchapters: "Competition Results", "User Adherence", and "Student Engagement". The "Competition Results" subchapter emphasized the real-time dashboard feature of the application, which provided a detailed analysis of the point totals of each class, their positions in the competition, and the dissemination methods of results. The second subchapter, "User Adherence ", investigated how teachers, operational assistants, and students interacted with the application, concentrating on weekly logs and assessments and student interactions with the application's exams. The final subchapter, "Student Engagement," evaluated the project's impact on student, teacher, and operational assistants engagement by contrasting pre- and post-implementation data regarding their motivation levels.

5.1 Competition Results

The competition results were presented in the application through a real-time updated dashboard, visible to all participants: students, teachers, and operational assistants. The first feature of the dashboard provided a graphical representation of the evolution of the points each class garnered throughout the competition. Figure 5.1 revealed the dynamic nature of the competition, illustrating how the accumulation of points fluctuated over time. It showcased various lead changes and shifts in the number of points accumulated by each class.

The dashboard also enabled the visualization of positional changes throughout the competition. It allowed participants to see the results of their class's performance about other classes. That feature complemented Figure 5.1, also illustrating how close the competition was.

The dashboard also featured a detailed breakdown of the points earned by each class. This breakdown was differentiated by the source of points (as can be seen in Figure 5.2) - whether they were awarded based on the records of the behavioral notes by teachers, operational assistants, class directors, the results of the summative evaluations, or the outcomes of the quizzes. This layer of detail allowed users to understand the different areas of performance contributing to their overall score and gave insights into where improvements could be made.

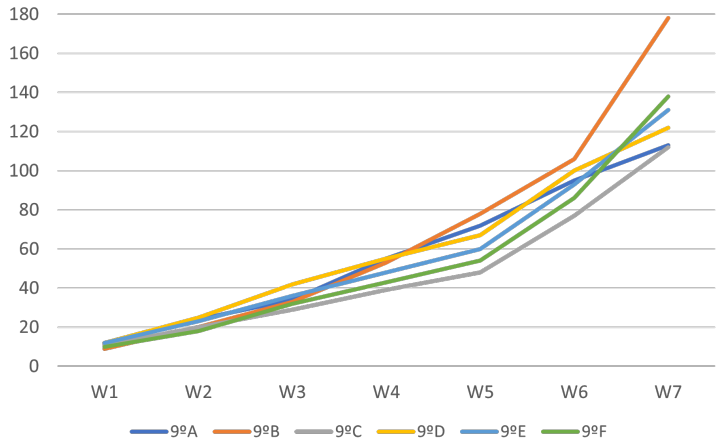

Figure 5.1: Evolution of Class Points and Positions

From the point distribution results, it became clear that 9ºB, the winning class, showcased a distinct advantage: it was the only class that acquired points from every available strand. The class successfully capitalized on the quizzes added to the app and scored 40 points solely from them.

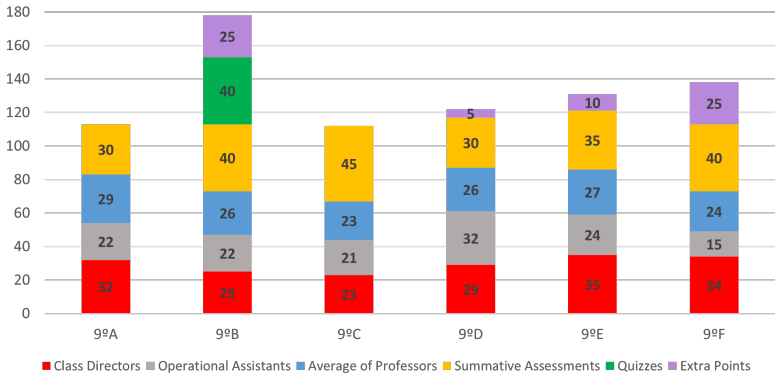

Figure 5.2: Point Distribution across 9th Grade Classes

To determine if any tangible improvement in classroom and extracurricular behavior existed—a key objective of this project— it was necessary to explore the evolution of the classes' behavioral records. It was found that all classes either maintained their behavioral standing or showed noticeable improvement during the competition period. This positive trend was observed in the behavior records documented by both teachers and operational assistants (with the exception in this case of class 9ºC which worsened its grade from a 4 in Week 1 to a 3 in Week 7), indicating an overall betterment in class conduct (as illustrated in Figure D.1 from Appendix D).

After 7 weeks of competition, the leaderboard declared 9ºB as the winning class, having accumulated a total of 178 points. They were followed by 9ºF in second place, with 138 points, and 9ºE in third place, securing 131 points. In fourth place, 9ºD accumulated 122 points, and in fifth place, 9ºA accumulated 113 points. Finally, with a total of 112 points, 9ºC took the sixth position. The

total points accumulated by each class in each week of the competition can be seen in Table 5.1.

Table 5.1: Points Accumulated per Week by each 9th Grade Class

	9ºA	9ºB	9ºC	9ºD	9ºE	9ºF
W1	12	9	11	12	12	10
W2	24	20	20	25	23	18
W3	34	33	29	42	36	32
W4	55	53	39	55	48	43
W5	72	78	48	67	60	54
W6	95	106	77	100	93	86
W7	113	178	112	122	131	138

A ceremonial recognition was held on the last day of school to acknowledge the 9ºB achievement (as seen in Figure D.3 from Appendix D). The class was awarded a trophy cup with sweet candies and an aesthetically pleasing A4 frame that encapsulated a picture of the entire class, underscored by the names of each successful student. This frame found its place on the school's KAIZEN GO Winners Wall (illustrated in Figure D.2 from Appendix D), which was located in the student's open social space within the school.

5.2 User Adherence

Adherence to the app among the users was measured based on the completion rates of quizzes, behavioral note submissions, and summative evaluation submissions. The application facilitated the tracking of class-level user participation, providing a clear picture of class engagement in the competition. A standout result was the performance of the 9ºB class, which demonstrated an average adherence to the quizzes of 64%. This was a significantly higher rate than the second-highest adherence class, 9ºE, which posted a 34% rate of adherence, as illustrated in Figure 5.3.

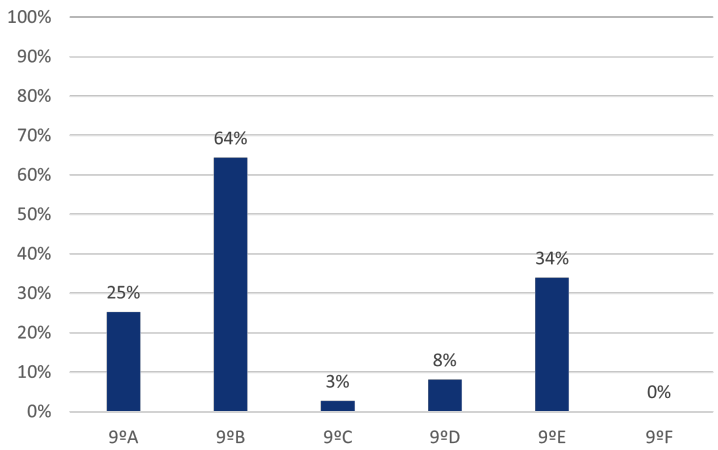

Figure 5.3: Average Adherence of Quiz Answers per Class

Certain limitations affected user engagement among some classes. The 9ºF class, for instance, faced technical constraints that limited their participation in quizzes, due to an incident at school that resulted in several students not owning a cell phone. Similarly, the 9ºC and 9ºD classes showed very low adherence rates of 3% and 8%, respectively.

Weekly submission rates of behavior notes provided another measure of user adherence. As per the design of the competition, class directors and operational assistants maintained a consistent record of behavior notes each week, manifesting an adherence level of 100%. However, submission rates among all teachers varied, as illustrated in Figure 5.4. The highest compliance rate was achieved by the 9ºA and 9ºB classes, registering 92%. The 9ºA class followed closely with an 88% compliance rate, with the 9ºF class fifth at 71%. The 9ºD and 9ºE classes experienced lower compliance rates of 58% and 46%, respectively.

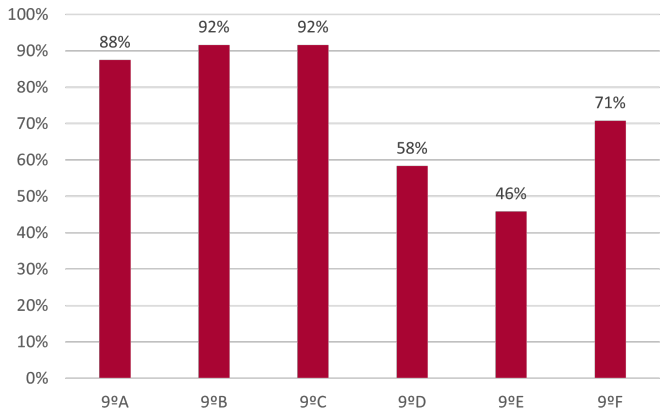

Figure 5.4: Percentage of Behavioral Notes Submissions per Class

In the context of summative evaluation records throughout the seven weeks of competition, a total of 34 moments of assessment were recorded. These moments provide insights into class performance and adherence to the competition objectives. Complete success was registered in 10 of these assessment moments, with 100% of the class scoring positively. This constitutes a success rate of 29% (10 out of 34 submissions). A total of 23 instances displayed an increase in the average grade compared to the previous assessment, indicating a 68% rate of progress. Lastly, in 11 moments, it was observed that 40% of the class or more obtained a grade equal to or higher than 4 points, representing a rate of 32%.

5.3 Student Engagement

After the implementation of the mobile application and the conclusion of the 18-week project, a follow-up survey was conducted to reassess the motivation levels among the 9th-grade students and the NPS of the application. Fifity-five students participated in this *Microsoft Forms* survey equal to the one presented in chapter 3 to assess the student's motivational levels pre-implementation of the app.

Among these students, 32 reported being regularly motivated to learn at school (58%). This represents an increase of 12 percentual points (pp) from the pre-implementation stage. Meanwhile, the number of students who said being rarely motivated decreased to 2 (4%), which represents a decrease of 2pp. These results can be seen in Figure 5.5.

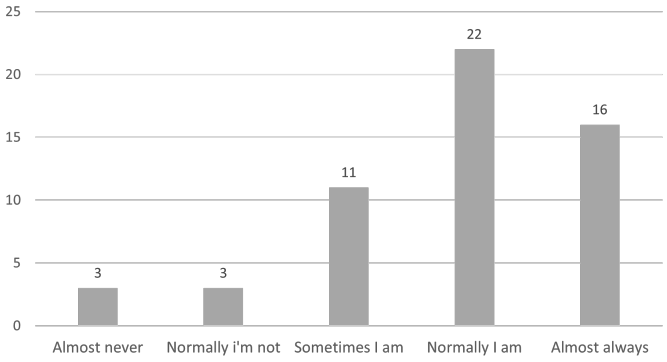

Figure 5.5: Escola de Campo student answers regarding their motivation levels in school (post-app implementation)

Turning to the teachers' and operational assistants' perspectives, 18 responses were collected post-implementation out of the 26 teachers and operational assistants that participated in the project. In this survey, 44% reported observing regular motivation in students during their learning at school, marking an increase of 36pp from the pre-implementation stage. These results can be seen in Figure 5.6.

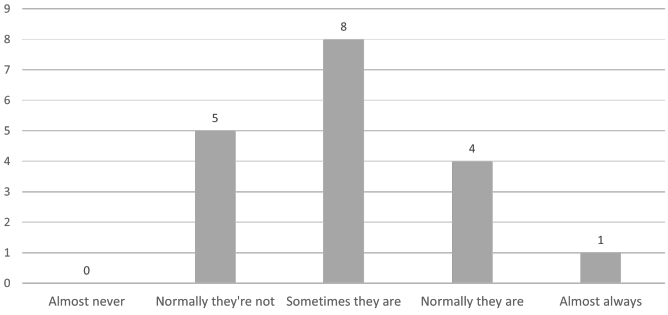

Figure 5.6: Escola de Campo teacher answers regarding their student's motivation levels in school (post-app implementation)

The NPS of the school was also in question in both surveys. When students were asked if they recommend ESBC to someone they know, the average classification obtained pre-implementation, on a scale of 1 to 10, was 6.91, with 27% of students being detractors (grades between 0 and 6) and only 21% being promoters (rates of 9 or 10) resulting on a negative NPS of -6. After implementation, the results shifted, with the student's average classification being 7.44, with 17% being detractors (10pp decrease) and 27% being promoters (6pp increase), resulting in an NPS of 10. When teachers and operational assistants were asked if they would recommend working in ESBC to someone they know, the average classification obtained pre-implementation, on a scale

of 1 to 10, was 7.76, with 20% of teachers and OA's being detractors and 48% being promoters resulting on an NPS of 28. After implementation, the results were even better, with the teacher's and OA's average classification being 8.33, with 12% of teachers and OAs being detractors (8pp decrease) and 72% of teachers and OAs being promoters (24 pp increase), resulting in an NPS of 60.

Lastly, the NPS for the mobile application was also calculated to measure its acceptance among users. Among the student users, the application achieved an NPS of 19. The teacher's and operational assistants' grades reflected an NPS of 27.

Thus, the post-implementation surveys illustrate changes in the reported motivation levels among students, the perceived motivation levels among teachers and operational assistants, the acceptance and use of the mobile application as per the NPS, and in the school NPS among all participants as seen in 5.7. It's important to highlight that there's a discrepancy in the sample used in both surveys, as in the pre-implementation study, 89 students and 25 teachers/OAs answered the Forms, and in the post-implementation survey, only 55 students (62% of the previous sample size) and 18 teachers/OAs (72% of the last size sample) answered the Forms.

	STUDENT SURVEY		
	PRE-APP IMPLEMENTATION	POST-APP IMPLEMENTATION	Δ(pp)
SAMPLE SIZE (NUMBER OF STUDENTS)	89	55	-34
% OF SUDENTS REGULARLY MOTIVATED TO LEARN AT SCHOOL	46%	58%	+12pp
% OF SUDENTS RARELY MOTIVATED TO LEARN AT SCHOOL	6%	4%	-2pp
SCHOOL NPS (AVERAGE CLASSIFICATION)	6.91	7.44	+0.53
% OF DETRACTORS	27%	17%	-10pp
% OF PROMOTERS	21%	27%	+6pp
APP NPS	NA	19	

	TEACHER/OA SURVEY		
	PRE-APP IMPLEMENTATION	POST-APP IMPLEMENTATION	Δ(pp)
SAMPLE SIZE (NUMBER OF TEACHERS/OAs)	25	18	-7
% OF SUDENTS REGULARLY MOTIVATED TO LEARN AT SCHOOL	8%	44%	+36pp
% OF SUDENTS RARELY MOTIVATED TO LEARN AT SCHOOL	8%	0%	-8pp
SCHOOL NPS (AVERAGE CLASSIFICATION)	7.76	8.33	+0.57
% OF DETRACTORS	20%	12%	-8pp
% OF PROMOTERS	48%	72%	+24pp
APP NPS	NA	27	

Figure 5.7: Student Engagement Results: Pre-App Implementation vs Post-App Implementation

Interpretations, implications, and conclusions drawn from these results will be thoroughly addressed in chapter 6. Additionally, this upcoming chapter explores potential future research opportunities related to this project and its further development.

Chapter 6

Main Conclusions And Future Research Opportunities

Before extracting conclusions, it is essential to reflect on the goals that were set out to achieve, the process followed, and the results obtained. This project's initial objective was to improve the educational experience of students, teachers, and operational assistants, by creating a supportive learning environment, with improved student behavior, increased motivation, and enhanced academic performance. These goals were monitored using strategic tools such as *Microsoft Forms* and the application's real-time dashboard. Using the data gathered and the observations made, this chapter summarizes the successes, identifies the limitations, and emphasizes the most important lessons learned throughout the project. Future research opportunities are also outlined, from expanding the project scope and user functionalities to using the application as a tool to formulate the School's Strategic Plan (SSP).

6.1 Conclusions

The main conclusions extracted from the results obtained (the competition results, the user adherence results, and the student engagement results) were the following:

- **Enhancement of Educational Experience:** Even though the sample size of students, teachers, and operational assistants that answered the surveys post-app implementation was not ideal (only 55 students out of 140 and 18 teachers and operational assistants out of 28 answered), the project has demonstrated high potential to have enhanced the educational experience of all participants, as can be seen by the results. Not only did the application receive a positive NPS from students (19) and staff (27), indicating that users, in their majority, viewed the application as valuable and advantageous, but also the school NPS improved (from -6 to 10 in students and from 48 to 60 in the case of teachers and operational assistants), suggesting and enhancement of the educational experience of all stakeholders of the project ;

- **Improved Motivation and Behavior:** The initiative appeared to have a significant impact on the motivation and behavior of students. Post-implementation surveys revealed a significant increase in student motivation, with fewer students reporting low motivation. This demonstrates that the application and attendant competition served as motivating factors, which likely contributed to the student's engagement and interest in academic tasks. Teachers and operational assistants have observed that students' conduct has improved, indicating that this motivation has had a domino effect on their behavior. This indicates a positive change in the learning environment;

- **Peer Support and Performance:** It appeared that the competition and point system fostered a culture of peer support among students. Class 9ºB, for instance, accumulated points from every conceivable source. This suggests a holistic approach to learning, which may include peer mentoring, collaborative study, and shared effort. The competition appeared to have fostered teamwork and encouraged students to assist one another, fostering both individual and collective development;

- **Increased Academic Performance:** Preliminary evidence suggests that academic performance has improved. There was a substantial increase in instances of assessment in which the average grade improved in comparison to the previous period. This demonstrates that the influence of the initiative could have extended beyond non-academic parameters and into the realm of academic achievement. However, a longer-term study should be done to establish this correlation conclusively;

- **Effective Project Tools:** Microsoft Forms served as an invaluable instrument for collecting and analyzing the motivational indices and NPS of the stakeholders. Effectively fostering engagement and competition, the real-time interface enhanced the interactivity and enjoyment of the learning process. These instruments were vital in accomplishing the project's main objectives;

Despite the overall success, a few obstacles were observed. There were technical difficulties in some classes, and the rate of teacher compliance varied. This indicates the necessity of addressing such problems in the future. Providing a more robust technological infrastructure, making the application more accessible, and incentivizing teachers to utilize the platform consistently are potential areas for development.

Overall, despite some reserves regarding the sample size obtained in the results, the initiative proved to have extreme potential in enhancing the educational experience, boosting motivation, fostering a cooperative learning environment, and even improving academic performance. It provides a promising foundation for future initiatives to expand, addressing its shortcomings to produce a more effective and enriching solution in the education sector.

6.2 Future Research Opportunities

The subchapter explores potential expansion and improvement avenues for the mobile application by determining how the application could be optimized for widespread usage and greater effectiveness throughout the entire school.

6.2.1 Formulating the School Strategic Plan

The mobile application also has the potential to significantly contribute to developing and implementing a robust school strategic plan (SSP). Given the inherent functionalities of the application, it could aid in critical areas of the SSP, fostering alignment, promoting comprehensiveness, and enhancing the decision-making process through an evidence-based approach.

Firstly, the application could be a valuable tool for ensuring alignment with the school's mission and vision. It provides an innovative platform that could be adapted to resonate with the school's overarching goals and objectives. For example, the app could be utilized to promote values such as inclusivity, academic excellence, or community engagement, depending on the specific vision and mission of the school.

Moreover, by capturing and aggregating data on student behavior, academic performance, participation, and motivation levels, the application enables a comprehensive understanding of the student population and the school context. This rich dataset provides insights that could inform tailored strategies and interventions to address specific needs and characteristics of the students and the broader school environment.

The mobile application, with its decision support system component, has an inherent potential to bolster the comprehensiveness of the school's strategic plan. The app ensures a clear link between needs, goals, and solutions by capturing diverse data points related to student and class performance. Therefore, the strategic plan, informed by this comprehensive data, the strategic plan could become more nuanced, relevant, and effective.

Furthermore, the app promotes evidence- and research-based strategies by providing a platform where practices can be tested, evaluated, and refined based on real-time data. This feature resonates with the need for school strategic plans to be grounded in evidence and research. Engaging parents and the community could also be facilitated through the app. The app could stimulate parental involvement and community interest by allowing visibility of class performances, upcoming events, or competitions.

Lastly, the app could be leveraged to focus on professional development within the school. The app could inform targeted professional development initiatives by identifying areas where teachers or operational assistants excel or require additional support. Thus, the application is valuable for developing a comprehensive, practical, and contextually relevant School Strategic Plan.

6.2.2 Expanding Project Scope and User Functionalities

To augment the application's effectiveness, incorporating a robust incident recording system can be highly beneficial. Operational assistants can log incidents like disciplinary issues or behavioral events directly into the application. This addition would facilitate a more seamless and comprehensive logging process. Moreover, with this feature, the school psychology office and the directorate would have immediate access to these reports, enabling them to promptly identify trends, discern patterns, and pinpoint areas that require attention. The insights from this data could serve as the basis for implementing targeted interventions, thus enhancing the overall educational environment and students' well-being.

Additionally, the application could be expanded to include monitoring of disciplinary absences, attendance records, and tardiness. This feature would give teachers a centralized platform for recording and tracking daily attendance. It would streamline attendance management, simplify identifying attendance patterns, and aid efforts to increase overall student attendance rates while, at the same time, making it easier to identify students needing additional assistance or intervention to address attendance-related issues and improve overall punctuality.

Incorporating grade records into the application would also be an added advantage since it would provide teachers with a convenient way to input and monitor students' academic performance. This feature would provide a comprehensive overview of students' grades, allowing for the timely identification of struggling students and facilitating the delivery of targeted academic support.

It's vital also to improve communication between all parties involved – teachers, students, operational assistants, and even parents. Incorporating parent access into the application would mark a significant stride toward enhancing the application's transparency and inclusivity. This feature would let parents stay updated on their child's progress, behavior, and upcoming events. By granting parents this level of access, the application becomes a shared space for interaction and involvement, fostering a more collaborative relationship between the school and parents. Parents could keep tabs on their child's academic performance, behavior, attendance, and incident reports, promoting a more holistic understanding of their child's school experience. This could be achieved by incorporating features such as messaging systems, virtual meetings, and shared calendars, making the application a comprehensive platform for interaction and collaboration.

Finally, in future editions of the competition, it's crucial to expand the scope of the application from being solely utilized by the ninth grade to the entire school, from fifth to twelfth grade. Younger students (from first to fourth grade) could also be included, and the app, in the future, could also expand to several schools in the country (or in other countries), promoting healthy competition among them within their respective age groups. To achieve this, the application would need scalable functionalities. This includes developing an adaptive interface and having the ability to handle multiple competitions or different points systems simultaneously, catering to the diverse needs of various grades, classes, and schools.

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Appendix A

Current State Diagnostic

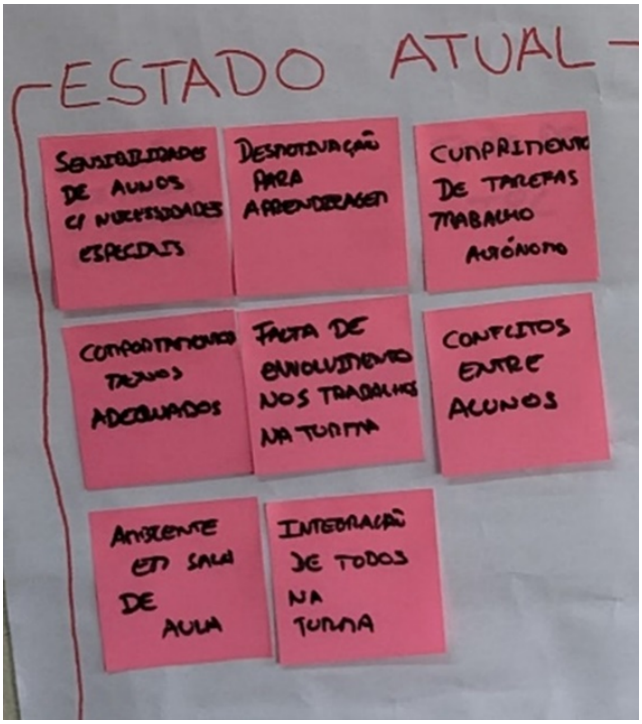

Figure A.1: Description of the current state of the school's 9th grade using post-its

Appendix B

Project Chronogram

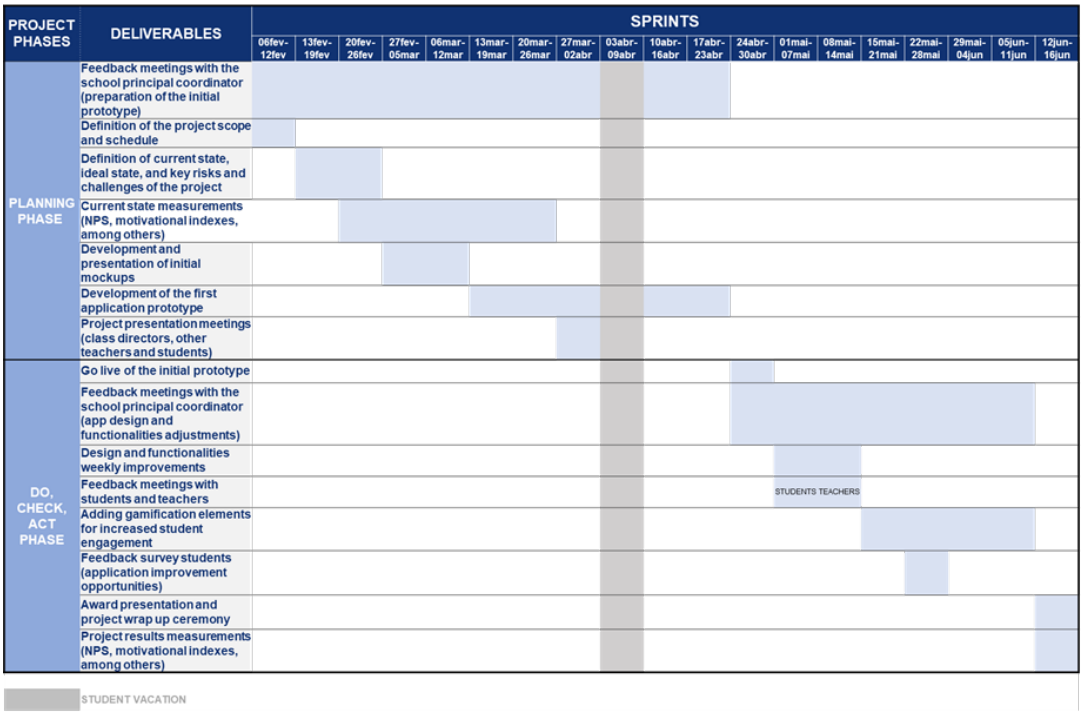

Figure B.1: Project Chronogram agreed upon with the School Principal Coordinator

Appendix C

Final Application Design and Functionalities

C.1 Calendar Feature

Figure C.1: Calendar interface showcasing (by color) each subject evaluation moment

C.2 Competition Dashboard

Figure C.2: Dashboard interface showcasing the competition's current leader and point distribution among classes

C.3 Summative Evaluation

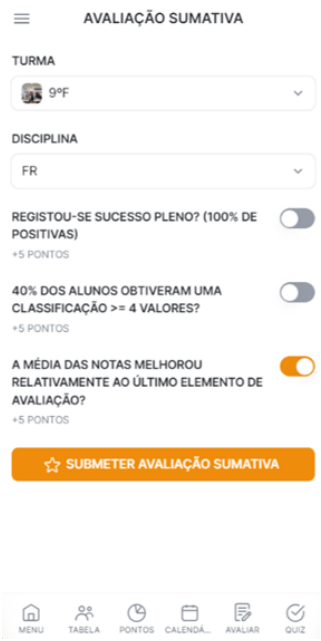

Figure C.3: Summative evaluation interface for teacher registration

C.4 Quiz Example

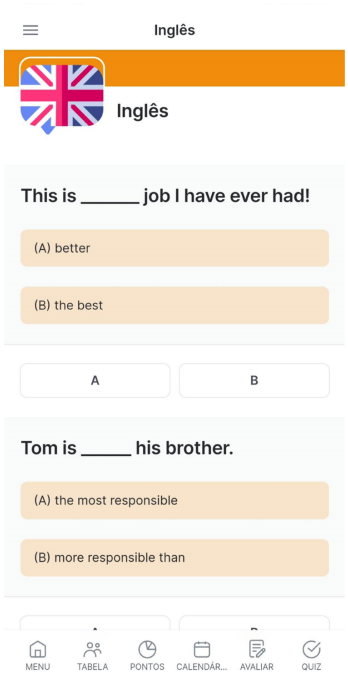

Figure C.4: Quiz interface for student answer regarding the English subject

Appendix D

Competition Results

D.1 Class Behavior

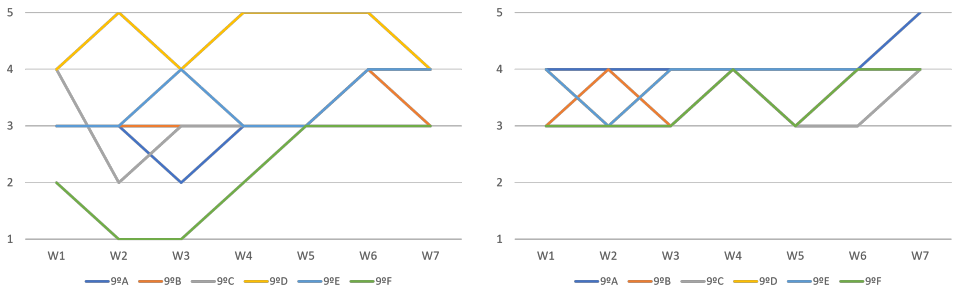

Figure D.1: Evolution of Class Behavior by OA's (Left) and Teachers (Right)

D.2 KAIZEN GO Winner Wall

Figure D.2: KAIZEN GO Winner Wall with personalized banner and winning class A4 frame

D.3 Award Ceremony

Figure D.3: Winning class (9ºB) celebration