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Contextualized Learning and Social Constructivism: Implementing a Project-Based Approach in Information Systems Development Education

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ABSTRACT This article investigates the impact of integrating authentic and contextualized activities into teaching on students' knowledge construction, grounded in social constructivism principles. The research focuses on applying the real-project approach within a "Mini-Project Workshop" module for third-year Information Systems Development (ISD) students at the Higher Institute of Technological Studies (HITS) of Charguia, Tunisia. Using a qualitative research design that includes observations, semi-structured interviews, and document analysis, the study explores how project-based learning influences knowledge construction, emphasizing the interplay between social, cognitive, and affective dimensions. The study advocates for an iterative project delivery approach with varied evaluations, fostering performance enhancement and deeper understanding through feedback and reflection. The results demonstrate positive impacts on the development of technical and transversal skills, while revealing that the experience of "the self-training classroom" where students train each other can effectively meet the specific needs of learners. Overall, the research underscores the value of embedding authentic, contextualized activities in teaching to promote meaningful learning experiences and equip students with essential skills.

Keywords Project-based approach, Contextualized learning, Iteration, Review, Retrospective, Learner-to-learner learning

1. INTRODUCTION

In an educational setting, the dynamic between teacher, learner and knowledge is constant and interdependent. We aspire to a better pedagogical adaptation of contextualized knowledge, by integrating the most relevant approaches that guarantee the development of a practical skill. We consider social constructivism as a contextualized learning model, highlighting the importance of social and cultural context in the process of knowledge acquisition. According to this perspective, learning involves the interpretation of experiences, languages, and phenomena, grounded in their respective contexts. Proponents of contextualized learning recommend the use of authentic tasks and learning situations that are as realistic as possible. It is in this context that our study aims to apply the real project approach for an internal didactic transposition of the module "Mini-Project Workshop" intended for students in the third year of information systems development. Through this research, we intend to highlight the implications of this approach on the construction of knowledge as well as on the interaction of the social, cognitive and affective dimensions on which the socio-constructivist model is based. Our approach begins with a description of the theoretical concepts underlying our research, including social constructivism and contextualized learning. Then, we present the experiment conducted and the results obtained.

1.1 Social Constructivism Approach

In a modern education context, the traditional learning model of teacher knowledge transmission, where information is expected to be absorbed by students like soft wax, is outdated (Guillemette, 2020). Similarly, the behaviorist approach, where learning is seen as a series of conditioned responses to stimuli, may be less effective and does not really promote the acquisition of practical knowledge that can be used immediately (Larochelle, Bednarz & Garrison, 1994). Indeed, the conquest of such knowledge should result from an imbalance caused by a teaching-learning situation where the learner is also an actor in his learning (Muhajirah, 2022). We are therefore looking for an interactive and participatory approach to help students build their knowledge. According to Hameline, learning is as much losing ideas as acquiring new

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ones (Hameline, 2022). These three models highlight several differences, particularly with regard to the perception of error. According to the transmissive approach, the mistake is often attributed to the student, who is considered responsible for his own learning and any mistakes made in the process. On the other hand, in the behaviorist approach, which is often considered to promote success, the error is more often attributed to the teacher (Brousseau, 1976). This approach aims to prevent errors by breaking down learning into small, thin, and well-structured units. Thus, any mistake is perceived as the result of a failure in the process put in place by the teacher, rather than as the responsibility of the student. However, in the socio-constructivist framework, error is not a fault, but rather a learning opportunity. It is perceived as an experience in its own right, a source of knowledge (Khasawneh, Al-Barakat, & Almahmoud, 2022). Sometimes we deliberately provoke error in order to allow the learner to better grasp and assimilate the knowledge. From this perspective, the origin of the error does not matter. What really matters is learning from these mistakes to gain more experience and foster greater learning success. This perception of error is one of the factors that demonstrates that socio-constructivism is appropriate in a contemporary learning context. This model emphasizes the contributions of culture, social interaction and the historical dimension of mental development (Rapanta, 2023). Indeed, the idea is that all knowledge is part of a construction process in which the main actor is the learner. The prefix socio emphasizes the importance of social interactions that influence this process. This trend can be traced back to Lev Vygotsky (1896-1934), a Soviet psychologist who was posthumously victimized because of his criticisms of the psychology of his time. It was not until twenty years later that his work "Thought and Words" was republished in a collection of six of Vygotsky's works under the title "Selected Psychological Researches". His groundbreaking ideas emphasize the role of culture and the social environment in a child's development. This development takes place through the mediation of the adult. According to him, the construction of knowledge, even if it is personal, takes place in a social context (Cole, & Wertsch, 1996). The information is related to the social environment, the context and comes from both what we think and what others bring to the table in terms of interactions (O'Brien & Battista, 2020). The orientation of Vygotsky's thinking leads the school to be more than a place of acquisition of knowledge, it is the place of privileged interactions where the learner acquires the knowledge, know-how and interpersonal skills specific to his society. The social constructivist teacher is a guide for learning and a potential source of information (Adam, 2006). He plans training sessions in which learners face challenges as a team. He is therefore a mediator. It enrolls itself and the learner in a social project. Learners think intensely, confront ideas, experiment and solve complex problems (Leiber, 2022). Thus, they are responsible for their own learning.

1.2 The Dimensions of Social Constructivism

The social model of learning promotes an active pedagogy at the heart of which learning emanates from interactions of three dimensions: social, cognitive and affective (Ajjawi & Boud, 2018). From a social point of view, interacting individuals develop their ability to exchange about the strategies used by each person to carry out a task and acquire knowledge. The learner-learner exchange allows everyone to move from an interpersonal to an intrapersonal level. Indeed, in a situation of solving a task, the coordination of learners allows for individual progress. According to Vygotsky, social interactions are essential and promote what he calls the "Proximal Zone of Development." ZPD refers to the difference between what the learner can accomplish independently and what he can accomplish with the help of a more competent tutor or peer (Wang, 2022). In other words, the ZPD represents the learner's current skill level as well as the potential for development that can be achieved with adequate support. According to him, by working with more competent people, learners can progress beyond their current abilities. However, the exchange is also a teacher-learner exchange that refers to the discussions in class, the explanations given by the teacher-mediator, his answers to questions, etc. These interactions are influenced by the mutual expectations defined by the didactic contract which refers to an implicit or explicit agreement between the teacher and learners about expectations, roles and responsibilities in the teaching and learning process. This contract establishes the rules of the pedagogical game and influences the dynamics of the classroom as well as the behavior of teachers and learners (do Carmo et. al, 2020). In a social constructivist context, the didactic contract emphasizes the active participation of students in the classroom, the teacher will be more inclined to encourage student discussions and questions, which will promote a more dynamic teacher-learner exchange. The cognitive dimension involves the management of mental activity. It is an element of learning theory that involves a confrontation of at least two points of view regarding a problem. This confrontation leads to cognitive development since it identifies a disagreement, a conflict that must be overcome in order to arrive at a new response that will be common (Peralta, Castellaro, Tuzinkievicz & Curcio, 2023). Indeed, none of the points of view should be imposed or abandoned. They must all be used for resolution. There are two benefits to this conflict. A more adequate solution to the problem at hand and a cognitive restructuring. It goes beyond Piaget's individualistic conception. Indeed, Doise and Mugny present peer interactions as a source of cognitive development provided that they give rise to socio-cognitive conflicts (Darnon, Buchs & Butera, 2006). According to

them, social interaction is constructive to the extent that it introduces confrontation and divergent conceptions. This leads to an initial inter-individual imbalance within the group, as each student is confronted with divergent points of view. In this way, the student becomes aware of his own thinking in relation to that of others. This causes a second imbalance of an intra-individual nature: the learner is led to reconsider at the same time his own relationships and those of others in order to reconstruct new knowledge. According to Bruner (Sidambarompoulle & Senteni, 2007), the narrative becomes, in this perspective, a means of thinking our own thoughts and refers to the understanding of one's own thought as well as that of others. From a social constructivist perspective, learning means developing one's own knowledge by necessarily going through a phase of interaction, or even socio-cognitive conflict with others, and this at any age. The affective dimension conditions learners' behavior in a learning situation: their feelings, emotions, attitudes, representations, beliefs, etc. (Alias, Lashari, Akasah & Kesot, 2014). It is guided by motivation, a psychological state that pushes one to act and that develops and evolves in the interaction between the learner and his environment. Motivation is influenced by internal factors related to the cognitive, affective and social characteristics of the learner and factors external to the learner involving the teacher, the pedagogical approach, tools, tasks and other learners. It's so important because long-term learning is a combination of inspiration and fun. Thus, the practitioner must act on the motivation of learners by creating a climate of trust and acceptance for group cohesion and by verbalizing rules for constructive learning. It must also adopt a motivating teaching approach by arousing curiosity, listening to learners' interests, seeking pleasure, protecting self-esteem and encouragement, developing autonomy and choosing formative feedback.

1.3 The Project-based Approach

The project-based approach is intrinsically aligned with the socioconstructivist model as it promotes collaborative knowledge construction and practical application of concepts, reflecting the idea that learning is actively constructed through social interactions and concrete experiences. Fundamentally, project-based approach isn't a technique or a prescribed method of instruction. Instead, it represents a mindset towards teaching aimed at fostering improved learning outcomes. It emphasizes learning through active engagement, with the learner taking the helm of their education and the teacher serving as a guide (Leclerc, 2007; Proulx,2004). A project approach is a collective enterprise managed by the class group and oriented towards concrete production. In our study, production is a software application. According to Perrenoud (Perrenoud,2002), the project-based approach induces a set of tasks in which all learners can get involved and play an active role, which can vary according to their means and interests. It encourages the learning of knowledge and know-how related to project management such as knowing how to decide, plan, coordinate, etc. The use of the project-based approach involves different phases. According to Perrenoud (Thien, Marguet, Favre, & Buty, 2013), a project is divided into four phases. The first phase is called the launch phase where the teacher presents the projects, the modalities and the operating rules. Teams are formed and roles are eventually distributed. The teacher is more or less directive at this stage, depending on his pedagogical intentions. The second is a project structuring phase where each one will be broken down into stages, then each step will be broken down into tasks. These must then be planned (Ngo, Marguet, Favre & Buty, 2013). The third is related to the realization of the project, for which it is necessary to compare the tasks carried out with the tasks prescribed. The last phase is a project evaluation phase that takes place at several points in time, taking place at different phases of the project and not only at the final phase. According to Proulx and Forrest, (Ngo, Marguet, Favre & Buty, 2013) formative evaluation is frequent and immediate during the course of the project.

2. METHOD

2.1 Context of The Study

In the realm of investigating the implementation of the social constructivist approach in education, we examine project-based learning, frequently linked with project-based pedagogy. We utilized this approach to promote identifiable learning outcomes in the "Mini-Project Workshop" module, part of the curriculum of third-year Information Systems Development (ISD) students at the Higher Institute of Technological Studies (HITS) of Charguia. Our target is a population of twenty eight students divided into four heterogeneous and representative teams to whom we ask to invoke all the concepts seen in prerequisites and parallel modules to succeed in their software engineering projects. Table 1 describes the group project.

Table 1 Group project

Group	Project
Group 1	Project and people management platform
Group 2	Event, congress and trade fair management platform
Group 3	Online computer hardware sales website
Group 4	VAPE product sales website

The overall objective of the module is to prepare learners for their end-of-study projects and professional life. From the students' perspective, the mini-project workshop involves designing and building a web application. From the teaching perspective, the aim is also to place each student in a context as close as possible to what they will encounter in a professional environment. We have applied Perrenoud's phases as presented earlier.

Additionally, we conducted a summative evaluation through the final products, which had to meet the specifications, and the final reports that documented the design steps. Learners also had to demonstrate their understanding of the concepts by presenting their work. At this stage, the evaluation focused not only on the final result but also, and most importantly, on the skills employed, their transferability to a real professional situation, and the overall approach.

2.2 Hopthesis

Through this context, we aim to explore the central question "What is the impact of integrating authentic and contextualized activities into teaching on students' ability to construct relevant and meaningful knowledge?" We claim that by implementing the group project-based pedagogical approach, in an active learning environment, students would be more likely to actively build their understanding of concepts and internalize knowledge through meaningful social interactions and successfully achieve the internal didactic transposition of the "Mini-Project Workshop" module. We hypothesize that integrating authentic and contextualized activities into teaching will enhance students' ability to build relevant and meaningful knowledge and apply it in practical, real-world situations.

2.3 Data Collection Techniques

To test our hypothesis, we proceeded with a qualitative approach that combines classroom observation with semi-structured interviews with students to gather their perspectives and experiences. Classroom observation is an effective method for collecting data on student behavior and interactions that occur during collaborative activities (Kumar, 2022). This will directly document how students engage in the collaborative learning process and how this influences the social construction of knowledge.

We observed students' interactions with teaching tools, their engagement in group activities, and their application of theoretical concepts in practical contexts. To guide this process, we used a structured observation guide with predefined criteria, such as active participation, peer collaboration, and the application of acquired skills. Data was collected through handwritten notes and audio recordings, which were subsequently transcribed and analyzed. Two members of the research team, trained in the use of the observation guide, conducted the observations to ensure consistency and reliability.

Semi-structured interviews were employed to gather qualitative insights into students' experiences, perceptions, and thoughts regarding the production stages of the web applications corresponding to their projects. This method allowed us to explore in depth the factors influencing their engagement and collaborative learning (Newton, 2010). A semi-structured interview guide with open-ended questions was developed to delve into participants' experiences and perceptions. Key questions focused on their experience with pedagogical activities, perceptions of the methods' effectiveness, and the challenges encountered during project implementation. The same researchers who conducted the observations also conducted the interviews, ensuring continuity in data collection and a deeper understanding of the observed contexts.

Additionally, personal notes during critical incidents, analysis grids, and screenshots of UML modeling diagrams and programs developed by students complemented these methods. These artifacts reinforced the data collection process by providing concrete evidence of student outputs and facilitating a comprehensive analysis.

2.4 The Didactic Scenario

We perceive the project-based approach as an application of the social constructivist model in the teaching-learning process. With this in mind, we will rely on a didactic scenario motivating the students and based on Perrenoud's division to guide the design of the activities at each stage of the project, as illustrated in the table 2. The pedagogical objective of the didactic scenario is to develop skills in modeling, programming and project management by collaborating to create web applications.

However, we have deviated from this division by opting for a three-iteration structure. Therefore, the realization and evaluation phases will be repeated three times for each iteration. We are leveraging the evaluation of the first iteration to correct deficiencies in operations and conduct necessary remediation. In the same way, the evaluation of the other two iterations provides us with valuable information for more efficient consolidation. Thus, the teaching-learning process is constantly evolving in a process of continuous improvement.

For each iteration, the teams' work should follow the process illustrated in Figure 1 below.

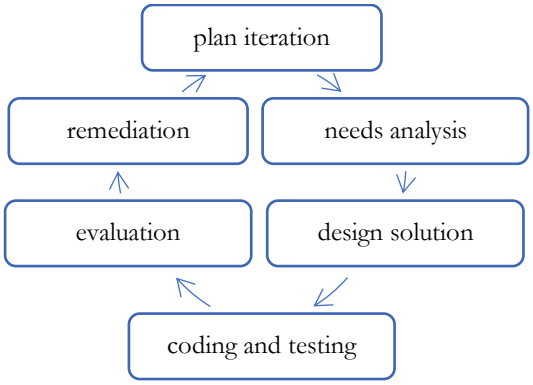

Figure 1 Iteration activities

3. RESULT AND DISCUSSION

3.1 Observation Results

The classroom observation method was used to collect qualitative data on the first three phases of the project where we obtained the data described in following table 3.

3.2 Semi-structured Interview Results

The semi-structured interview method was deployed in the last phase of the project, the evaluation phase, to reveal the data relating to the various assessments maintained and presented in the following table 4.

3.3 Theorical Implications

The implementation of PBL within the project context demonstrated its alignment with socioconstructivist principles, fostering both individual autonomy and collaborative engagement. Teams' freedom in choosing members and topics highlighted the value of active decision-making, which enhanced their involvement and commitment. Constructive exchanges and debates during the structuring phase encouraged creative problem-solving and enriched understanding, reflecting the social dynamics of learning inherent to PBL. Realization challenges, such as handling unexpected obstacles, fostered resilience and emotional investment, essential for both individual and collective success. These findings underscore the strength of PBL in creating a learning environment that not only supports the development of critical thinking (Wang, 2022) and problem-solving skills but also deepens social interactions and collaboration, promoting a shared sense of achievement and enhancing overall group dynamics. Indeed, we believe that project-based learning holds a valuable position among educational approaches (Maros, Korenkova, Fila, Levicky & Schoberovaall, 2023). Ultimately, a complex mix of emotions among the participants helps shape their learning experience and contributes to both cognitive and affective growth, highlighting the powerful synergy between learner autonomy, social engagement, and collaborative knowledge construction in a PBL setting.

It is also important to relate the results of the experiment conducted with the three dimensions that characterize the theoretical framework of the socio constructivist model. Indeed, we highlight the following implications across these dimensions:

- The social dimension reflects the collaborative essence of PBL, where teamwork and peer interactions foster shared problem-solving and knowledge exchange. This aligns with the theoretical framework of PBL, as described by Perrenoud and Proulx, which emphasizes collaborative knowledge construction and collective project work. These interactions directly support the ZPD, enabling learners to benefit from working with more knowledgeable peers or mentors. This dimension is further reinforced by the concept of the self-training classroom, a peer-led initiative that emphasizes learner-learner exchanges and the transition from interpersonal to intrapersonal learning. These training sessions position students as mediators of knowledge, fostering mutual strategy exchange and ZPD activation as they simultaneously teach and learn from each other. This concept of ZPD is emerging as both a research topic and a methodological tool for constructing new research (Zaretsky, 2021).
- The cognitive dimension aligns with the iterative problem-solving inherent in PBL, where students encounter socio-cognitive conflicts, resolve disagreements, and engage in cognitive restructuring to succeed in their project web development. Student-led training sessions where concepts are presented and explained by students for the benefit of their peers, encourages reflective thinking and deeper understanding. In addition, our deviation from the Perrenoud division by carrying out the implementation steps in three iterations allowed us to iterate the evaluations convinced of the role of assessments as a fundamental part of pedagogy (Black & Wiliam, 2018). Therefore, the iterative nature of functional and technical reviews, retrospection, and feedback introduces new opportunities for socio-cognitive conflict and the re-evaluation of ideas, promoting both problem-solving and cognitive restructuring. This approach resonates with Proulx's interpretation of PBL, where learners take ownership of their education while the teacher serves as a guide.
- The affective dimension complements PBL by emphasizing the importance of motivation, curiosity and emotional engagement, which are essential to sustain efforts in the contextualized projects at hand. Iterative evaluations and formative feedback foster motivation, improve self-esteem and support continuous learning. Our study demonstrated that PBL can be effectively used for iterative assessments, building on previous research that highlighted its application for teaching iterative methods (Marnewick, 2023).

The study's comprehensive approach ensures that the combination of these dimensions prepares students for real-world scenarios, echoing the importance of balancing technical expertise with soft skills development. The social dimension builds collaborative and interpersonal skills. The cognitive dimension strengthens analytical and problem-solving abilities and the affective dimension ensures that students are emotionally resilient, motivated, and prepared for professional challenges.

Table 2 Project phases and activities

Phases	Activities
Launch of the project	1. Choosing members and topics to build work teams. 2. Define the technical activities to be carried out for software production. These activities are associated with the transposed knowledge, correspond to the teaching objective and are related to: • Needs analysis, • Solution design, • Frontend coding, • Backend coding, • Testing
Structuring the project	1. Understand the features to be achieved for each project. 2. Break down work into iterations. 3. Plan iterations.
Realization of each iteration	1. The team breaks down the activities of software production into basic tasks. 2. Each member chooses one voluntarily and undertakes to do so. 3. Everyone exchanges with others in order to succeed in the chosen task. 4. Everyone records the progress of their work and the difficulties they encounter on a board called the "iteration board". 5. The team follows the iteration chart on a daily basis. 6. By the end of iteration, the team obtain an increment of product
Evaluation	The increment obtained at the end of each iteration is subject to: 1. A functional review with the teacher playing the role of a customer to judge the satisfaction of the result in relation to expectations. It tests the application and evaluates its usefulness, usability and performance, simulating a professional environment. 2. A technical review of the activities carried out by the teacher to evaluate the analysis and design diagrams and the quality of the code. 3. A retrospective where students reflect on their own contribution to iteration, identifying their achievements, challenges, and learnings. 4. Feedback where the teacher is a problem solver encountered by the team in its process of carrying out the iteration so teams can undertake remediations

Table 3 Data observed and discussed

Phase	Results	Discussions
Launch phase	Teams' autonomy and involvement were observed as they chose their members and topics, aligning with the principles of PBL.	This illustrates that giving individuals the opportunity to actively contribute to decision-making fosters their engagement in the project and autonomy which is a psychological need essential for undertaking a project (Wijnen et. al, 2018). It reflects the socioconstructivist model, where social interactions and shared responsibilities enhance group cohesion and collective knowledge construction.
Structuring phase	Constructive exchanges and debates were central to the process.	These interactions foster creativity and critical thinking within PBL, encouraging the sharing of ideas and productive brainstorming. Students become independent learners and thinkers (Lim, Jawawi, Jaidin & Roslan, 2023). From a socioconstructivist perspective, they promote social engagement, enrich understanding, and stimulate collaborative knowledge construction, while also facilitating the resolution of socio-cognitive conflicts.
	The presence of lively and sometimes confrontational debates revealing differences of opinion and tensions.	This highlights the diversity of perspectives within the team, which challenges and enriches the collaborative process. Such debates mirror real-world teamwork challenges emphasized in PBL, fostering critical thinking and problem-solving. Socioconstructivism aligns with Vygotsky's concept of socio-cognitive conflict, which is considered a potential situation for knowledge construction (Peralta, Castellaro, Tuzinkievicz & Curcio, 2023), promoting deeper learning through the resolution of differing opinions.
Realization phase	A strong spirit of mutual aid, where each member strived to help his teammates.	Mutual aid reflects the cooperative nature of PBL, where students share responsibilities and actively support one another. This aligns with social constructivist principles, particularly the Zone of Proximal Development (ZPD), where students learn from each other and benefit from the support of more capable peers (Wang, 2022), recognizing that individual success contributes to the collective success of the group.

Table 3 Data observed and discussed (*Continued*)

	Remarkable resolve and tackled the challenges with enthusiasm.	This illustrates the strong emotional investment of each team member, a fundamental condition of the PBL approach. Collective enthusiasm and dedication foster a deep commitment to the group's goals, reinforcing motivation and dynamism. The ZPD, where peer interactions provide the necessary support and motivation for shared learning, underpins this dynamic. This proove the significance of merging intellectual and emotional aspects in PBL (Yu, 2024).
	A deep sense of internal satisfaction and joy upon overcoming challenges	This emotional fulfillment fosters intrinsic motivation and perseverance, characteristics of the PBL approach. It is strengthened by a sense of camaraderie and belonging, which enhance the social aspect of learning, reinforcing the value of collaboration and fostering a shared sense of achievement within the team.
	Some moments of panic and stress due to unexpected obstacles, such as incorrect modeling diagrams or coding issues.	Such emotional responses reflect the affective dimension of learning, where frustration and anxiety can act as both barriers and motivators to progress. Within PBL, these challenges help students develop resilience and adaptability, enhancing their overall learning experience.

Table 4 Data discovered and discussed

Type	Description	Cognitive benefits
A functional review	The increment produced during each iteration is evaluated from the point of view of its functionality. The learners is placed in a professional context where they must present their work to a teacher acting as a customer.	• Simulation of a professional environment familiarizes students with the expectations of real-world practices. By assessing whether iteration outcomes meet the customer's expectations, students learn to adopt the perspective of end users, understanding their needs and preferences. This fosters an awareness of the importance of customer satisfaction in software development and encourages a realistic, practical approach to project execution. • Development of communication skills is another critical benefit. Students must articulate their design choices, address the teacher-customer's questions and concerns, and integrate feedback to refine their work, which reflects essential professional skills.
Comments : These benefits align strongly with the principles of contextualized learning within PBL, immersing students in authentic, real-world scenarios that reinforce practical and transferable skills. Teaching for contextualised learning become more effective for the benefit of 21st century students (Morgado, Leite & Dourado, 2022).		
A technical review	The teacher returns to his initial role and evaluates outcomes related to analysis, design, implementation and testing.	• Consolidation of theoretical knowledge where students are required to apply their software engineering prerequisites to real-life cases, which reinforces their understanding of technical concepts. Many students were able to benefit from teammates' mistakes and the teacher's instructions and corrections. Error is confirmed as a source of learning, as announced by the founders of social constructivism (Khasawneh, Al-Barakat, & Almahmoud, 2022). • Development of critical thinking that emerges when the teacher reviews discuss the analysis and design diagrams as well as the quality of the code produced. Sudents must exercise their ability to identify errors, gaps and opportunities for improvement which develops their ability to evaluate and constructively criticize their own work. • Development of problem solving related to software analysis, design, and implementation. Students face technical challenges that require them to analyze, synthesize, and apply their knowledge to come up with effective solutions.
Comments : These points illustrate how contextual learning through PBL leads to a meaningful learning (Hernáiz-Pérez et. al, 2021). It supports the integration of theory and practice, encourages students to actively engage with their learning process, critique their own work, and develop robust problem-solving abilities.		

Table 4 Data discovered and discussed (*Continued*)

A retrospective	Learners self-evaluate by reflecting on their contributions to understand their achievements, challenges, learnings, progress, and continuously improve.	• Development of metacognitive skills when learners reflect on their mental processes, learning strategies, and skills, which strengthens their ability to regulate their own learning. • Improved self-understanding by recognizing their strengths and weaknesses, allowing learners to identify areas for improvement. • Reinforcement of self-directed learning which encourages learners to reflect independently and fosters strategies for enhancing their understanding and performance.
Comments : The context of PBL enhance learners engagement in self-reflection and self-assessment to evaluate their own contributions and progress. This reflective practice supports the development of metacognitive skills and helps align individual growth with collective learning within the team.		
Feedback	Review the functioning of the team. Rather, the teacher acts as a coach who detects the problems encountered that need to be remedied	• Communication problems raised by intra-learner conflict are managed through different strategies such as games, structured dialogues, stories, etc. • Technical problems related to tools like Angular, SpringBoot, and GitHub among many learners are identified. To address this, training seminars led by students was organized. This approach not only allowed students who were proficient in these areas to share their knowledge with their peers but also fostered an environment of self-directed learning. The experience of self-training proved successful, as evidenced by positive feedback from participants who highlighted the achievement of training objectives with content tailored to their needs and effective facilitation. However, they also pointed out logistical challenges, such as time management and resource availability.
Comments : This peer-learning initiative promoted cognitive benefits by enhancing students' understanding and competence in critical technical areas, encouraging collaborative problem-solving, and fostering the ability to learn autonomously from one another. It also serves as a means to promote self-directed learning, an essential skill for fostering lifelong learning (Sze-yeng & Hussain, 2010).		

4. CONCLUSION

In conclusion, the project-based approach provides a practical and engaging method to explore and implement social constructivist principles in teaching. By engaging learners in meaningful and authentic projects, it fosters active participation, motivation, and autonomy while emphasizing collaboration and group learning. Consistent with the theories of Piaget and Vygotsky, this study confirms that knowledge construction is an interactive process. The findings demonstrate the positive impact of key factors such as autonomy and responsibility on engagement, the value of diverse perspectives in problem-solving, and the critical role of emotional management in learning.

Our study not only achieved a didactic transposition of contextualized knowledge but also fostered the development of transversal skills including communication, collaboration, critical thinking, problem-solving, and emotional management, all valuable in professional contexts. By organizing student-led training seminars, we created a collaborative learning environment encouraging peer knowledge-sharing and mutual support. Additionally, iterative assessment methods including functional and technical reviews, retrospection, and feedback allowed for continous improvement and performance enhancement. Together, These findings highlight the holistic benefits of PBL in strengthening cognitive, social, and emotional competencies.

The theoretical implications for social constructivism emphasize the importance of social interaction, collaboration, and emotional engagement in the learning process. By integrating real-world contexts, such as simulating professional environments and contextualized evaluations, this approach bridges the gap between theoretical concepts and their practical application reinforcing the constructivist view that meaningful contexts enrich learning. Collaborative knowledge-building was evident through iterative evaluation processes and student-led training sessions, which underscore the role of interaction and cooperation in constructing knowledge. Emotional investment, reflected in moments of satisfaction and frustration during problem-solving, complements the cognitive and social dimensions of learning, reinforcing the significance of affect. Moreover, the dynamic roles adopted by the teacher, fluctuating between evaluator, coach, and facilitator, align with constructivist practices and supports learners'autonomy and mastery.

Looking ahead, we plan to investigate the technical assessment results to identify challenges faced by students in knowledge construction. We also aim to conduct comparative studies with other pedagogical methods to evaluate their effectiveness relative to the project-based

approach. Additionally, exploring the long-term effects of project-based learning on students' personal and professional development through longitudinal studies will be crucial in assessing the enduring impact of this approach on their skills, attitudes, and career trajectories.

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HIGHLIGHTS

- Integration of Theories: Demonstrates how social constructivism and project-based learning can be effectively combined in an educational setting to and impact transversal skills.
- Peer-Led Training Seminars: Organized and conducted by students, enhancing technical skills through self-study and peer learning, and fostering a collaborative learning environment.
- Iterative Assessment Methods: Includes functional and technical reviews, retrospection, and feedback, contributing to continuous improvement and performance enhancement in project-based learning.
- Holistic Development: Integrates cognitive, social, and emotional skills, ensuring students are well-prepared for professional challenges.
- Collaborative Learning Environment: Emphasizes the role of student-led initiatives in creating a supportive and effective learning atmosphere.

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