

Development of 21st-Century Skills and Competencies in High School Students Through the Interactive E-Books Creation

Deivid Eive dos Santos Silva
Federal University of Paraná
ORCID: 0000-0003-1066-0750
dessilva@inf.ufpr.br

Marialina Corrêa Sobrinho
Federal University of Western Pará
ORCID: 0000-0002-3928-5432
linasobrinho@gmail.com

Natasha Malveira Costa Valentim
Federal University of Paraná
ORCID: 0000-0002-6027-3452
natasha@inf.ufpr.br

Abstract

Currently, the need to prepare students for the challenges of the 21st-Century is being recognized, referred to as Education 4.0. This paradigm aims to redefine the education model by fostering the development of 21st-Century skills and competencies, such as problem-solving, creativity, collaboration, communication, and learning to learn. Therefore, this article explores the uses of the Teacher Assistance Educational Process (TAEP4.0) in a real educational scenario. TAEP4.0 is a student-centered process inspired by Education 4.0, which assists teachers in creating projects in the Informatics Lab. The TAEP4.0 process was implemented through a case study focused on fostering 21st-Century skills and competencies among High School students, using the Book Creator platform for interactive e-book creation projects. TAEP4.0 consists of a series of steps that include suggested activities, tools, and support materials. However, teachers have the flexibility to adapt the TAEP4.0 process, exercising their creativity and making decisions regarding project elements, such as the choice of Information and Communication Technology (ICTs) for project creation and monitoring, with the aim of promoting skills and competencies. In this case study, five classes of two High School teachers participated, involving a total of 189 students in the projects. The data collected were analyzed both quantitatively and qualitatively. During the projects, students engaged in activities and reported difficulties, primarily related to communication and teamwork. This feedback enables teachers to gain insight into students' challenges in applying the necessary skills to produce a project. Such evidence can assist teachers in addressing these issues in the future, allowing for project reuse and the creation of new projects that focus on improving specific skills and competencies.

Keywords: Education 4.0, Interactive e-Books, Skills and Competencies, 21st-Century, High School

1 Introduction

In Education 4.0, the focus is on personalized learning processes that aim to prepare young people for the contemporary world. This approach allows students to have the flexibility to construct knowledge and work towards achieving their desired goals (Hartono, Kosala, Supangkat, & Ranti, 2018). Moreover, Education 4.0 emphasizes the cultivation of a dynamic mindset, encouraging students to collaboratively and creatively solve real-world problems, generate innovative and technological solutions, and become active and responsible participants in their own learning (Angrisani et al., 2018). Consequently, students need to develop 21st-Century skills and competencies (Silva, Lopes, Corrêa Sobrinho, & Valentim, 2021).

This article aligns with the definition provided by the European Center for the Development of Vocational Training (CEDEFOP, 2008), which distinguishes between skills and competencies. According to this definition, skills refer to the ability to perform specific tasks and solve problems within a particular context. On the other hand, competencies involve applying acquired skills in various contexts, such as educational, professional, and personal settings. Competence is seen as a combination of knowledge, experiences, and skills (Angrisani et al., 2018). As a result, competence encompasses not only cognitive elements but also functional aspects (technical skills) and interpersonal attributes (social and organizational skills) (Ananiadou & Claro, 2009).

In this sense, education needs to enable the use of Information and Communication Technologies (ICTs) to support the development of 21st-Century skills and competencies (Angrisani et al., 2018) because who will succeed in the contemporary world will be a country with innovation, creativity, and skill in the technological field (Gaol, Napitupulu, Soeparno, Trisetarso, et al., 2018). Hence, it is essential to provide students with adequate preparation during their Basic Education years, as this lays the foundation for the development of skills and competencies required for success in Higher Education. By acquiring these essential skills and competencies early on, students are more likely to have a positive and enriching experience during their higher education journey. Moreover, possessing such skills and competencies significantly enhances their employment prospects in the contemporary world. (Pérez-Pérez, Gómez, & Sebastián, 2018).

Education 4.0 advocates the use of various ICTs to support the learning process. These technologies include robotics, digital platforms, interactive books, and interactive videos (Ciolacu, Svasta, Berg, & Popp, 2017; Ciolacu, Tehrani, Beer, & Popp, 2017). When integrated with active methodologies like project-based learning and collaborative learning, these ICTs can enable students to take on a more active role in their education through engaging in practical, interactive, and diverse activities (Jumari, Mohd-Yusof, & Phang, 2016). By combining technology with these active learning approaches, Education 4.0 aims to create a more participatory and immersive learning environment for students.

Adapting learning approaches that focus on competencies and skills to the social, cultural, and educational contexts of each location is crucial (Magrin et al., 2022). In the case of Brazil, for instance, the National Common Curricular Base (Base Nacional Comum Curricular - BNCC¹) provides guidance to schools, emphasizing the development of various competencies, including the use and creation of ICTs. These competencies aim to assist students in problem-solving, knowledge production, information dissemination, and fostering personal and collective agency

¹<http://download.basenacionalcomum.mec.gov.br/>

(Moraes, Duran, & Bittencourt, 2023). Additionally, considering the socioeconomic context of many Brazilian schools, low-cost approaches are often preferred (Moraes et al., 2023). This approach ensures that education is accessible and relevant to the specific needs and resources of the local context.

In the Brazilian scenario, Fiorio, Varela, and Semler (2020) used the Khan Academy platform for Physics classes in High School, making it possible to encourage mainly the motivation and protagonism of students through resources such as videos, e-books, and solving activities. Besides, Magrin et al. (2022) and Moraes et al. (2023) worked with educational robotics and STEAM (an acronym that allows to actively work on the content of the following areas: Science, Technology, Arts, and Mathematics) in Elementary and High Schools. Magrin et al. (2022) worked mainly on hard skills related to robots, such as backward, forward, left, and right movements. In Moraes et al. (2023), it was also possible to work on non-technical skills, emphasizing teamwork and special attention to students' concentration. However, no approach was identified that would support the teacher in classes planning, allowing the inclusion and assessment of 21st-Century skills and competencies in the learning process.

Based on the aforementioned observations, this case study focuses on fostering 21st-Century skills and competencies among students through projects created by High School teachers. To facilitate this objective, the teachers employed the TAEP4.0 methodology. TAEP4.0 consists of a series of steps that assist teachers in documenting, sequencing, and evaluating activities. However, TAEP4.0 goes beyond mere activity organization; it provides teachers with resources and materials to develop skills and competencies effectively. In this particular case, students were engaged in creating interactive e-books using the Book Creator platform and the available ICTs in the Informatics Lab. This approach aimed to provide students with a hands-on experience that fostered the development of essential skills and competencies in a dynamic and interactive manner.

The researchers aimed to address the following research question: "What 21st-Century skills and competencies were developed in High School students when they participated in the interactive e-book projects built with TAEP4.0?". Additionally, three sub-questions were answered: (SQ1) What skills and competencies did the students demonstrate a higher level of mastery in during the projects?; (SQ2) What skills and competencies did the students encounter the most difficulties with during the projects?; and (SQ3) What insights can the teacher extract from student feedback regarding the development of skills and competencies? To answer these research questions, the researchers administered a self-assessment questionnaire to High School students. The questionnaire was designed to assess the development of specific skills and competencies, including Creativity and Innovation, Problem-Solving, Decision-Making and Critical Thinking, Learn to Learn and Metacognition, Communication, Collaboration, and Teamwork. These skills and competencies were chosen based on their prominence in the literature (Binkley et al., 2012; Messias et al., 2018) and their inclusion in the project planning scope defined by the teachers. The collected data were analyzed using both quantitative and qualitative methods. The results provided insights into the difficulties and strengths observed among students in relation to the investigated set of skills and competencies. This information can guide teachers in addressing these issues and helping students deal with the challenges of the 21st-Century effectively.

2 Background

The term Education 4.0 is relatively new and lacks a standardized and universally accepted definition in the literature. Much of the existing literature on Education 4.0 consists of abstract and theoretical studies (Bonfield, Salter, Longmuir, Benson, & Adachi, 2020; Himmetoglu, Aydug, & Bayrak, 2020). In order to understand the expectations associated with Education 4.0, researchers examined works that encompassed the characteristics and definitions attributed to this concept. From an industry perspective, Education 4.0 can be seen as a broad approach or trend aimed at preparing the future workforce for the demands of Industry 4.0 (Bonfield et al., 2020). It represents a response to the needs of Industry 4.0, where humans and technologies are aligned, opening up new possibilities (Hussin, 2018). From an educational standpoint, Education 4.0 is characterized by virtual courses that incorporate interactivity through blended learning, as well as resources driven by technologies like Artificial Intelligence (Ciolacu, Tehrani, et al., 2017). The goal of Education 4.0 is to cultivate individuals with the skills necessary for creativity and innovation (Silva et al., 2021). In Education 4.0, teaching and learning are expected to be student-centered, with the main responsibility for learning shifting to the students themselves (Maria, Shahbodin, & Pee, 2018; Hussin, 2018). It should be noted that some education specialists may consider the industry-centric definition of Education 4.0 inadequate, as the concept extends beyond the specific goals of the industry. Education 4.0 has the potential to prepare young people for the contemporary world in a broader sense, addressing the multifaceted challenges and opportunities of the modern era.

Given the lack of a precise and universally agreed-upon definition, Education 4.0 can be characterized as a student-centered learning paradigm that aims to prepare students for the challenges of the 21st-Century. This paradigm involves the integration ICTs in the educational process and emphasizes the development of relevant skills and competencies. It acknowledges the need for students to acquire not only subject-specific knowledge but also a range of 21st-Century skills such as critical thinking, problem-solving, creativity, collaboration, communication, others. Education 4.0 recognizes the transformative potential of technology and strives to leverage its capabilities to create engaging, interactive, and personalized learning experiences that equip students with the skills and knowledge necessary for success in the contemporary world. (Ciolacu, Tehrani, et al., 2017; Maria et al., 2018; Mourtzis, 2018; Himmetoglu et al., 2020; Silva et al., 2021).

In Education 4.0, the learning process is centered around fostering innovation through individual and collective practices that involve the use of ICTs (Himmetoglu et al., 2020). In this way, the role of the teacher shifts to that of a facilitator who is available to address complex issues and provide support to students (Ciolacu, Tehrani, Binder, & Svasta, 2018; Hartono et al., 2018). The teacher's responsibilities include nurturing student motivation, enhancing their skills and competencies, and providing appropriate guidance to help them construct new knowledge (Jumari et al., 2016). Education 4.0 enables various approaches to learn, including: a) Dynamic learning: Students have the autonomy to determine what they want to learn, when, how, why, and where. In this scenario, the teacher's role is to guide and encourage students throughout their learning journey; b) Experiential learning: Students engage in social interactions with their peers, groups, and teams, which allows for collaborative and experiential learning experiences; and c) Learning by doing: Students learn through practical activities, gaining hands-on experience and developing practical knowledge that is relevant to their lives in the 21st-Century (Hartono et al., 2018). By adopting these approaches, teachers in Education 4.0 empower students to take ownership of their

learning, foster collaboration and social interaction, and acquire practical skills that are essential for thriving in the modern world.

2.1 Development and Assessment of 21st-Century Skills and Competencies

In Education 4.0, there is a significant focus on developing and assessing skills and competencies due to their innovative and essential nature for life in the 21st-Century (Messias et al., 2018). These skills and competencies are seen as crucial for individuals to thrive in a rapidly changing society influenced by ICTs (Gresse von Wangenheim et al., 2020). Students need to develop these skills to effectively utilize new ICTs and contribute to technological advancements and innovations (Maria et al., 2018). Among the various 21st-Century skills and competencies, the ones that have been extensively studied in the literature include Creativity and Innovation, Problem-Solving, Communication, Collaboration, and Learn to learn (Messias et al., 2018).

The development of 21st-Century skills and competencies has indeed posed a significant challenge in education. However, they are considered essential as they enable students to apply their knowledge across various domains to solve real-life problems, whether in domestic or community settings (Kong et al., 2014). In this regard, Kong et al.(2014) identified six critical research issues that can impede the development of these skills in schools, as presented in Table 1.

Table 1: Critical Research Issues for 21st-Century Skills and Competencies Development.

| Critical research questions | Research suggestions |
|---|---|
| Lack of motivation for school leaders to make competencies and skills a priority in the curriculum | Show evidence of the benefits of developing 21st-Century skills and competencies in elementary and High School students |
| Lack of relationship between school curriculum and real situations in society | Present possibilities of how to work the curriculum content practically to allow authentic and contextualized learning |
| Need for student-centered learning | Indicate alternatives so that teachers may include resources and scenarios that allow to students develop of 21st-Century skills and competencies |
| Defense of active learning and use of digital technologies | Explore ways to provide learning analytics to collect evidence of improvement, make students aware of progress, assist teachers in pedagogical decision-making, and maximize student learning opportunities in 21st-Century skills and competencies development |
| Lack of a coherent and formative mechanism for assessing 21st-Century skills and competencies | Study ways to support schools in using Information Technology to assess 21st-Century skills and competencies integrated with domain knowledge |
| Lack of teacher support to prepare students with 21st-Century skills and competencies | Present theoretical frameworks and practical strategies to promote the development of 21st-Century skills and competencies. Besides, it allows teachers to design, apply, reflect and iteratively refine their pedagogical practice to achieve student-centered learning with the use of ICTs |

Fonte: (Kong et al., 2014)

These critical research issues highlight the complexities and multifaceted nature of developing 21st-Century skills and competencies in education. Researchers play a crucial role in addressing these challenges and can contribute to understanding the changes in the objectives, processes, and outcomes of learning in Basic Education over a span of ten years (2014-2024), as outlined in Table 1. Their contributions can inform educational practices, curriculum design, pedagogical approaches, assessment methods, teacher training, and policy development, ultimately facilitating the effective integration and development of 21st-Century skills in educational settings.

Indeed, the Assessing and Teaching of 21st-Century Skills (ATC21S) initiative is frequently mentioned in the literature as a comprehensive framework for assessing and developing 21st-Century skills and competencies. The ATC21S model defines ten skills that are grouped into four categories, as follows: (a) Ways of Thinking (Creativity and Innovation; Problem-Solving, Critical Thinking, and Decision-Making; Learn to Learn and Metacognition); (b) Ways of Working (Collaboration and Teamwork; and Communication); (c) Tools to Work (Information Proficiency, and Information Communication Technology Proficiency); and (d) Living in the World (Global and Local Citizenship, Life and Career, Social and Personal Responsibility) (Binkley et al., 2012). This framework provides a comprehensive and well-structured approach to understanding and assessing 21st-Century skills and competencies. It encompasses both cognitive and socioemotional aspects, reflecting the multifaceted nature of these skills. By defining these skills and categorizing them into meaningful groups, the ATC21S model offers guidance for educators, policymakers, and researchers to integrate and develop these skills within educational settings.

Next, researchers identified some works that utilized the ATC21S model by Binkley et al. (2012) to assess and develop 21st-Century skills and competencies. :

- **Assessing 21st-Century Skills Model (bASES21):** This model consists of a self-assessment questionnaire used to measure the impact of Computer Education in schools. The model presents 82 sentences divided into 13 categories. Unlike Binkley et al. (2012), bASES21 has three more skills categories, which are: Computational Proficiency, Health Proficiency; and Environmental Awareness (Mioto, Petri, von Wangenheim, Borgatto, & Pacheco, 2019).
- **21st-Century Skills Self-Assessment Questionnaire:** Five skills were considered among the skills presented by Binkley et al. (2012), being Creativity and Innovation, Problem-solving, Communication, Collaboration and Learn to learn. Thirty-four High School students participated in this case study. At the end of this study, students provided feedback about robotics activities performed in the context of Education 4.0 (Messias et al., 2018).
- **Questionnaire for assessing 21st-Century skills:** Twenty students rated on a scale from 1 to 5 the degree to which they believe have acquired 21st-Century skills. Among the skills presented by Binkley et al. (2012) are Decision-making, Critical thinking, Innovation / Creativity, Problem-solving, Communication, Collaboration / Teamwork, among others. Students were also asked to explain the reasons for their responses (Talmi, Hazzan, & Katz, 2018).

The ATC21S model was considered for this case study to prepare the 21st-Century skills and competencies self-assessment questionnaire. Also, some bASES21 sentences were added to the questionnaire. The selected sentences could be ranked on a 5-point Likert scale as used by Messias et al. (2018). Unlike Talmi et al. (2018), which also evaluates on a five-point scale, but does not use

sentences, only the skill categories. In addition to quantitative responses, students could provide qualitative feedback, explaining the reason for their responses on the Likert scale (Messias et al., 2018; Talmi et al., 2018). The 21st-Century skills and competencies self-assessment questionnaire is available at the following link: <https://figshare.com/s/030fe9f22e7c47110a8f>.

2.2 Related Work

This subsection presents some studies that sought to develop and assess 21st-century skills and competencies. Moreover, the studies present technologies that can be used as alternatives in the context of Education 4.0. In this context, in Latorre-Coscolluela et al. (2021), students could use audiovisual resources, such as videos, figures, diagrams, graphics and images, quiz-type questions, mind maps, or the design of questions to exchange with other classmates. The authors applied an online questionnaire with university students after carrying out projects using the Flipped Classroom methodology to develop 21st-Century skills and competencies. These skills and competencies were organized into seven different dimensions: Character building, Collaboration, Communication, Citizenship, Critical thinking, and Creativity. The authors aimed to present and describe this experience before and during the COVID-19 pandemic. The results showed a high agreement among students on the benefits and effectiveness of projects to develop skills and competencies. Students who performed the online experience were less favorable to indicators of skills and competencies related to collaboration and learning with classmates. The authors realized that if online learning students recognized support regarding the use of technology and monitoring of learning in the projects, their assessment of the acquisition of skills and competencies would have been more positive.

Next, in Obi, Eze, and Chibuzo (2022), simulations and business games are used. In this work, the authors aimed to determine experiential learning activities required of business education to develop 21st-Century skills. The skills investigated were: Critical Thinking, Communication, and Collaboration. The authors performed descriptive research using a structured questionnaire that contained 26 items. The instrument used a five-point rating scale of: strongly agree, agree, undecided, disagree, strongly disagree. Three business education specialists validated the data collection questionnaire. Results revealed that respondents engaged in experiential learning activities involving role-plays, practice in business labs, real-life case studies, peer reviews, creative competitions, and self-directed projects. Thus, the authors concluded that business education programs need to be deeply rooted in experiential activities, as these activities contribute to the development of 21st-Century skills.

Subsequently, Lavi, Tal, and Dori (2021) suggest the use of Massive Open Online Courses (MOOCs) to deliver course materials, and they also suggest the creation of technological systems to instill engineering principles in students. Thus, the authors conducted a study that aimed to characterize the skills developed in students and write how participants developed these skills during their studies. A total of 1578 participants participated in this study: 930 alumni and 648 finalists from a research university in Science, Technology, Engineering, and Mathematics (STEM). The authors created a self-report questionnaire containing 14 skills organized into 3 domains. The skills were: domain-general skills (Complex problem-solving, Critical thinking, Individual learning, Questions posing, Systems thinking), soft skills (Creativity, Collaboration, Intercultural communication, Oral and Written communication), STEM skills (Engineering design, Experimenting

and testing, STEM knowledge application). Content analysis of qualitative data revealed nine teaching and learning methods through which skills developed. The quantitative analysis identified that the methods that enabled active learning had a medium-sized effect on STEM-specific skills and soft skills, while passive methods did not affect any groups. The active methods are course assignments, projects, research, and laboratory lesson. Active methods developed the following skills: 1. Course assignment (Collaboration, Creativity, Oral, and Written communication, Complex problem-solving); 2. Project (Engineering Design, Collaboration, and Entrepreneurship); 3. Research (Experimentation and testing, Written communication); 4. Laboratory classes (Experimentation and testing).

Finally, Liu and Zhang (2022) presented the WeChat, a network-connected mobile instant text and voice messaging communication service. This social software is supported by all smartphone platforms, including IOS, Android, and Windows operating systems. In this work, the authors conducted a quasi-experimental study to compare traditional teacher-centered instruction and a flipped classroom to investigate student achievements and higher-order thinking skills such as Critical Thinking and Problem-Solving. Ninety-four university students participated in this study and were divided into an experimental group ($n = 50$) and a control group ($n = 44$). The authors used a questionnaire composed of 14 items and 3 dimensions about problem perception, problem process, and problem effect. Responses were given on a 5-point Likert scale organized into strongly disagree, disagree, neither disagree nor agree, agree and strongly agree. As a result, the authors found that students' flipped classroom achievements and higher-order thinking skills were significantly better than their peers who had been taught in a traditional classroom setting. However, they also realized that students need time to adapt to these new learning activities. Moreover, some time is needed to change attitudes and adapt to this approach, including the ability of students to understand the teacher's guidance. Although the authors do not consider creative skills, they consider them relevant to be included in the future.

In short, the studies presented sought to develop 21st-Century skills and competencies through practical activities, including ICTs, projects, experiences, and methods. The skills and competencies in common in the studies presented were: Collaboration, Communication, Critical thinking, Creativity, and Problem-solving. The remaining skills and competencies were Engineering design, experimentation, testing, individual learning, systems thinking, citizenship, among others. Most studies considered the descriptive research method (Latorre-Coscolluela et al., 2021; Obi et al., 2022; Lavi et al., 2021), while Liu and Zhang (2022) used a comparative method. Only Lavi et al. (2021) collected qualitative data among the works identified. However, Liu and Zhang (2022) considered a lack of qualitative analysis a limitation of their study, as it would deepen and reach more comprehensive results. In all studies, an online questionnaire was used as a data collection instrument, where the statements were organized on a Likert scale of 5 points (Obi et al., 2022; Lavi et al., 2021; Liu & Zhang, 2022) or 10 points (Latorre-Coscolluela et al., 2021), going from totally agree to totally disagree. Based on the findings achieved in these studies, it is possible to say that the lack of support and monitoring of students in the teaching and learning processes can make it difficult to assess the acquisition of skills and competencies of the 21st-Century (Latorre-Coscolluela et al., 2021). Also, learning activities and experiences can foster the development of skills and competencies. Therefore, the earlier students are involved with these practical experiences, the greater the chances of developing skills and competencies (Obi et al., 2022). In this sense, active learning methods can enhance skills and competencies through projects and laboratory classes (Lavi et al., 2021; Liu & Zhang, 2022).

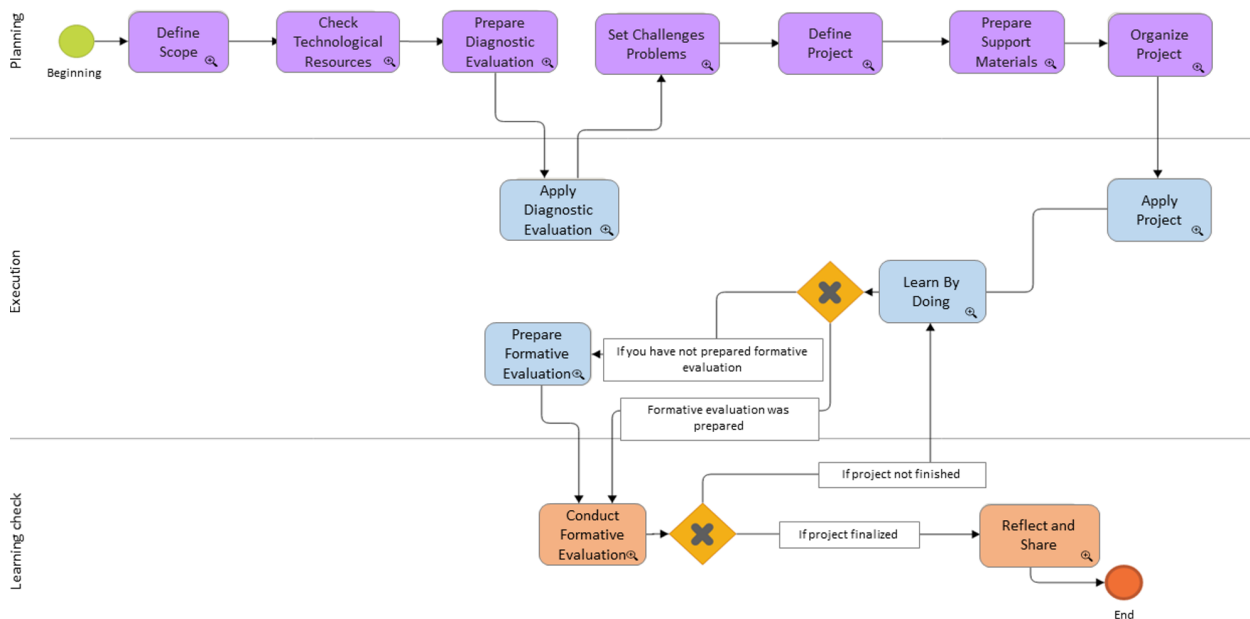


Figure 1: Flowchart of the TAEP4.0 Educational Process used in the case study (Silva, Corrêa Sobrinho, & Valentim, 2020).

3 Purpose and Importance of this Case Study

In this case study, the focus is on assessing the development of 21st-Century skills and competencies in High School students through the creation of interactive e-books. The specific skills and competencies investigated include: Creativity and Innovation, Critical Thinking, Problem-Solving and Decision-Making, Learn to Learn and Metacognition, Communication, Collaboration, and Teamwork. These skills and competencies were defined based on the teachers’ planning and being the most investigated in the literature. To achieve this goal, TAEP4.0 was used by teachers to carry out projects in the Informatics lab.

The TAEP4.0 process is designed to support teachers in structuring their workflow and implementing ICT activities in line with the principles of Education 4.0. It provides a systematic approach to guide teachers in utilizing TAEP4.0 to carry out activities that foster the development of 21st-Century skills and competencies. The TAEP4.0 process consists of thirteen steps organized into three main activities (Figure 1): Planning, Execution, and Verification. Each activity corresponds to specific tasks that the teacher needs to perform before, during, and after the class. (1) Planning: Define Scope, Check Technological Resources, Prepare Diagnostic Evaluation, Set Challenges Problems, Define Project, Prepare Support Materials, and Organize Project; (2) Execution: Apply Diagnostic Evaluation, Apply Project, Learn by Doing, and Prepare Formative Evaluation; and (3) Verification: Conduct Formative Evaluation, and Reflect and Share. For detailed information on each step of the TAEP4.0 process, please refer to the resource or documentation provided by TAEP4.0.

Thus, in the TAEP4.0 process, the teacher starts by defining the scope of the activity based on the available document. This helps the teacher determine the focus of their subject and the

specific skills and competencies they want to emphasize in their students. After defining the scope, the teacher moves on to the Check Technological Resources step, where they assess the technological resources available in their school or classroom. TAEP4.0 provides suggestions for educational technologies that can be used, such as educational robotics, block programming, and digital storytelling. The teacher chooses the technology that best suits their school's reality and the goals of the activity. To gain a better understanding of their students' difficulties and prior knowledge, the teacher prepares and applies a diagnostic evaluation. This evaluation helps identify any challenges or gaps that need to be addressed during the project. Based on the real problems or challenges identified, the teacher prepares support materials to guide and assist the students throughout the activity. The teacher then organizes the physical space and presents the project to the class, following the steps of Define Project and Apply Project. It is emphasized in TAEP4.0 that students are encouraged to build something of their interest, promoting engagement and motivation. During the learn-by-doing step, the teacher actively accompanies the students, providing guidance, encouragement, and evaluation as they progress through the learning process. The teacher also prepares and conducts formative evaluations to monitor students' progress and provide timely feedback. Finally, the Reflect and Share step involves the student's self-assessment of the skills and competencies developed throughout the project. This step allows students to reflect on their own learning, identify areas of growth, and share their experiences with others.

The strategic placement of transitions within the TAEP4.0 process is intended to create a smooth and natural flow for the teacher, ensuring a coherent progression from planning to execution and verification. The Prepare and Apply Diagnostic Evaluation steps serve as the first transition within the process, bridging the Planning and Execution activities. During this transition, the teacher assesses the available resources and materials, identifying the specific needs and difficulties of the students. This information allows the teacher to make necessary adjustments and finalize their planning in a way that is more tailored to the students' reality. Once the planning is complete, the teacher moves on to proposing and organizing the project for the students, marking the second transition between the Planning and Execution activities. This step sets the stage for the students to actively engage in the project, promoting their active participation and ownership of the learning process. The Learn by doing step receives particular emphasis in TAEP4.0, as it encourages hands-on learning and active student participation. This step contributes to a closer relationship between the teacher and the students, fostering a continuous cycle of transitions between the Execution and Verification activities. As the students engage in the project and produce their work, the teacher closely monitors their progress and provides guidance as needed. This dynamic interaction between the teacher and students continues until the students complete their projects. By incorporating these transitions and emphasizing active student involvement, TAEP4.0 promotes a dynamic and interactive learning experience. It encourages continuous feedback and guidance from the teacher, ensuring that students receive the necessary support to successfully develop their skills and competencies throughout the project.

The gaps identified in the related works highlight the need for support and guidance during the teaching and learning processes, the importance of active learning methods, the impact of students' prior experience, and the benefits of combining qualitative and quantitative analysis. In the case study presented, we addressed these gaps by providing support and guidance to High School students in using ICTs through the involvement of the Educational Technology coordination. Teachers were actively involved in all stages of creating the interactive e-books, ensuring that students received the necessary guidance and assistance throughout the process. To pro-

mote active learning, collaborative projects were implemented, where students actively engaged in creating interactive e-books using the Book Creator platform and the resources available in the Informatics lab. This approach differed from passive learning methods, such as exam preparation and lecture-based instruction, which were found to have a limited impact on the development of skills and competencies. The choice of High School students as the study population aimed to address the identified gap regarding students' prior experience and its influence on skill development. By involving students in experiences of this nature during Basic Education, we believe they will be better prepared and more successful in developing 21st-Century skills and competencies when they transition to university. Lastly, the need for both qualitative and quantitative analysis was acknowledged, as it allows for more comprehensive results. In our case study, we will present and analyze both quantitative and qualitative data to provide a more holistic understanding of the impact of the project on the development of 21st-Century skills and competencies. By addressing these gaps and incorporating these considerations into the case study, we aim to contribute to the existing literature and provide insights about strategies for developing 21st-Century skills and competencies in students.

4 Description of Case Study

This case study presents descriptive and non-experimental research based on a self-assessment questionnaire, similar to the study conducted by Latorre-Coscolluela et al. (2021). Thus, the aim of this study was not to manipulate variables but rather to explore and describe them (Lietz, 2010). This type of research enables a systematic and objective description of the characteristics and facts pertaining to a particular population (Latorre-Coscolluela et al., 2021). Consequently, this case study was crucial in analyzing the perceptions of High School students regarding the competencies and skills they developed through projects. The study was conducted at Dom Amando school, a private institution located in the western Pará region of Brazil, within the city of Santarém. The researchers collaborated with the ET coordination of this school, which led to its selection for convenience. This partnership was prioritized to facilitate close observation and practical immersion. To initiate the collaboration, a letter of introduction was sent to the school director, outlining the research proposal and seeking authorization to engage with teachers and their students.

The activities spanned a period of three months and involved the ET coordination, teachers, and students. The ET coordination took the initiative to invite school teachers to participate in the case study. As a result, two High School teachers, both of whom are female, accepted the invitation. One teacher specializes in teaching Arts, while the other teaches Spanish. The selection of these teachers was based on their availability and interest in the study. The teachers received training twice a year on the use of ICTs, although neither of them frequently utilized the Informatics lab, despite the ongoing training. Initially, the teachers were required to sign the Informed Consent Form (ICF) and underwent training on the utilization of TAEP4.0, which aimed to promote skills and competencies. During the training sessions, two artifacts were employed: a) Presentation slides: These slides encompassed the goals, motivations, procedures, an overview of the steps involved in TAEP4.0, and its relationship with the context of Education 4.0; and b) Planning model: A planning model was provided to the teachers to assist them in preparing an educational project. This model consisted of the seven steps involved in TAEP4.0 planning. Consequently,

the teachers were able to review the suggestions available at each step, consult the defined lesson plan, and finally record their choices.

This case study was structured according to the steps of TAEP4.0, which include Planning (1), Execution (2), and Verification (3). The infographic depicted in 2 provides a concise overview of the activities undertaken by the teachers, following the guidelines and instructions of TAEP4.0.

In the Planning activity (1), each teacher selected specific content from the first school term to work on, utilizing the available ICTs in the Informatics lab. For instance, the Arts teacher opted for Artistic Languages content, including Architecture, Painting, Dance, Sculpture, Theater, Photography, and Music. On the other hand, the Spanish teacher chose Urban Tribes content, encompassing Hip Hop, Floggers, Darks, Emos, Indie, Skaters, and Bikers. The teachers formed seven teams, corresponding to each content theme, within their respective classes. The team sizes varied, with four to five participants in the 1st grade and five to six participants in the 2nd grade. From the technology options provided in TAEP4.0, the teachers decided to use the Book Creator platform, as they had received prior training on its usage. This choice facilitated the prompt initiation of the projects, as using other ICTs would have required additional training time before commencing the projects with the students. The Book Creator platform proved beneficial in assisting students in creating interactive e-books, incorporating multimedia resources such as images, texts, audio, and videos. The projects extended over a period of five weeks, with one class per week conducted in the laboratory. The duration was determined by considering the students' productivity and the number of tasks designated by the teachers. As mutually agreed upon between the teachers and students, the produced e-books served as evaluative components for the first school term grades. The ET coordination played a role in finalizing the project planning by reviewing the scheduled classes in the Informatics lab and ensuring the allocation of projects within the available lab hours. This scheduling process took into account the teachers' class days and times. Following the training, the teachers expressed their desire to implement the projects with some of their classes.

In the Execution activity (2), the teachers had the freedom to choose the classes they wished to work with. Consequently, they selected five High School classes to participate in the case study: three classes of Arts from the 1st grade (A, B, C), and two classes of Spanish from the 2nd grade (A and B), totaling 189 students. The students' ages ranged from 15 to 17 years old, with 98 female students and 91 male students. At the beginning of the projects, the researcher created five libraries on the Book Creator platform, one for each class. Students were registered on the platform, and QR codes were generated to facilitate student access and the creation of interactive e-books. The teachers organized the projects into five classes, with two classes dedicated to the execution activities and three classes for the verification activities. During the first class, the teacher presented the project proposal to the students and demonstrated some examples using an interactive projector. The aim was to foster imagination, curiosity, and creativity among the students. Additionally, the coordination provided instructions on how to access the platform using a QR code and introduced the main functionalities of the platform. These functionalities included creating pages (defining backgrounds, paper types, borders, patterns, and textures), adding media (importing or creating images, audios, texts, and videos on the platform), and incorporating comics and geometric shapes. If necessary, these functionalities were reviewed with the teams during the creation of their interactive e-books. In the second class, the students conducted research on their chosen themes. They saved and organized relevant media in folders for their



Figure 2: Infographic with the main activities carried out in the projects using the TAEP4.0 steps.

work. Furthermore, the teams were encouraged to collaborate and decide on the best ideas to be implemented in their projects.

In the Verification activity (3), the students started receiving more frequent monitoring from the teachers during their scheduled class times. In the third and fourth classes, the teams were given the opportunity to layout the pages, refine their ideas, engage in discussions and team organization, seek clarification on platform features, and explore additional tools they deemed necessary to enhance their work. The teacher assisted them in analyzing and synthesizing the text to ensure the inclusion of useful and relevant information. Simultaneously, the coordination provided support in evaluating the interactive e-books, assessing aspects such as font size and type, media quality, colors, number of pages, and other relevant criteria. This collaborative effort aimed to ensure the finalization of high-quality interactive e-books. Finally, in the fifth class and last stage of TAEP4.0, During the fifth and final class of the TAEP4.0 process, the students completed a self-assessment questionnaire regarding the skills and competencies fostered throughout the projects. The teachers took care to inform the students that this assessment was not part of their formal evaluation. Therefore, participation was voluntary and students were under no obligation to take part unless they felt comfortable doing so. To maintain anonymity and ensure data confidentiality, the students responded to the questionnaire anonymously, adhering to ethical recommendations. The self-assessment questionnaire followed a specific structure, including the following elements: i) Categories of 21st-Century skills and competencies; ii) Statements related to the activities carried out within the projects; iii) A Likert five-point scale ranging from "strongly disagree" to "strongly agree"; and iv) Space for open questions. The artifacts used in this case study, including the self-assessment questionnaire, were prepared and reviewed by a researcher specializing in Informatics in Education and validated by the ET coordination for use with both teachers and students. The complete set of artifacts used in this study is available for reference on Figshare: <https://figshare.com/s/030fe9f22e7c47110a8f>.

The self-assessment questionnaire was developed based on the consolidated models ATC21S and bASE21, as described in Section 3, by a researcher specializing in Education 4.0. This approach aimed to minimize potential risks associated with the questionnaire. Furthermore, the questionnaire underwent a peer-review process conducted by two researchers specializing in Informatics in Education. They reviewed the questionnaire and provided suggestions for adjustments to the statements. Subsequently, the ET coordination revised and approved the final version of the questionnaire. The collected data were subjected to both quantitative and qualitative analyses. For quantitative analysis, the closed questions in the questionnaire were analyzed using descriptive statistical methods, which involved organizing, summarizing, and representing the data (Dimić, Rančić, Rančić, & Spalević, 2019). Microsoft Office Excel was used for this purpose. The quantitative analysis aimed to quantify the extent of difficulties and ease experienced by students during the project, with reference to the specific activities that represented these challenges. Subsequently, the qualitative analysis sought to provide explanations for the identified problems, enabling a deeper understanding of the results. The open questions in the questionnaire were analyzed using the Grounded Theory (GT) method (Corbin & Strauss, 2014). GT is a widely used qualitative research method that involves a systematic set of procedures for data analysis, as detailed in Section 6. To automate the process of discovering, integrating, and validating the findings, Atlas.ti version 6 was employed for this case study. Overall, the combination of quantitative and qualitative analyses allowed for a comprehensive examination of the collected data, providing valuable insights into the students' experiences and perceptions throughout the project.

5 Quantitative Results

For this case study, the Arts teacher worked with classes A, B, and C of the 1st grade, and the Spanish language teacher worked with classes A and B of the 2nd grade. The TE coordination supervised both teachers in the Informatics lab. In the fifth class, 182 students answered the self-assessment questionnaire, 37 students from 1st-grade A, 35 from 1st-grade B, 29 from 1st-grade C, 40 from 2nd-grade A, and 41 from 2nd-grade B. The skills investigated were grouped according to the teachers' planning, who defined them as behavioral (Creativity and Innovation), cognitive (Critical Thinking, Problem-Solving, and Decision-Making, Learn to Learn and Metacognition), communicative (Communication), and socioemotional (Collaboration and Teamwork). Twenty-three sentences from the models BASES21 and ATC21S were used for adapting the questionnaire. The sentences were written in Portuguese, the native language of the participants and researchers. These sentences are represented in Tables 2 to 6 with the percentage values, and in Figures 4 to 8 with student numbers. The Creativity and Innovation skills have four sentences (Table 2). The Problem-Solving, Critical Thinking and Decision-Making skills have five sentences (Table 3). The Learn to Learn and Metacognition skills have five sentences (Table 4). The Communication skill has four sentences (Table 5). The Collaboration and Teamwork skills have five sentences (Table 6). The sentences were answered on a five-point Likert scale: Strongly Agree (SA), Partially Agree (PA), Neither Agree Nor Disagree (NAND), Partially Disagree (PD), and Strongly Disagree (SD).

Regarding the **Creativity and Innovation Skills** (Table 2), three students strongly disagreed with the 1st sentence (Figure 3), "I tried to improve my ideas", being 1st-grade C students (6.90% | N = 2) and 2nd-grade A (2.50% | N = 1) among the dissenting students. On the other hand, 94 students strongly agreed with the 1st sentence, being students from the 1st-grade A (54.10% | N = 20), 1st-grade B (57.10% | N = 20), 1st-grade C (41.40% | N = 12), 2nd-grade A (52.50% | N = 21), and 2nd-grade B (51.20% | N = 21). This sentence indicates that students sought to improve their ideas for work through examples found on the internet and suggestions for improvements made by the teacher. Subsequently, in the 2nd sentence (Figure 3), "I managed to put my ideas into practice to be used", three also students strongly disagreed, with none from the 1st-grade A and 2nd-grade B classes. Moreover, a greater discrepancy was noticed, having a higher amount of neutral responses (N = 32). This discrepancy may have occurred due to the teams did not use all ideas because students needed to be discussed and accepted by the collective. In sequence, 82 students were positive in the 3rd sentence (Figure 3), "I managed to communicate my ideas to my colleagues". However, eight students in classes 1st-grade B (5.70% | N=2), 1st-grade C (6.90% | N=2), 2nd-grade A (5.00% | N=2), and 2nd-grade B (4.90% | N=2) strongly disagreed. Among these disagreements, there was no strong disagreement in the 1st-grade A. Even so, this sentence may indicate that not all students could present their ideas for the team because some considered the ideas of their colleagues more interesting to be implemented. Subsequently, in the 4th sentence (Figure 3), "I managed to have new and valuable ideas", 74 students strongly agreed, especially in 1st-grade B (34.30% | N=12) and in 2nd-grade A (20.00% | N=8). Most of the responses from these classes were in partial agreement blue(N = 76), being 1st-grade B (54.30% | N=19) and 2nd-grade A (52.50% | N=21), being classes with most difficulties in obtaining new and valuable ideas.

Regarding the **Problem-Solving, Critical Thinking, and Decision-Making Skills** (Table 3), in the 1st sentence (Figure 4), "I managed to explain my opinions and decisions in the project",

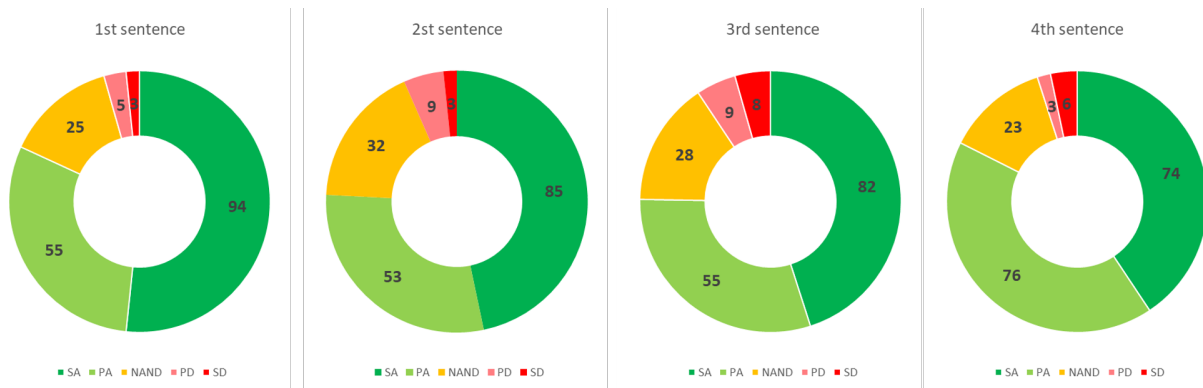


Figure 3: Creativity and Innovation Skills Sentences.

Table 2: Creativity and Innovation Skills.

| Sentences | Classes | SA | PA | NAND | PD | SD | |
|--|--|-------------|-------|-------|-------|------|------|
| I tried to improve my ideas | 1st-grade A | 54.10 | 32.40 | 13.50 | 0.00 | 0.00 | |
| | 1st-grade B | 57.10 | 34.30 | 8.60 | 0.00 | 0.00 | |
| | 1st-grade C | 41.40 | 24.10 | 24.10 | 3.40 | 6.90 | |
| | 2nd-grade A | 52.50 | 22.50 | 17.50 | 5.00 | 2.50 | |
| | 2nd-grade B | 51.20 | 36.60 | 7.30 | 4.90 | 0.00 | |
| | I managed to put my ideas into practice to be used | 1st-grade A | 48.60 | 35.10 | 16.20 | 0.00 | 0.00 |
| I managed to communicate my ideas to my colleagues | 1st-grade B | 34.30 | 34.30 | 22.90 | 5.70 | 2.90 | |
| | 1st-grade C | 55.20 | 17.20 | 20.70 | 0.00 | 6.90 | |
| | 2nd-grade A | 40.00 | 35.00 | 17.50 | 2.50 | 5.00 | |
| | 2nd-grade B | 56.10 | 22.00 | 22.00 | 0.00 | 0.00 | |
| | I managed to have new and valuable ideas | 1st-grade A | 43.20 | 32.40 | 18.90 | 5.40 | 0.00 |
| | | 1st-grade B | 57.10 | 34.30 | 2.90 | 0.00 | 5.70 |
| 1st-grade C | | 41.40 | 20.70 | 27.60 | 3.40 | 6.90 | |
| 2nd-grade A | | 40.00 | 35.00 | 17.50 | 2.50 | 5.00 | |
| 2nd-grade B | | 43.90 | 26.80 | 12.20 | 12.20 | 4.90 | |
| 1st-grade A | | 54.10 | 32.40 | 10.80 | 0.00 | 2.70 | |
| I managed to have new and valuable ideas | 1st-grade B | 34.30 | 54.30 | 5.70 | 5.70 | 0.00 | |
| | 1st-grade C | 51.70 | 37.90 | 6.90 | 0.00 | 3.40 | |
| | 2nd-grade A | 20.00 | 52.50 | 22.50 | 0.00 | 5.00 | |
| | 2nd-grade B | 46.30 | 31.70 | 14.60 | 2.40 | 4.90 | |

eight students strongly disagreed, being from the 1st-grade B (5.70% | N = 2), 1st-grade C (3.40% | N = 1), 2nd-grade A (5.00% | N = 2), and 2nd-grade B (7.30% | N = 3), with no strong disagreements from 1st-grade A. This sentence may represent that these students had difficulty explaining their opinions and making decisions in creating e-books. Subsequently, in the 2nd sentence (Figure 4), “I chose and organized the material you need to do our project”, five students strongly disagreed with this sentence, being only students from the 1st-grade A (5.40% | N=2) and 2nd-grade B (7.30% | N=3), which demonstrates that most students were able to organize themselves

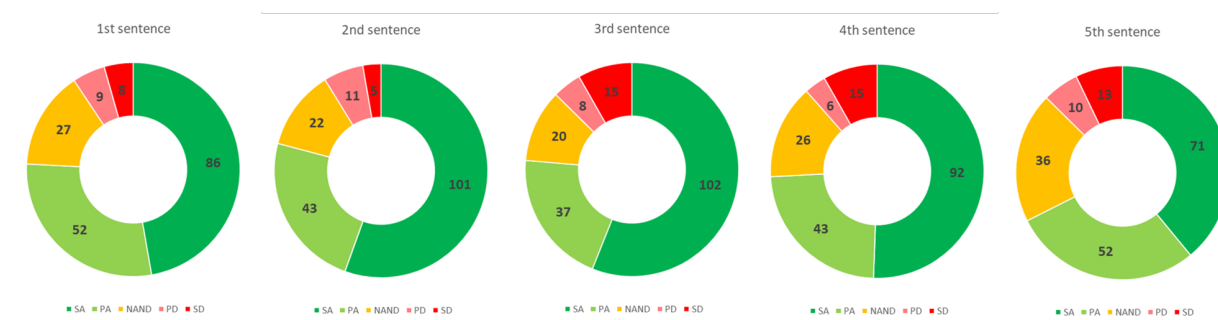


Figure 4: Problem-Solving, Critical Thinking, and Decision-Making Skills Sentences.

in the projects, as they were encouraged to keep their materials in folders on the school server. However, students could put them in the cloud, smartphone, pen drive, and others for easy access. In sequence, in the 3rd sentence (Figure 4), “I managed to compare opinions/ideas to see which was the best”, 15 students strongly disagreed, being 1st-grade A (5.40% | N = 2), 1st-grade B (11.40% | N = 4), 2nd-grade A (12.50% | N = 5), and 2nd-grade B (9.80% | N = 4), with no strong disagreement from 1st-grade C. In addition, 102 students expressed themselves positively about comparing opinions and ideas to decide which was the most suitable for the project, strongly agreeing. In the 4th sentence (Figure 4), “I managed to interact with my colleagues to achieve better results in difficult parts of the problem”, 15 students had a little more difficulty in interacting with colleagues to solve the problem, strongly disagreeing. Moreover, 92 students believe they were able to solve problems through interaction within groups, strongly agreeing. Regarding the 5th sentence, “I managed to think of solutions to the problem”, 13 students totally disagreed with the sentence, being 1st-grade A (5.40% | N = 2), 1st-grade B (2.90% | N = 1), 1st-grade C (6.90% | N = 2), 2nd-grade A (7.50% | N = 3) and 2nd-grade B (12.20% | N = 5). Among the classes, it was observed that 2nd-grade B students presented more difficulty designing their interactive e-books from the ICTs available in the Informatics lab. Finally, 71 students believe they were able to think of solutions for their e-books, strongly agreeing.

Regarding the **Learn to Learn and Metacognition Skills** (Table 4), in the 1st sentence (Figure 5), “I was able to dedicate myself to the project to overcome the difficulties”, 12 students strongly disagreed, being 1st-grade A (10.80% | N = 4), 1st-grade B (11.40% | N = 4), 1st-grade C (10.30% | N = 3) and 2nd-grade B (2.40% | N = 1), with no total disagreement of the 2nd-grade A. Furthermore, 88 students strongly agreed, indicating that most students finished their interactive e-books within the allotted time, and some met the requirements requested by the teacher. Subsequently, in the 2nd sentence (Figure 5), “I managed to concentrate on activities”, seven students strongly disagreed, such as 1st-grade A (8.10% | N = 3), 1st-grade B (2.90% | N = 1), 1st-grade C (3.40% | N = 1), and 2nd-grade A (5.00% | N = 2), with no disagreement of the 2nd-grade B. These sentences demonstrate that some students were able to concentrate on their projects either to learn the Book Creator platform or to search for multimedia material necessary for the creation of interactive e-books. Regarding the 3rd sentence (Figure 5), “I learned not to give up easily”, even 88 students strongly agreed with this sentence; ten participants strongly disagreed. Thus, these sentence indicates that a little more difficulty concerning learning not to give up easily in the face of difficulties. Later, in the 4th sentence (Figure 5), “I learned to have discipline in my activities”, of the nine students who strongly disagreed, it was observed that 1st-

Table 3: Problem-Solving, Critical Thinking, and Decision-Making Skills.

| Sentences | Classes | SA | PA | NAND | PD | SD |
|--|-------------|-------|-------|-------|-------|-------|
| I managed to explain my opinions and decisions in the project | 1st-grade A | 48.60 | 35.10 | 16.20 | 0.00 | 0.00 |
| | 1st-grade B | 37.10 | 48.60 | 5.70 | 2.90 | 5.70 |
| | 1st-grade C | 31.00 | 20.70 | 37.90 | 6.90 | 3.40 |
| | 2nd-grade A | 55.00 | 22.50 | 10.00 | 7.50 | 5.00 |
| | 2nd-grade B | 58.50 | 17.10 | 9.80 | 7.30 | 7.30 |
| I chose and organized the material you need to do our project | 1st-grade A | 51.40 | 16.20 | 18.30 | 8.10 | 5.40 |
| | 1st-grade B | 60.00 | 22.90 | 14.30 | 2.90 | 0.00 |
| | 1st-grade C | 24.10 | 48.30 | 17.20 | 10.30 | 0.00 |
| | 2nd-grade A | 62.50 | 20.00 | 7.50 | 10.00 | 0.00 |
| | 2nd-grade B | 70.70 | 17.10 | 4.90 | 0.00 | 7.30 |
| I managed to compare opinions/ideas to see which was the best | 1st-grade A | 45.90 | 27.00 | 16.20 | 5.40 | 5.40 |
| | 1st-grade B | 51.40 | 22.90 | 8.60 | 5.70 | 11.40 |
| | 1st-grade C | 55.20 | 24.10 | 17.20 | 3.40 | 0.00 |
| | 2nd-grade A | 52.50 | 20.00 | 10.00 | 5.00 | 12.50 |
| | 2nd-grade B | 73.20 | 9.80 | 4.90 | 2.40 | 9.30 |
| I managed to interact with my colleagues to achieve better results in difficult parts of the problem | 1st-grade A | 40.50 | 29.70 | 18.90 | 8.10 | 2.70 |
| | 1st-grade B | 60.00 | 22.90 | 5.70 | 2.90 | 8.60 |
| | 1st-grade C | 37.90 | 20.70 | 27.60 | 0.00 | 13.80 |
| | 2nd-grade A | 57.50 | 22.50 | 10.00 | 5.00 | 5.00 |
| | 2nd-grade B | 53.70 | 22.00 | 12.20 | 0.00 | 12.20 |
| I managed to think of solutions to the problem | 1st-grade A | 40.50 | 24.30 | 21.60 | 8.10 | 5.40 |
| | 1st-grade B | 40.00 | 31.40 | 20.00 | 5.70 | 2.90 |
| | 1st-grade C | 34.50 | 31.00 | 27.60 | 0.00 | 6.90 |
| | 2nd-grade A | 37.50 | 30.00 | 17.50 | 7.50 | 7.50 |
| | 2nd-grade B | 41.50 | 26.80 | 14.60 | 4.90 | 12.20 |

grade C had more problems, being where the students strongly disagreed most (13.80% | N = 4) and the lowest strong agreement (31.00% | N = 9). In this class, it was perceived that a few students missed some classes, yet the rest of the team sought to continue producing the interactive e-book. Later, in the 5th sentence (Figure 5), “I learned to be independent in my activities”, 105 students said they strongly agree with the sentence. In addition, five students totally disagreed, being 1st-grade A (2.70% | N = 1), 1st-grade B (5.70% | N = 2), 1st-grade C (3.40% | N = 1), and 2nd-grade A (2.50% | N = 1), with no total disagreement of the 2nd-grade B. Thus, it is understood that some students could accomplish the tasks even with some disinterested colleagues in the team.

Regarding the **Communication Skill** (Table 5), in the 1st sentence (Figure 6), “I was not ashamed to speak in a group/public”, 13 students demonstrated communication, strongly disagreed. These sentences may indicate that some students had difficulty presenting their work in the classroom to colleagues and teachers. Subsequently, in the 2nd sentence (Figure 6), “I managed

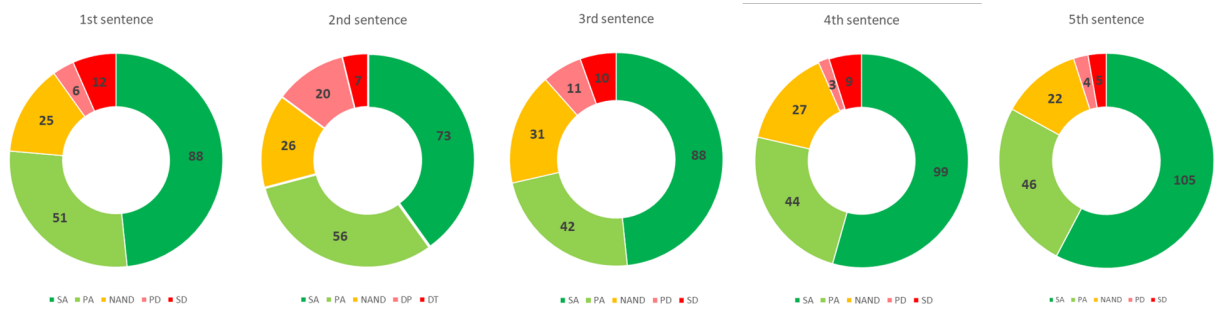


Figure 5: Learn to Learn and Metacognition Skills Sentences.

Table 4: Learn to Learn and Metacognition Skills.

| Sentences | Classes | SA | PA | NAND | PD | SD |
|---|-------------|-------|-------|-------|-------|-------|
| I was able to dedicate myself to the project to overcome the difficulties | 1st-grade A | 45.90 | 16.20 | 27.00 | 0.00 | 10.80 |
| | 1st-grade B | 37.10 | 40.00 | 8.60 | 2.90 | 11.40 |
| | 1st-grade C | 34.50 | 24.10 | 20.70 | 10.30 | 10.30 |
| | 2nd-grade A | 57.50 | 40.00 | 0.00 | 2.50 | 0.00 |
| | 2nd-grade B | 61.00 | 19.50 | 14.60 | 2.40 | 2.40 |
| I managed to concentrate on activities | 1st-grade A | 48.60 | 21.60 | 18.90 | 2.70 | 8.10 |
| | 1st-grade B | 40.00 | 28.60 | 11.40 | 17.10 | 2.90 |
| | 1st-grade C | 20.70 | 41.40 | 13.80 | 20.70 | 3.40 |
| | 2nd-grade A | 40.00 | 35.00 | 12.50 | 7.50 | 5.00 |
| | 2nd-grade B | 46.30 | 29.30 | 14.60 | 9.80 | 0.00 |
| I learned not to give up easily | 1st-grade A | 35.10 | 27.00 | 18.90 | 5.40 | 13.50 |
| | 1st-grade B | 45.70 | 20.00 | 17.10 | 5.70 | 11.40 |
| | 1st-grade C | 41.40 | 20.70 | 20.70 | 13.80 | 3.40 |
| | 2nd-grade A | 62.50 | 17.50 | 17.50 | 2.50 | 0.00 |
| | 2nd-grade B | 53.70 | 29.30 | 12.20 | 4.90 | 0.00 |
| I learned to have discipline in my activities | 1st-grade A | 54.10 | 27.00 | 16.20 | 0.00 | 2.70 |
| | 1st-grade B | 60.00 | 25.70 | 8.60 | 0.00 | 5.70 |
| | 1st-grade C | 31.00 | 34.50 | 13.80 | 6.90 | 13.80 |
| | 2nd-grade A | 57.50 | 20.00 | 17.50 | 2.50 | 2.50 |
| | 2nd-grade B | 63.40 | 17.10 | 17.10 | 0.00 | 2.40 |
| I learned to be independent in my activities | 1st-grade A | 45.60 | 18.90 | 27.00 | 2.70 | 2.70 |
| | 1st-grade B | 60.00 | 31.40 | 2.90 | 0.00 | 5.70 |
| | 1st-grade C | 55.20 | 17.20 | 20.70 | 3.40 | 3.40 |
| | 2nd-grade A | 65.00 | 25.00 | 5.00 | 2.50 | 2.50 |
| | 2nd-grade B | 58.50 | 31.70 | 7.30 | 2.40 | 0.00 |

to talk and hear different opinions about the project”, of the 11 strong disagreements, 1st-grade A showed a greater amount of strong disagreement (13.50% | N = 5) concerning the other classes. Thus, it was observed that some students from the 1st-grade A presented communication problems with the team, indicating that the class had more students with difficulty discussing and aligning

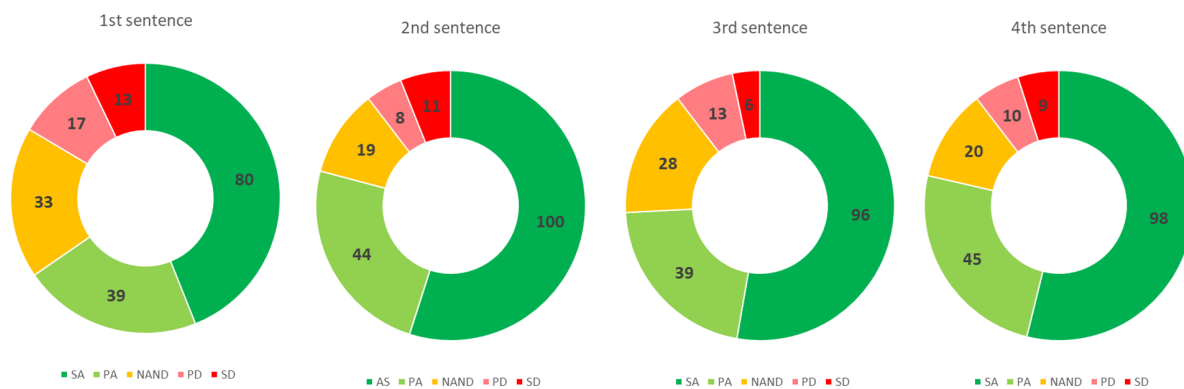


Figure 6: Communication Skill Sentences.

the opinions to be implemented in the interactive e-book. Then, in the 3rd sentence (Figure 6), “I managed to understand what my colleagues told me”, six students strongly disagreed, being 1st-grade B (2.90% | N = 1), 1st-grade C (6.90% | N = 2), 2nd-grade A (2.50% | N = 1) and 2nd-grade B (4.90% | N = 2), with no strong disagreement from 1st-grade A. Therefore, 1st grade A was able to understand what their colleagues were saying to improve the work and deliver it within the time, even though some students had certain communication difficulties. Subsequently, in the 4th sentence (Figure 6), “I managed to communicate clearly with my colleagues”, 98 participants declared that they could communicate clearly with their colleagues, strongly agreeing. However, nine students strongly disagreed, being 1st-grade A (8.10% | N = 3), 1st-grade B (2.90% | N = 1), 1st-grade C (6.90% | N = 2), 2nd-grade A (2.50% | N = 1), and 2nd-grade B (4.90% | N = 2). Among the participating classes, it was observed that 1st-grade A demonstrated more difficulty communicating than the other classes, considering that it is the class with the highest level of total disagreement (8.10% | N = 3) and the lowest level of total agreement (37.80% | N = 14).

About the **Collaboration and Teamwork Skills** (Table 6), in the 1st sentence (Figure 7), “I managed to respect the differences of people from other regions, countries, and religions”, 141 students strongly agreed, being 1st-grade A (64.90% | N = 24), 1st-grade B (80.00% | N = 28), 1st-grade C (62.10% | N = 18), 2nd-grade A (90.00 | N = 36), and 2nd-grade B (85.40% | N = 35). The students demonstrated to be more positive in this sentence than others, indicating that they sought to respect their team colleagues. Besides, an increase in strong concordances was identified, mainly in the 2nd-grades A and B. The researchers believed that this increase is due to the definition of the project’s scope, where the Spanish teacher aligned the content of her class (Urban Tribes) to the tenth Sustainable Development Goal (reduced inequalities) of United Nations Organizations, as seen in Figure 2 of Section 4. In the 2nd sentence (Figure 7), “I managed to use my skills to help my colleagues achieve our goal”, 2nd-grade A (5.00% | N = 2) was the only class that showed strong disagreement. Moreover, 114 students said they strongly agree, demonstrating that they were able to help their colleagues reach the goal, either to use the e-book’s Creator platform or to understand the contents. In sequence, in the 3rd sentence (Figure 7), “I managed to organize teamwork to achieve our goal”, 1st-grade A and B did not present strong disagreements. Of the 4 strong disagreements, responses were only received from 1st-grade C (3.40% | N = 1), 2nd-grade A (5.00% | N = 2), and 2nd-grade B (2.40% | N = 1). In this sense, it was noticed that some students had difficulties organizing themselves in teams to distribute

Table 5: Communication Skill.

| Sentences | Classes | SA | PA | NAND | PD | SD |
|---|-------------|-------|-------|-------|-------|-------|
| I was not ashamed to speak in a group/public | 1st-grade A | 45.90 | 18.90 | 13.50 | 5.40 | 16.20 |
| | 1st-grade B | 40.00 | 20.00 | 17.10 | 17.10 | 5.70 |
| | 1st-grade C | 48.30 | 13.80 | 27.60 | 6.90 | 3.40 |
| | 2nd-grade A | 42.50 | 22.50 | 22.50 | 5.00 | 7.50 |
| | 2nd-grade B | 43.90 | 29.30 | 12.20 | 12.20 | 2.40 |
| I managed to talk and hear different opinions about the project | 1st-grade A | 48.60 | 13.50 | 18.90 | 5.40 | 13.50 |
| | 1st-grade B | 48.60 | 28.60 | 17.10 | 2.90 | 2.90 |
| | 1st-grade C | 48.30 | 31.00 | 10.30 | 3.40 | 6.90 |
| | 2nd-grade A | 62.50 | 30.00 | 5.00 | 2.50 | 0.00 |
| | 2nd-grade B | 63.40 | 19.50 | 2.40 | 7.30 | 7.30 |
| I managed to understand what my colleagues told me | 1st-grade A | 37.80 | 24.30 | 27.00 | 10.80 | 0.00 |
| | 1st-grade B | 65.70 | 20.00 | 8.60 | 2.90 | 2.90 |
| | 1st-grade C | 41.40 | 13.80 | 24.10 | 13.80 | 6.90 |
| | 2nd-grade A | 52.50 | 25.00 | 12.50 | 7.50 | 2.50 |
| | 2nd-grade B | 63.40 | 22.00 | 7.30 | 2.40 | 4.90 |
| I managed to communicate clearly with my colleagues | 1st-grade A | 37.80 | 32.40 | 10.80 | 10.80 | 8.10 |
| | 1st-grade B | 54.30 | 31.40 | 8.60 | 2.90 | 2.90 |
| | 1st-grade C | 48.30 | 20.70 | 20.70 | 3.40 | 6.90 |
| | 2nd-grade A | 67.50 | 15.00 | 7.50 | 7.50 | 2.50 |
| | 2nd-grade B | 58.50 | 24.40 | 9.80 | 2.40 | 4.90 |

tasks among themselves. Subsequently, in the 4th sentence (Figure 7), “I managed to respect the different ideas of my colleagues”, 15 students strongly disagreed, being 1st-grade A (10.80% | N = 4), 1st-grade B (2.90% | N = 1), 1st-grade C (6.90% | N = 2), 2nd-grade A (7.50% | N = 3) and 2nd-grade B (12.20% | N = 5). Furthermore, 109 students strongly agreed, indicating that were able to respect the different ideas of their colleagues and discuss them in a team to see which ones would be implemented in the interactive e-books. Subsequently, in the 5th sentence (Figure 7), “I managed to listen to my colleagues with care and patience”, 19 students totally disagreed, being 1st-grade A (16.20% | N = 6), 1st-grade B (2.90% | N = 1), 1st-grade C (6.90% | N = 2), 2nd-grade A (12.50% | N = 5), 2nd-grade B (12.20% | N = 5). This sentence stands out from the others because it presents a higher level of strong disagreements, indicating that one of the main difficulties students had to listen to colleagues carefully and patiently.

In short, considering the levels of discrepancies shown in Tables 2 to 6, it was noticed that 2nd-grades A and B students were more optimistic about developing skills and competencies than the students of 1st-grades A, B, and C. Besides, the 1st-grade C class showed a little more difficulty in performing the tasks and little mastery of the skills investigated in this work. Also, researchers identified that one of the biggest problems students faces is the difficulty of communicating effectively and working as a team.

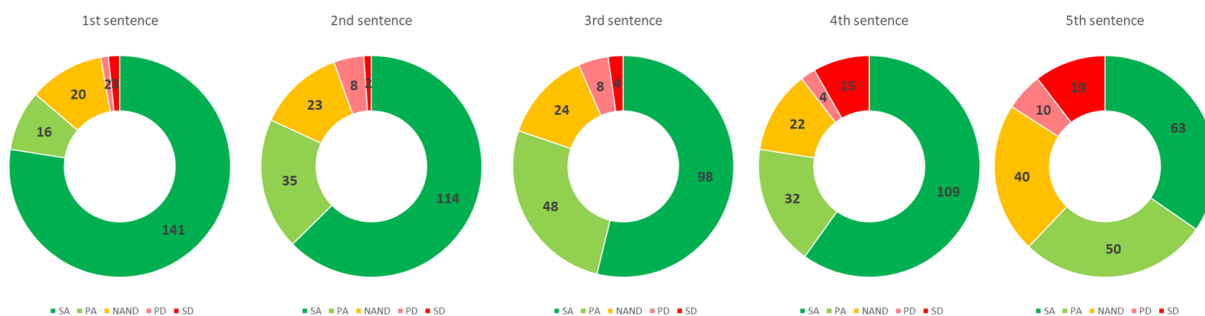


Figure 7: Collaboration and Teamwork Skills Sentences.

Table 6: Collaboration and Teamwork Skills.

| Sentences | Classes | SA | PA | NAND | PD | SD |
|---|-------------|-------|-------|-------|-------|-------|
| I managed to respect the differences of people from other regions, countries, and religions | 1st-grade A | 64.90 | 10.80 | 24.30 | 0.00 | 0.00 |
| | 1st-grade B | 80.00 | 8.60 | 8.60 | 0.00 | 2.90 |
| | 1st-grade C | 62.10 | 6.90 | 20.70 | 6.90 | 3.40 |
| | 2nd-grade A | 90.00 | 5.00 | 2.50 | 0.00 | 2.50 |
| | 2nd-grade B | 85.40 | 12.20 | 2.40 | 0.00 | 0.00 |
| I managed to use my skills to help my colleagues achieve our goal | 1st-grade A | 67.60 | 5.40 | 24.30 | 2.70 | 0.00 |
| | 1st-grade B | 60.00 | 22.90 | 11.40 | 5.70 | 0.00 |
| | 1st-grade C | 41.40 | 41.40 | 10.30 | 6.90 | 0.00 |
| | 2nd-grade A | 60.00 | 20.00 | 10.00 | 5.00 | 5.00 |
| | 2nd-grade B | 78.00 | 12.20 | 7.30 | 2.40 | 0.00 |
| I managed to organize teamwork to achieve our goal | 1st-grade A | 43.20 | 24.30 | 29.70 | 2.70 | 0.00 |
| | 1st-grade B | 57.10 | 28.60 | 8.60 | 5.70 | 0.00 |
| | 1st-grade C | 41.40 | 31.00 | 20.70 | 3.40 | 3.40 |
| | 2nd-grade A | 65.00 | 22.50 | 5.00 | 2.50 | 5.00 |
| | 2nd-grade B | 58.50 | 26.80 | 4.90 | 7.30 | 2.40 |
| I managed to respect the different ideas of my colleagues | 1st-grade A | 54.10 | 13.50 | 18.90 | 2.70 | 10.80 |
| | 1st-grade B | 65.70 | 20.00 | 11.40 | 0.00 | 2.90 |
| | 1st-grade C | 44.80 | 24.10 | 17.20 | 6.90 | 6.90 |
| | 2nd-grade A | 70.00 | 10.00 | 12.50 | 0.00 | 7.50 |
| | 2nd-grade B | 61.00 | 22.00 | 2.40 | 2.40 | 12.20 |
| I managed to listen to my colleagues with care and patience | 1st-grade A | 35.10 | 18.90 | 29.70 | 0.00 | 16.20 |
| | 1st-grade B | 40.00 | 37.10 | 17.10 | 2.90 | 2.90 |
| | 1st-grade C | 13.80 | 31.00 | 37.90 | 10.30 | 6.90 |
| | 2nd-grade A | 40.00 | 22.50 | 12.50 | 12.50 | 12.50 |
| | 2nd-grade B | 39.00 | 29.30 | 17.10 | 2.40 | 12.20 |

6 Qualitative Results

For the qualitative analysis of the data, some procedures of the GT method were used (Corbin & Strauss, 2014). The participants' comments were analyzed using a subset of the open (1st stage) and axial (2nd stage) coding phases. In the 1st stage of the GT (open coding), the codes were identified (concepts) according to the student's responses. The codes were grouped according to their properties, forming concepts representing categories. Finally, these codes were related to each other in axial coding (2nd step). The researcher did not choose a central category because the rule in the GT is the circularity between the stages of collection and analysis until the theoretical saturation is reached (Corbin & Strauss, 2014). Selective coding was not performed (3rd stage of the GT method) because this analysis is a specific context for using the TAEP4.0, and it is not yet possible to reach theoretical saturation. In this case study, the goal of the qualitative analysis was to verify which skills and competencies of the 21st-Century were encouraged in the students during the execution of the teachers' projects.

The recommendation of the GT is not to use a prefigured categorization scheme. Thus, other skills and competencies were perceived that had not been defined in the questionnaire, such as Autonomy and Initiative, Interpersonal Relationships, Resilience, Empathy, and Flexibility. Participants were coded from P1 to P182. Quotations from participants are represented in the text using these codes. The categories identify represent the competencies and skills identified in the analysis. To facilitate their presentation in this article, we have organized them into four groups, such as behavioral skills, cognitive skills, communication skills, and socio-emotional skills. In each skill group, positive responses are presented first, followed by negative ones, and ending with a brief discussion. The categories and quotations will be presented below.

A. Behavioral skills: Autonomy and Initiative, and Creativity.

With regard to Autonomy and Initiative skills, one of the participants reported that he could do a job as planned (see the quotation from P9). Moreover, another participant shared that it was necessary to have an attitude to make the necessary choices (see the quotation from P20). About the Creativity skill, one of the participants said that he could express his ideas in the e-book production (see the quotation from P28). Likewise, one of the participants said that the technology used allowed him to express his creativity (see the quotation from P26).

“I was free to do a job the way the team wanted.” (P9)

“There were a lot of resources on the platform, so just depending on our choice.” (P20)

“Through the project, I was able to perfectly express my ideas and turn them into content for the pages of my e-book.” (P28)

“The platform encouraged my creativity and allowed my choices to be expressed in the production of my work.” (P26)

Nevertheless, some students were found to have failed to develop behavioral skills so well. Regarding the Autonomy skill, one of the participants reported that it still depends a lot on colleagues' opinions (see the quotation from P32). In addition, one participant shared that he could not have the attitude to make his own decisions (see the quotation from P13). For the Creativity skill, one participant said that the theme chosen by the group did not allow him to have so many ideas (see the quotation from P12).

“I felt that I still depended a lot on the opinion of my teammates.” (P32)

“I was unable to make my own decisions, due to the work being in a group, making other people not accept my opinion very much.” (P13)

“My work was about Photography, an area where I don’t do well, I didn’t get to have so many ideas, exercising little of my creativity. If the work was about music, I think it would have been different.” (P12)

Behavioral skills may have helped students improve their ideas in creating e-books (1st sentence of Figure 3), enabling them to engage in more active learning by implementing their ideas (2nd sentence of Figure 3) and effectively communicating them to their peers (3rd sentence of Figure 3). Furthermore, this approach fostered creative thinking, allowing students to generate innovative and valuable ideas to solve the given problem (4th sentence of Figure 3). These skills are essential for 21st-Century students, as they are crucial for achieving excellence in their work. Furthermore, the market demands professionals who possess these attitudinal characteristics. However, some students struggle to develop these skills. Certain students demonstrate a lack of active participation and tend to rely heavily on the opinions and acceptance of their peers when making decisions. As a result, teachers recognize the need to equip students with these skills to foster creativity, innovation, autonomy, active engagement, and a genuine interest in learning.

B. Cognitive skills: Critical thinking, Problem-solving, and Decision-making

In relation to Critical Thinking skills, one of the participants said that dialogue influenced the development of critical thinking (see the quotation from P18). Regarding Problem-Solving, another participant noted that the dialogue helped solve problems critically (see the quotation from P19). About the Decision-Making, one of the participants shared that it was necessary to make decisions (see the quotation from P22). Besides, one of the participants had to make decisions to keep the work organized (see the quotation from P25).

“I was able to develop critical thinking, to disagree and to agree with my colleagues.” (P18)

“To solve the problems, we had to discuss certain ideas. This attitude allowed us to make critical decisions.” (P19)

“The work was defined by decisions that needed to be made, from the layout of the e-Book to its number of pages.” (P22)

“We had to decide the font, the colors, and many other things to make the work beautiful and organized.” (P25)

However, some students were found to have failed to develop cognitive skills so well. Regarding the Problem-Solving skill, one of the participants reported that some colleagues could not solve problems effectively and quickly (see the quotation from P30). For the Decision-Making skill, one of the participants said that he could not make his own decisions (see the quotation from P14). Moreover, one participant shared that the decision was made by one person in the group and not together (see the quotation from P30).

“Most of the solutions to the problems were good, but there were disagreements among colleagues who did not know how to solve problems effectively and quickly.” (P30)

“I was unable to make my own decisions; my colleagues did not accept my opinion very well.” (P14)

“Most of the ideas came from just one person. So, the work was reduced to one person making decisions and the rest shaking their heads.” (P30)

Cognitive skills enabled students to comprehend the class’s content and effectively articulate their opinions and decisions to their classmates (1st sentence of Figure 5). As part of the project proposal, students were encouraged to select and organize materials for use in creating e-books (2nd sentence of Figure 5). Cognitive skills played a vital role in facilitating the comparison of opinions and ideas, leading to informed decision-making (3rd sentence of Figure 5), as well as fostering interactions with peers and the teacher, resulting in positive outcomes (4th sentence of Figure 5). This approach facilitated the development of problem-solving strategies (5th sentence of Figure 5). These skills are not merely about memorizing content; instead, it is linked to the student’s mental process of understanding and transforming their research into practical and meaningful information for life. However, certain situations have been observed that hinder the development of specific cognitive skills. Some students struggle to solve challenges due to disagreements within the group, experiencing difficulty in making independent decisions, expressing their opinions about the project, and questioning why their ideas are not accepted. These situations can be attributed to deficiencies in other essential skills such as initiative, self-confidence, interpersonal relationships, adaptability, and the ability to work under pressure.

C. Communication skills

One of the participants reported that he felt safer talking about the class’s content (see the quotation from P35). Another participant said that communication enabled the group to reach a consensus (see the quotation from P38). Also, one of the participants shared that it was necessary to communicate to perform teamwork (see the quotation from P20). And, one participant said that the communication made it possible to clarify the opinions of colleagues in the group (see the quotation from P26).

“I was more confident when talking about the subject.” (P35)

“Everyone in the group talked to each other to reach a consensus, with the aim that the work was done in the best way.” (P38)

“I communicated whenever I needed to with my colleagues so that we could carry out a job in which everyone participated.” (P20)

“We had great communication when developing the work, clarifying the opinions of all members of the group.” (P26)

However, some students were found to have failed to develop their Communication skills so well. In this sense, one of the participants said that the communication in the group was flawed (see the quotation from P21). Another participant shared that the team poorly performed communication (see the quotation from P24). Moreover, one participant realized that not all colleagues develop communication during the school phase and this problem remains in High School (see the quotation from P37).

“Communication was flawed in my group because part of the group members were away, and we were unable to interact.” (P21)

“The communication skill was poorly done on my team but speaking in public was not a problem.” (P24)

“Communication skills begin to be developed during school life. But not everyone was able

to develop as well, having a variety of personality, which allows us to have more extroverted and introverted people in our team.” (P37)

Communication skills empowered students to feel more confident discussing the topic and eliminated any hesitation or embarrassment when speaking within the group (1st sentence of Figure 7). Students actively engaged in dialogue and actively listened to diverse opinions (2nd sentence in Figure 7) to understand their colleagues’ proposals (3rd sentence in Figure 7). Clear and effective communication enhanced teamwork among students (4th sentence in Figure 7). Thus, Communication skill enabled students to enhance their learning, problem-solving abilities, decision-making, and teamwork. Effective communication entails expressing oneself clearly and understanding messages from both peers and teachers. However, some students enter High School with significant communication challenges, struggling even to ask their teacher questions about their doubts. In this case study, it was observed that some students were more interested in completing the work rather than actively engaging in the learning process, which necessitates planning, communication, and active participation. In such cases, TAEP4.0 can assist the teacher in identifying students with communication difficulties and implementing various formats and resources to develop this skill effectively.

D. Socioemotional skills: Collaboration and Teamwork, Interpersonal Relationship, Resilience, Learn to learn, Empathy, and Flexibility.

Related to Collaboration skill, one participant said that collaboration facilitated teamwork (see the quotation from P16). About the Interpersonal Relationship skill, one participant shared that the relationship with his group influenced the completion of the work (see the quotation from P32). Regarding the Resilience skill, one of the participants said that he learned not to give up his goals in difficulties (see the quotation from P29). With regard to the Learn to learn skill, one of the participants told that he could dedicate himself and develop independence in his activities (see the quotation from P35). Regarding the Empathy skill, one participant said of the need to respect differences in other cultures (see the quotation from P13). Finally, concerning the Flexibility skill, one of the participants was able to adapt and work with the available resources (see the quotation from P32).

“With the help of classmates, we were able to work very well on this project.” (P16)

“My team’s harmony helped us to conclude without regrets.” (P32)

“I learned that we must not give up and always strive to achieve what we want.” (P29)

“I learned to be independent in my activities and I dedicated myself to work.” (P35)

“We realized that there are other cultures in our world and that they need to be respected.” (P13)

“There was not much content on my topic, so I had to work with what I had.” (P32)

Nevertheless, students were found to have failed to develop socioemotional skills so well in activities. Regarding the Collaboration and Teamwork skill, one of the participants said that he does not like working in a team and thinks it is bad to share his ideas (see the quotation from P8). Besides, one participant shared that he has difficulties working as a team (see the quotation from P11). About the Interpersonal Relationship skill, one participant reported that his main difficulty was dealing with his team (see the quotation from P24). Moreover, one participant said that he preferred to do the activity alone (see the quotation from P8). For the Empathy skill, one participant criticized colleagues who were having difficulties (see the quotation from P11).

“I hate group work because sharing ideas is very bad, I want everything to be the way I want it.” (P8)

“Group work requires empathy, responsibility, and understanding. I don’t have it.” (P11)

“I had no difficulties with the platform or the tools used, but with my team.” (P24)

“This job was for me to do alone with my ideas. My group only has boring people, just like me.” (P8)

“There were only slow people in my group, it was difficult.” (P11)

Socioemotional skills provide the students with the values of good citizenship and contribute to the construction of a better society. These skills encompass respecting the differences among individuals from diverse regions, countries, and religions (1st sentence of Figure 7). Within project settings, students actively sought to assist their colleagues (2nd sentence of Figure 7) and organized themselves for effective teamwork (3rd sentence of Figure 7). This collaborative work was characterized by mutual respect among all participants (4th sentence of Figure 7), which involved actively listening to one’s colleagues with care and patience (5th sentence of Figure 7). These skills are considered strategic, particularly in light of societal and work relationship changes. They promote increased student participation, self-regulation, peer conflict reduction, and improved classroom discipline. However, some students faced significant challenges, such as difficulties in relating to their peers, contributing their ideas, assisting others, or displaying an individualistic or superior attitude towards their team members. In such cases, the TAEP4.0 enables teachers to identify these situations, assess students’ learning progress, and implement new strategies that facilitate their socioemotional development.

7 Discussions

In the quantitative analysis, the researchers aimed to address research questions SQ1 and SQ2 by examining the twenty-three questionnaire statements and the discrepancies in students’ responses on the Likert scale.

For SQ1, the results indicate that students across all five High School classes demonstrated improvement in generating ideas for their projects (1st sentence of Creativity and Innovation skills). They showcased increased creativity and innovation while searching for new ideas to create interactive e-books. Furthermore, students demonstrated proficiency in selecting and organizing the necessary materials (2nd sentence of Problem-Solving, Critical Thinking, and Decision-Making skills), highlighting the importance of organization for problem-solving, critical thinking, and decision-making skills. Additionally, students exhibited independence in their activities (5th sentence of Learn to Learn and Metacognition skills), and the researchers believe that this autonomy contributed to the successful completion of the projects. Moreover, students demonstrated an understanding of their peers’ perspectives (3rd sentence of Communication skill), indicating that active listening played a role in facilitating collaborative and team-based project creation. Finally, students showed respect for their colleagues’ differences, emphasizing the value of mutual respect within the teams. In summary, autonomy, respect, and organization emerged as key elements in fostering skills such as Creativity, Problem-Solving, and Learning to Learn.

Regarding SQ2, the results indicate that students encountered difficulties in effectively com-

municating their ideas to their colleagues (3rd sentence of Creativity and Innovation skills). The researchers believe that this problem hindered the development of Creativity and Innovation as a whole and was linked to communication skills. Furthermore, students faced challenges in effectively collaborating with their colleagues to achieve better results (4th sentence of Problem-Solving, Critical Thinking, and Decision-Making skills). Insufficient communication skills likely impacted their problem-solving, critical thinking, and decision-making abilities. Additionally, some students found it easier to work individually and struggled with the collaborative and teamwork aspects of the projects. Furthermore, students experienced difficulties speaking in groups and in public (1st sentence of Communication skill). The researchers speculate that feelings of shame or shyness directly affected some students, hindering the development of other targeted skills. Lastly, students encountered challenges in actively and patiently listening to their colleagues, which likely impacted teamwork and collaboration. Overall, effective communication, collaboration, and teamwork were crucial for developing other skills such as Creativity, Problem-Solving, and Decision-Making. Although students demonstrated respect and a willingness to listen to their peers, some struggled with effective communication within their teams.

The researchers observed that certain students lacked active participation, relying on their colleagues' opinions to make decisions. This indicates the need to continue implementing projects of this nature to enhance the education of students in the final stages of basic education. Additionally, some students were more focused on submitting the work rather than engaging in the learning process, which necessitates planning, communication, and active participation. Some students faced challenges in solving group conflicts or communicating due to feelings of shame and shyness. On the other hand, proactive students took the lead in projects, effectively utilizing their time, and presenting more elaborate and organized work. Hence, these projects highlighted to students the importance of skills and competencies for their learning and education. Students have long been accustomed to memorizing content and completing tasks solely for grades. Therefore, the projects presented an opportunity for students to learn curricular content through Informatics, fostering the development of 21st-Century skills and competencies.

In the qualitative analysis, the researchers aimed to identify valuable lessons for the teacher based on the results. The findings from SQ3 indicated that the teacher gained insights into the various difficulties and challenges that each student encountered in their learning process, extending beyond the understanding of specific content. As a result, the teacher can address these issues with their students and foster the development of the necessary skills and competencies. The teacher can choose to reuse the project with necessary adjustments or create a new one to better prepare students for the challenges of the 21st-Century. The responses obtained through the 23-sentence self-assessment questionnaire can assist the teacher in identifying students who are facing difficulties in developing specific skills and competencies. However, the researchers also emphasized the significance of the teacher's daily monitoring and encouragement during the project's construction, which likely contributed to a clearer understanding of the students' real needs. Furthermore, this teacher's support and encouragement may have directly influenced the participants' performance. This case study also prompts teachers to reflect on traditional teaching methods, which often rely on theoretical classes that may lack meaningful connections to students' lives. Through project-based learning, teachers were able to observe students' active involvement in the learning process, track project progress, and address emerging doubts without overshadowing the students' role and agency.

This case study demonstrates a process that enables researchers to assess 21st-Century skills and competencies in alignment with the principles of Education 4.0. TAEP4.0, referring to the specific method or tool used, contributes to the three focal points of developing these skills and competencies, as proposed by Kong et al. (2014). It guides teachers in defining the skills they aim to cultivate in their students (Define scope step) and determining the information and communication technologies (ICTs) that will be utilized in the projects (Verify technological resources step). Subsequently, teachers plan activities based on the school's context and needs (Define, organize, and apply the project steps). Throughout the process, teachers provide guidance and support to students during their project work (Conduct formative evaluation step), emphasizing the first focal point of skill and competency development. The researchers also observed that TAEP4.0 empowers students to take an active role as protagonists in their learning through practical and interactive activities (Learn by doing step), mirroring the philosophy of TAEP4.0. Continuous monitoring ensures that students receive adequate support to successfully complete their activities (Conduct formative evaluation step), addressing the second focal point. Lastly, TAEP4.0 enables teachers to facilitate self-assessment among students, promoting reflection on their learning and allowing them to assume a leading role in the evaluation process (Reflect and share step), which aligns with the third focal point.

The findings of this case study highlight the importance of supporting and guiding students in developing skills and competencies. As noted by Latorre-Coscolluela et al. (2021), teacher support and guidance can have a positive impact on the assessment process, particularly when students are engaged in new projects. Furthermore, Obi et al. (2022), emphasize that students who participate in fewer experiences tend to have fewer developed skills. In this context, the first and second-grade High School students in this study had their initial experiences with projects that required the exercise of skills and competencies. The researchers believe that, in the long term, these students will be better equipped with enhanced mastery of these skills and competencies by the time they complete High School. According to Lavi et al. (2021), university students generally exhibit lower scores in social skills like Communication and Collaboration, and High School students face significant challenges in these areas as well. These findings indicate that the issue extends across educational levels and necessitates attention and resolution. Rios, Ling, Pugh, Becker, and Bacall (2020) demonstrate that Communication and Collaboration are prominent 21st-Century skills highly sought after by employers. Consequently, Lavi et al. (2021) conclude that active learning methods positively contribute to the development of social skills. The active methods identified by Lavi et al. (2021) include projects, coursework, research, and laboratory classes. In this case study, these methods were implemented through TAEP4.0, the specific approach used. Finally, Obi et al. (2022) argue that active methods are more effective and efficient for assessing and developing skills and competencies relevant to the 21st-Century.

In summary, the case study underscores the significance of supporting and guiding students in skill and competency development. It aligns with previous research that emphasizes the importance of teacher involvement and active learning methods in fostering skills such as Communication and Collaboration. By implementing TAEP4.0 and its associated active methods, it is expected that students will have greater opportunities to enhance their skills and competencies, ultimately preparing them for the demands of the 21st-Century.

8 Threats to Validity

In this case study, efforts were made to address and mitigate four types of validity threats: Internal Validity, External Validity, Conclusion Validity, and Construct Validity, as suggested by Wohlin et al. (2014).

For Internal Validity, measures were taken to ensure that students received support and guidance from teachers and ET coordination while still allowing for originality in their productions. Teachers were advised not to interfere with students' ideas and decision-making, promoting autonomy and self-organization within the projects. All classes had the same amount of time to complete their projects, minimizing potential confounding variables. Additionally, the teachers' projects were reviewed and adjusted by the ET coordination, incorporating the recommendations of TAEP4.0. Student feedback was also analyzed and reviewed by an Informatics in Education researcher, adding another layer of validation.

Regarding External Validity, the study included participation from different High School classes, such as 1st-grade (Arts) and 2nd-grade (Spanish), to ensure a more heterogeneous sample. The TAEP4.0 approach was implemented in its entirety, with students actively engaged in executing the teachers' projects. Researchers also sought to involve ET coordination throughout the project steps, increasing the external validity of the findings.

Concerning Conclusion Validity, there were some potential threats. The sample size consisted of 189 students, which may limit the generalizability of the results. Additionally, all participants came from the same institution, introducing homogeneity into the sample. As a result, the findings are considered evidence for a specific context and require further investigation and replication in different High School classes to achieve theoretical saturation and generalizability.

In terms of Construct Validity, the use of closed questions in the self-assessment questionnaire could have influenced the results. However, students were given the opportunity to provide feedback using their own words to address specific aspects. They were also provided with a dedicated class to answer the questionnaire without the presence of teachers, ensuring a comfortable environment. The potential bias was further reduced by employing the GT method in the qualitative analysis, allowing for the identification of codes and categories based on students' feedback. The researchers actively sought negative feedback to understand the difficulties and problems students encountered during the projects, while also considering the positive feedback to inform future work.

Overall, while efforts were made to mitigate validity threats, it is important to acknowledge the limitations and context-specific nature of the findings. Further research involving a broader range of High School classes will be necessary to enhance the robustness and generalizability of the reported strategies and outcomes.

9 Conclusions and Future Work

The article aimed to develop 21st-Century skills and competencies in High School students by utilizing TAEP4.0 to support teachers in planning and executing interactive e-book projects. The

students were then asked to complete a self-assessment questionnaire to evaluate their skills and competencies. The researchers observed that the participants demonstrated growth and maturity throughout the projects, as they were able to self-assess their own progress. This approach aligns with the principles of Education 4.0, which emphasizes student responsibility and involvement in the learning process.

The investigated skills and competencies in this case study included Creativity and Innovation, Problem-solving, Critical Thinking and Decision-making, Learn to learn and Metacognition, Communication, Collaboration, and Teamwork. However, through the GT method, the researchers identified additional skills such as Resilience, Empathy, Flexibility, Initiative, and Autonomy that were not initially included in the questionnaire. This highlights the importance of a comprehensive approach to developing 21st-Century skills and competencies.

The case study involved the participation of High School teachers and students, with researchers providing support and maintaining direct contact with the teachers throughout the process. The TAEP4.0 facilitated the rethinking of content delivery using ICTs, allowing teachers to focus on student-centered approaches and become learning experience designers. The flexibility of TAEP4.0 was evident, as some steps could be omitted or added based on the teachers' proposals, catering to the specific needs and realities of the school. It encourages teachers' creativity and decision-making in designing projects.

The continuous and effective use of TAEP4.0 can support the professional development of teachers who may not have a background in informatics. However, the researchers emphasized the need for pedagogical coordination or school leadership to encourage teachers to utilize ICTs. Although the steps of TAEP4.0 are commonly known or partially used by teachers, the framework was designed to be applicable and useful, particularly for public schools with limited financial resources that aim to innovate through ICTs. While TAEP4.0 is not a fully functional or management system, it provides teachers with instructions for Education 4.0 and access to validated websites, tools, and materials from previous studies conducted by education professionals, informatics specialists, and educational managers.

Based on the quantitative results, the researchers noted that the 2nd-grade classes showed more positive outcomes compared to the 1st-grade classes in terms of the encouraged skills and competencies. The younger age and recent transition from elementary school may have influenced the performance of 1st-grade students in the projects, as it was their first experience with greater autonomy in High School. Communication and Teamwork were identified as areas of difficulty for students in developing the investigated skills and competencies. The teachers can use the participants' feedback to reorganize their projects and provide additional support to students struggling with specific skills and competencies. If challenges persist, future projects can be planned accordingly. The next step of the research is to support teachers in addressing the identified difficulties and analyze their experiences in project development and execution using TAEP4.0. Furthermore, the intention is to include the results of the planning and execution of interactive e-book projects by teachers, as well as their integration into the school curriculum and the evaluation of selected content.

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