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Student-Centered Pedagogies for 21st-Century STEM: A Comparative Review and Implementation Guide

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ABSTRACT

This review synthesizes learner-centered pedagogies for STEM education and evaluates their feasibility under common classroom constraints. Using a structured search of scholarly databases, we analyzed 61 sources on constructivist, inquiry-, problem-, and project-based learning; design thinking; brainstorming; cooperative learning; Six Thinking Hats; flipped classroom; and interactive teaching. Comparative findings indicate no single "best" approach. Effective selection depends on instructional aims, student characteristics, and local conditions, especially advanced preparation time, in-class time demands, and availability of digital and material resources. Evidence highlights persistent barriers—limited time, teacher training needs, and infrastructure gaps—yet also documents gains, particularly for flipped models in mathematics. We conclude with a practical decision frame and recommendations for curriculum design, professional development, in-service support, and classroom assessment guidance.

Keywords: constructivism, research-based learning, problem-based learning, project-based learning, design thinking, six thinking hats, flipped classroom, differentiated classroom

INTRODUCTION

It is the responsibility of the teacher to establish a culture within the classroom, which encompasses the teaching style and, consequently, the teaching methods employed. The efficacy of the learning objectives depends on the teaching methods employed (Pasigon, 2022). Each student possesses a distinct temperament and a unique set of interests, which they seek to explore. It is the responsibility of the teacher to select the most appropriate educational method for their classroom (Bryce & Withers, 2003). It is, of course, inevitable that throughout the academic year the teacher will be required to utilise a variety of pedagogical techniques to accommodate the diverse personalities of his students.

The following section will examine the contemporary pedagogical methods that can facilitate the attainment of the objectives associated with STEM education. An educator who employs these methods can reduce the achievement of both cognitive objectives and 21st-century competencies by their students. The integrated development of students' personalities and skills represents a fundamental aspect of education (Galindo-Dominguez, 2021). It is therefore considered that the strategies that teachers should follow should be oriented in this way (Aidoo, 2023). This approach has been incorporated into the curricula of numerous countries, including France, Spain, and the United Kingdom (Galindo-Dominguez, 2021). It seems appropriate, therefore, to refer to these techniques while exploring the educational objectives achieved in each case.

In the studies (Permanasari et al., 2021; El-Deghaidy & Mansour , 2015; Thi To Khuyen et al., 2020; Golegou et al., 2025) which document teachers' views and attitudes about 21st-century skills, there is a consensus that it is important for students to master these skills. Similarly, in (Permanasari et al., 2021; Rifandi et al., 2020; Bell et al., 2018; Ampartzaki et al., 2022; Golegou et al., 2025), the majority of teachers indicated that they had acquired knowledge about STEM education through their own initiative, with the internet being the primary source of information. Concurrently, a multitude of studies have endeavoured to ascertain teachers' perspectives on the principal impediments to the implementation of STEM education. The most frequently cited obstacles are a lack of dedicated classroom time for implementation and insufficient teacher preparation prior to the lesson (Thi To Khuyen et al., 2020; Yildirim & Türk, 2018; Hackman et al., 2021). Insufficient infrastructure and equipment in schools (Permanasari et al., 2021; Rifandi et al., 2020; Ampartzaki et al., 2022; Yildirim & Türk, 2018). Similarly, the research summary by (Aidoo, 2023) also identifies these issues about the implementation of problem-based learning. In the studies by (El-Deghaidy & Mansour , 2015; Ampartzaki et al., 2022; Yildirim & Türk, 2018; Baltsavias & Kyridis, 2020) , the teachers involved stated that they lacked the necessary preparation to implement STEM practices in their classrooms. In contrast (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics

achievement and interest among secondary school students., 2024) found that the flipped classroom learning approach had a positive effect on mathematics achievement and interest among secondary school students. In addition to other factors associated with poor student achievement in mathematics, incorrect instructional strategies and teaching approaches, as well as a lack of resources, have been identified as contributing to this phenomenon (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024).

In light of the aforementioned data, the principal objectives of this research are as follows:

1. The primary objective of this research is to identify pedagogical methods that can be applied during STEM education and contribute to the acquisition of 21st-century skills. The purpose is to identify pedagogical methods that can be applied during STEM education and contribute to the acquisition of 21st-century skills. This systematic literature review can inform the curricula of pedagogical schools and the organisation of seminars and in-school training. In light of the willingness of teachers to pursue their own professional development through the enhancement of their pedagogical practices in the classroom.
2. Considering the challenges educators face when integrating STEM education and the corresponding pedagogical approaches, an effort is made to identify and select methods that effectively address these challenges. A critical analysis will therefore be conducted of each of the methods in question, concerning the following characteristics:
    a. The time required for lesson preparation by the teacher before the lesson itself.
    b. The time required for the lesson to be carried out in the classroom.
    c. The resources required for the lesson

LITERATURE REVIEW

21ST Century Skills

It is incumbent upon educators to plan their instruction in a manner that ensures their students will have acquired some of the 21st-century skills by the conclusion of the academic year. The accelerating pace of technological advancement and scientific progress is precipitating changes in the pedagogical paradigm, which cannot be ignored. Consequently, educators are obliged to venture beyond the confines of their comfort zone and explore the potential of novel pedagogical approaches, (Warren, 2021). Selecting an appropriate educational strategy is crucial for effective classroom management and student

motivation. An effective strategy creates a conducive learning environment that engages students and promotes their motivation to learn (Syamsu et al., 2022).

It is imperative to underscore that curricula must be duly aligned to accommodate the incorporation of novel pedagogical approaches (Afzal, 2020). It is important to note that the responsibility for shaping the education system does not lie with the teacher; this is a central policy of each state. It is the teacher who is responsible for implementing the curriculum, and therefore it is the teacher who should be permitted to adapt the educational objectives to suit the specific requirements of their own classroom.

To foster creativity in students, educators must possess familiarity with the pertinent theoretical frameworks (Kaplan, 2019; Thornhill- Miller et al., 2023). These frameworks facilitate the acquisition of knowledge while encouraging exploration and discovery over automatism (OECD, 2019). In such a supportive environment, it engenders positive affect and mood in students, thereby stimulating their creativity (Thornhill- Miller et al., 2023). Furthermore, the support of diverse ideas and the perception of task difficulty by peer students are also required (OECD, 2019). The cultivation of habits and characteristics pertinent to creativity among students through training programs (Thornhill- Miller et al., 2023).

It is similarly essential for teachers to encourage their students to engage in critical thinking. The acquisition of this skill necessitates the utilisation of methodologies such as brainstorming, business games, case studies (Meirbekov et al., 2022) and other pedagogical techniques that prioritise the student and problem-solving. The utilisation of digital tools can facilitate the implementation of these methodologies (Meirbekov et al., 2022). It is therefore incumbent upon the teacher to be able to utilise these tools and to disseminate their knowledge about them to their students. The capacity for data analysis, which constitutes a component of critical thinking, can be cultivated through the instruction of mathematics, computer science, engineering, and science (Hafni et al., 2020).

The implementation of appropriate instructional strategies in the classroom is a crucial prerequisite for achieving pedagogical goals and fostering the development of skills such as critical thinking, creativity, innovation, problem-solving, and collaboration (Aidoo, 2023).

RESEARCH METHOD

This study reports a narrative literature review. We searched four scholarly indexes—Google Scholar, Semantic Scholar, MDPI**,** and Scopus—using the following Boolean query (applied identically in each database):

(**"STEM education"**) AND (**constructivism** OR **"inquiry-/research-based learning"** OR **"problem-based learning"** OR **"project-based learning"** OR **"design thinking"** OR **brainstorming** OR **"cooperative learning"** OR **"Six Thinking Hats"** OR **"flipped classroom"** OR **"interactive teaching"/"differentiated instruction"**)

After title/abstract screening for relevance to classroom implementation of learner-centered STEM pedagogies, **61 sources** were retained and coded by primary pedagogy (non-exclusive categories): constructivism **22.95% (n=14)**; inquiry-based **14.47% (n=7)**; problem-based **37.70% (n=23)**; project-based **19.67% (n=12)**; design thinking **6.56% (n=4)**; brainstorming **8.20% (n=5)**; cooperative learning **14.48% (n=7)**; Six Thinking Hats **8.20% (n=5)**; flipped classroom **13.11% (n=8)**; interactive teaching **8.20% (n=5)**. Because some articles addressed multiple approaches, percentages exceed 100% in aggregate.

Constructivism

Traditional teaching methods mainly focus on students accumulating knowledge, which they are then required to recall to be assessed on their achievement of learning objectives through a series of exams (Oon-Seng, 2023). In this approach, students memorize, imitate and model (Oon-Seng, 2023). The course is taught through passive listening during lectures (Petre, 2020). This approach is not motivating for students, resulting in low performance (Syamsu et al., 2022).

Modern pedagogy, on the other hand, focuses on the student, with the central goal being learning rather than teaching per se (Heystek, 2021; Zavlanos, 2003; Li Y. , 2025). Methods are also student-centered, based on active student participation in the educational process (Heystek, 2021), (Brown, 2008). Innovative learning, however, requires educational methods in which students face real challenges, engage in higher-order thinking, use interdisciplinary approaches, find and manage information, work in groups and communicate with each other (Oon-Seng, 2023).

Constructivist learning models form part of modern pedagogy, explaining how knowledge is produced, how students learn, and, more generally (Shah, 2019), (Heystek, 2021), how people understand things (Heystek, 2021). When applied to STEM education, these methods contribute to the development of 21st century skills (Keiler, 2018).

Table 1 shows the common characteristics of constructivist learning models, the role of the teacher in them and the educational goals achieved by students through their use.

Table 1 Common characteristics of constructivist learning models, the role of the teacher in them, as well as the educational goals achieved by students through their use.

Elements/ Characteristics	Teacher's role	Results
• Active student participation (Zavlanos, 2003) (Brown, 2008) (Heystek, 2021). • Reducing the gap between students and teachers (Zavlanos, 2003) • Implementation of democratic processes (Zavlanos, 2003) • Interaction between students (Heystek, 2021). • Communication between team members (Heystek, 2021). • Cooperation between team members (Ellerton & Kelly, 2021; Susiani et al., 2019). • Discovery of knowledge (Susiani et al., 2019) • Solving everyday life problems (Susiani et al., 2019) (Heystek, 2021) • Use of collaborative methods (Gündüz, 2023)	• Keeps up to date with developments in his field of science (Zavlanos, 2003). • Plans teaching activities with the student at the center (Brown, 2008). • Conveys prerequisite knowledge by presenting basic concepts (Goodwin, 2024). • Guides students towards acquiring knowledge by answering their questions (Heystek, 2021) (Brown, 2008). • He gives students the necessary time to think (Heystek, 2021), (Brown, 2008). • He distributes responsibilities while leaving room for his students to respond (Brown, 2008).	• Development of thinking (Ellerton & Kelly, 2021) • Acquisition of motivation (Goodwin, 2024). • Direct connection to everyday life (Goodwin, 2024). • Improvement of students' academic performance (Goodwin, 2024). • Acquisition of 21st century skills (Gündüz, 2023) (collaboration (Brown, 2008), communication (Afzal, 2020), critical thinking (Brown, 2008), creativity (Jones, 2007)). • Students become independent (Brown, 2008). • Enhancing higher-order thinking through active participation in class (Heystek, 2021). • Breaking down prejudices (Ellerton & Kelly, 2021). • Optimal results (Ellerton & Kelly, 2021).

Many modern methods focus on the student. This document first analyzes constructivist methods and then methods based on the same principles. More specifically, it analyzes:

- Research-based teaching
- Problem-based teaching
- Project-based teaching
- Design thinking
- Brainstorming
- Collaborative learning
- Six thinking hats
- Flipped classroom
- Differentiated instruction.

Research-based Teaching

Research-based learning uses the research process for two purposes. Firstly, students achieve the learning objectives of the course while learning to conduct research (Dekker & Walsarie Wolff, 2016). Table 2 shows the characteristics of this method, the role of the teacher and the educational goals achieved.

Table 2 The characteristics, the role of the teacher and the educational goals achieved when using research-based teaching

Elements/ Characteristics	Teacher's role	Results
• The student is at the center of learning (Keiler, 2018). • Research is at the heart of learning (Ellerton & Kelly, 2021; Susiani et al., 2019) • Knowledge is built gradually (Dekker & Walsarie Wolff, 2016). • Students observe in order to investigate (Dekker & Walsarie Wolff, 2016). • Use of cutting-edge technologies (Dekker & Walsarie Wolff, 2016). • Finding information on the internet and analyzing and summarizing it	• Guides (Reyk et al., 2022) • Supports (Reyk et al., 2022)	• Developing 21st-century skills (Keiler, 2018) (critical thinking (Keiler, 2018) (Reyk et al., 2022) (Meirbekov et al., 2022)). • Learning to question, a cornerstone of research (Ellerton & Kelly, 2021; Wang & Jia, 2023) . • Cultivating curiosity (Reyk et al., 2022). • Cultivating a spirit of enquiry (Reyk et al., 2022). • New fields of knowledge are created.

(Meirbekov et al., 2022).		

Problem-Based Learning

Problem-based learning is primarily designed to divide students into groups that are assigned to solve a real-life problem (Keiler, 2018), which serves as the starting point for learning (Heystek, 2021; Goodwin, 2024). The groups that are formed should consist of a small number of students (Pozuelo-Muñoz et al., 2023).

First, the teacher presents the problem to be solved to the class (Asghar et al., 2012). The problem must be structured in such a way that questions are asked whose answers will lead to the acquisition of new knowledge (Aidoo, 2023) (Pozuelo-Muñoz et al., 2023). The next step is to create a list of what they know (data collection) (Heystek, 2021) about the problem and what they need to do to solve it (Asghar et al., 2012).

TABLE 3 shows the characteristics, the role of the teacher, and the educational goals achieved when using problem-based learning.

This method must be integrated into the curriculum for it to be applied, and the complexity of the selected problem depends on the students' cognitive level and age. Previous experience is also a key factor (Oon-Seng, 2023). The curriculum should facilitate the use of new technologies, giving students access to information beyond that provided by the teacher (Aidoo, 2023).

Table 3 The characteristics, the role of the teacher, and the educational goals achieved when using problem-based teaching.

Elements/ Characteristics	Teacher's role	Results
• The problem is related to everyday life, stimulating students' interest (Heystek, 2021; Katsaounos et al., 2014). • Students actively participate in the entire process (Aidoo, 2023) , (Heystek, 2021; Katsaounos et al., 2014). • Team members interact and communicate (Jones, 2007) • Team members are equal, so learning is self-directed (Oon-Seng, 2023). • Synthesis of knowledge from different fields, as everyday problems are complex (Asghar et al., 2012; Katsaounos et al., 2014). • Information must be found from different sources (Oon-Seng, 2023; Pohan et al., 2020), [48, 27] and evaluated (Oon-Seng, 2023; Pohan et al., 2020) (Heystek, 2021) in	• Coordinates • Guides (Alt & Raichel, 2022) , (Asghar et al., 2012), (Heystek, 2021) • Supports (Alt & Raichel, 2022) • Encourages (Alt & Raichel, 2022) • Provides support and encouragement to students where necessary, without providing ready-made solutions (Aidoo, 2023) (Pozuelo-Muñoz et al., 2023) (Asghar et al., 2012), (Heystek, 2021) (Goodwin, 2024).	• Acquiring 21st century skills (Oon-Seng, 2023) (collaboration (Oon-Seng, 2023; Jones, 2007; Gündüz, 2023), communication (Jones, 2007), creativity (Lasky & Yoon, 2020), critical thinking (Aidoo, 2023), (Meirbekov et al., 2022), (Heystek, 2021), (van der Zanden et al., 2020), (Alsaleh, 2020) , (Ellerton & Kelly, 2021), (Perera, 2022), (Wang & Jia, 2023). (Keiler, 2018), (Alsaleh, 2020), (Ellerton & Kelly, 2021), (Wang & Jia, 2023) (Gündüz, 2023), (Keiler, 2018), (Gafour & Gafour, 2020), (Alsaleh, 2020), lifelong learning (Heystek, 2021), (Alt & Raichel, 2022), adaptability (Gündüz, 2023; Sirotiak & Sharma, 2019)). • Acquiring research skills (Aidoo, 2023) (Pozuelo-Muñoz et al., 2023). • Stimulating curiosity (Asghar et al., 2012) • Learn how to learn (Pohan et al., 2020) . • Development of design thinking (Li et al., 2019).

order to retain what is useful and valid (Oon-Seng, 2023; Pohan et al., 2020). • Students are responsible for their actions (Alt & Raichel, 2022). [46] • The task is open-ended, allowing for more than one correct solution and method. • If students identify a gap, they should be able to review and re-examine (Heystek, 2021). • Students should be able to discover the knowledge needed to solve the problem (Heystek, 2021; Katsaounos et al., 2014), (Keiler, 2018; Gafour & Gafour, 2020; Alsaleh, 2020).		• Acquisition of new knowledge, which the students themselves recognize (Heystek, 2021). • The knowledge acquired is a means of achieving learning objectives (Pohan et al., 2020). • Understanding of the concepts encountered during the educational process (Aidoo, 2023) . • The proposed solution is sustainable (Heystek, 2021). • Assessment of whether the found solution is beneficial and applicable (Oon-Seng, 2023). • Proposal of an innovative solution to the problem (Katsaounos et al., 2014). • Improvement of students' academic performance (Aidoo, 2023). • Acquired knowledge is retained in memory for a longer period of time (Alt & Raichel, 2022).

Project-based Learning

This method also places students at the center and has been linked to the development of critical thinking and success in STEM class projects (Keiler, 2018). As Zavlanos reports, this method was originally developed by Dewey, and subsequently by Kilpatrick. Initially, the emphasis was on students gaining real-life experience. It was then linked to the active and enthusiastic participation of students throughout the process (Zavlanos, 2003). This method is worth analyzing as it contributes to students acquiring 21st-century skills (Zulyusri et al., 2023).

The project method initially presents a stimulus for action to those involved, after which a proposal for action is formulated (Baiana). This can begin with a question to guide students on how to act (Goodwin, 2024) . The next step is to finalize the decision. Team members then plan how they will proceed (Baiana), set timetables and deadlines (Zulyusri et al., 2023), and allocate responsibilities (Alt & Raichel, 2022). During implementation, students receive feedback at intervals (Alt & Raichel, 2022), while the use of technology and other tools is required (Goodwin, 2024). Students must also be able to argue in favor of the method they have chosen (Zulyusri et al., 2023). The presentation of the results achieved by the team marks the completion of the process (Alt & Raichel, 2022). At the end of the process, the team presents its results and conclusions to the whole class or community (Goodwin, 2024). The entire process usually takes weeks or even months and includes more than one topic (Goodwin, 2024).

Table 4 shows the basic elements and characteristics of the method, as well as the teacher's role and the results of its use.

Desing Thinking

Design thinking is a teaching method belonging to constructivism that is based on interdisciplinarity and collaborative learning (Seevaratnam et al., 2023). Rather than focusing on the final product, it refers to the mental process that an individual follows to complete the assigned task (Razali et al., 2022). It is considered an appropriate method for solving ill-defined and indescribable problems (Koh et al., 2015) (Razali et al., 2022). This is because the outcome of design thinking can be adapted to a constantly changing environment (Koh et al., 2015).

Table 5 shows the elements and characteristics of this pedagogical method, as well as the role of the teacher and the results.

Table 4. The characteristics, the role of the teacher, and the educational goals achieved when using project-based learning.

Elements/ Characteristics	Teacher's role	Results
• Either all members of each group work together from the outset, or each member works alone and then combines their findings to find a common solution (Baiana). • The group of students searching for the solution may differ from the group that implements it (Gafour & Gafour, 2020). • Students participate actively (Almazroui, 2023), (Zulyusri et al., 2023). • There is a connection between the problem and everyday life (Zavlanos, 2003; Opris, 2025). • The approach should be interdisciplinary (Baiana). • During the process, students will need to collect, evaluate and synthesize information from different sources (Meirbekov et al., 2022) (Zulyusri et al., 2023; Opris, 2025). • Questions, activities, technological tools and derivative construction are used to achieve the learning objectives (Almazroui, 2023).	• The use of other student-centered models is required (Goodwin, 2024). • A clear and predetermined goal (Zavlanos, 2003). • A willingness to cooperate with students (Almazroui, 2023). • Devoting a large part of their personal time to lesson preparation (Almazroui, 2023). • Facilitates students throughout the process (Almazroui, 2023). • Shares power with students in a democratic context (Keiler, 2018). • Guides students without providing ready-made solutions (Keiler, 2018). • Is willing to continuously develop professionally (Almazroui, 2023).	• 21st-century skills are developed, such as creativity (Almazroui, 2023; Wu & Wu, 2020), critical thinking (Meirbekov et al., 2022; Wu & Wu, 2020), (Zulyusri et al., 2023), problem solving (Zulyusri et al., 2023; Wu & Wu, 2020; Opris, 2025). • Students become motivated to acquire new knowledge themselves (Zulyusri et al., 2023). • Team members interact with each other (Almazroui, 2023) . • Students are responsible for planning and carrying out the project (Zavlanos, 2003). • The chosen solution must meet sustainability requirements (Zulyusri et al., 2023). • The product is unique (Almazroui, 2023).

Table 5. The characteristics, the role of the teacher, and the educational goals achieved through the use of design thinking.

Elements/ Characteristics	Teacher's role	Results
• The approach developed by the students is interdisciplinary (Seevaratnam et al., 2023) (Koh et al., 2015) (Razali et al., 2022). • Students approach the problem in different ways (Samrat et al., 2024). • Individuals recognize the complexity of the issue at hand (Koh et al., 2015). • Before starting the task, team members should identify any potential changes (Koh et al., 2015) (Razali et al., 2022). • Finding the optimal solution requires a series of control steps for each possible solution (Razali et al., 2022). • It takes a long time to implement (one teaching hour is not enough) (Razali et al., 2022).	• It provides feedback on students' thoughts (Razali et al., 2022; Seitz, 2025).	• Acquisition of 21st-century skills (Seevaratnam et al., 2023) (Razali et al., 2022) (communication (Razali et al., 2022), critical thinking (Koh et al., 2015), creativity (Koh et al., 2015) (Seevaratnam et al., 2023), (Samrat et al., 2024) , (Razali et al., 2022), innovation (Seevaratnam et al., 2023), (Samrat et al., 2024) , (Razali et al., 2022), solving everyday problems (Samrat et al., 2024) (Koh et al., 2015) (Razali et al., 2022)) • The proposed solution takes social, economic and political parameters into account (Koh et al., 2015). • There will be multiple solutions and the optimal one must be selected (Razali et al., 2022) (Samrat et al., 2024) • The product should fully meet the user's needs (Samrat et al., 2024)

Brainstorming

Brainstorming is another widespread educational method that places the student at the center of the educational process and can contribute to the development of the required skills (Doğan & Batdı, 2021). In this method, students are asked to freely express their thoughts on an issue or solution to a problem without any restrictions (Page, 2021), (Doğan & Batdı, 2021). The teacher records these ideas without making any corrections, comments (Page, 2021) or comparisons (Doğan & Batdı, 2021). During the process, so many ideas are recorded that some of them are rejected by the students themselves. The remaining ideas will be discussed in the plenary session of the class (Doğan & Batdı, 2021). At this stage, the teacher acts as a guide (Doğan & Batdı, 2021), while the students carry out the final evaluation. Meaningful interaction between the students is a prerequisite for the success of this stage (Ghavifekr, 2020).

Table 6 shows the characteristics, elements and role of the teacher when using brainstorming in the classroom, as well as the results.

Cooperative Learning

Most of the methods mentioned above belong to the cooperative learning category, as they require students to work together in groups to achieve the desired goals. This method is considered so beneficial that it is included among the ways to improve national education (Ghavifekr, 2020). Students work in groups and must cooperate with each other, as well as cope with the social challenge of listening to different perspectives on an issue and arguing in favor of their own views in relation to someone else's (Goodwin, 2024). Groups should have the following characteristics:

• Small
• Structured
• Diverse (Zhou & Colomer, 2024).
• Promote the strengths of each member (Goodwin, 2024).

Table 7 shows the elements and characteristics of collaborative learning, as well as the role of the teacher and the results.

Table 6. The characteristics, the role of the teacher, and the educational goals achieved when using brainstorming.

Elements/ Characteristics	Teacher's role	Results
• The focus is on the students' thoughts (Gafour & Gafour, 2020). • Students interact with each other (Ghavifekr, 2020). • Participants remain alert throughout the process (Doğan & Batdı, 2021). • The use of mind mapping is recommended to demonstrate the various correlations (Gafour & Gafour, 2020).	• Encourages students to express their ideas (Gafour & Gafour, 2020), (Doğan & Batdı, 2021). • Creates an environment of trust (Page, 2021). • Guides students throughout the process (Doğan & Batdı, 2021). • The use of other teaching methods, such as collaborative learning, is required (Ghavifekr, 2020).	• Acquisition of 21st-century skills, such as creativity (Gafour & Gafour, 2020), (Doğan & Batdı, 2021) (Gong et al., 2022) and innovation (Gafour & Gafour, 2020). • Students develop a positive attitude towards the subject (Doğan & Batdı, 2021). • From the multitude of solutions, the most innovative and feasible one will be selected (Gafour & Gafour, 2020). • Previous knowledge is restructured (Doğan & Batdı, 2021).

Table 7. The characteristics, the role of the teacher, and the educational goals achieved when using collaborative learning.

Elements/ Characteristics	Teacher's role	Results
• The combined use of other teaching methods is required (Norris et al., 2023; Goodwin, 2024) (problem solving (Norris	• Detailed and precise planning of classroom	• Acquiring 21st century skills (Zhou & Colomer, 2024) (leadership, critical thinking, communication, collaboration (Petre, 2020; Zhou & Colomer, 2024)). • Acquiring a sense of responsibility (Zhou & Colomer, 2024)

et al., 2023), inquiry-based learning (Goodwin, 2024; Norris et al., 2023)). • Students actively participate in the entire process (Petre, 2020). • Cooperation between members is required (Zhou & Colomer, 2024). • Proper distribution of individual tasks is required (Zhou & Colomer, 2024). • There is no strictly defined timeframe for completing the task (Goodwin, 2024). • The use of digital tools is required (Zhou & Colomer, 2024).	activities (Zhou & Colomer, 2024). • Setting differentiated goals for each student in the group (Goodwin, 2024). • Create an environment that allows for interaction but keeps students focused (Afzal, 2020).	• Ability to manage disagreements (Zhou & Colomer, 2024) • Strengthening motor skills (Zhou & Colomer, 2024) • Interdependence among team members is necessary for success (Goodwin, 2024). • Exchange of knowledge among team members (Zhou & Colomer, 2024). • Improved classroom atmosphere (Ghavifekr, 2020; Liebech-Lie & Sjølie, 2020) • Improved academic performance (Ghavifekr, 2020; Liebech-Lie & Sjølie, 2020) • Retention of knowledge for a longer period of time (Petre, 2020). • Deeper understanding of how to apply knowledge (Zhou & Colomer, 2024). • Applying knowledge to problem solving (Ghavifekr, 2020; Petre, 2020). • Reducing cultural and racial differences (Zhou & Colomer, 2024) • Reduced stress levels (Zhou & Colomer, 2024).

The Six Thinking Hats

The Six Thinking Hats is a pedagogical method that enables students to consider a specific topic from different perspectives. Proposed by Edward De Bono in the 1980s (GÃ¼rsoy & Ã–zcan, 2022; Elbilgahy & Alanazi, 2025), it is based on the assumption that thinking is the most advanced process the human organism can perform (GÃ¼rsoy & Ã–zcan, 2022; Dahlia et al., 2024).

In this educational method, either six actual or imaginary hats are present in the classroom. Each hat is a different color, symbolizing a different way of thinking. More specifically:

- The white hat represents objective thinking, based mainly on facts and figures.
    - It relates to the information we already have, the information needed to solve the problem, what information is missing and how it will be found.
- The red hat represents emotions such as anger and rage, and is intended to allow the student wearing it to express their feelings.
    - Here, students express their opinions and impressions. At this stage, there is no requirement to document what is expressed.
- The black hat represents caution. The student wearing it looks for weaknesses and gaps in the ideas that have already been expressed.
    - Problems and difficulties are identified until a solution is found. Errors and omissions made in previous stages of thinking are identified.
- The yellow hat represents positive thinking and emotions such as optimism.
    - The student wearing the yellow hat focuses on the benefits.
- The green hat signifies creativity and the expression of new ideas.
    - Students wearing the green hat tend to go beyond what they already know and apply new ideas.
- The blue hat is related to the organization of thought and controlling what has been said by the other hats.
    - Everything recorded while students were wearing the other hats is summarized so the student wearing the blue hat can draw conclusions and ensure the rules are followed during the process (DeBono, 2006; Elbilgahy & Alanazi, 2025).

The students are then divided into groups. Each group wears a different hat, then switches hats, with each group recording their thoughts (Dahlia et al., 2024). The hats can be used individually when a very specific way of thinking is required, or sequentially, one after the other, when a topic needs to be explored from many different perspectives (DeBono, 2006). When applying the method in an educational setting, teachers refer to the hats by their color rather than their function because it is easier to instruct students to remove the yellow hat than to

stop them from thinking positively (DeBono, 2006). The teacher asks questions relating to the color of the hat worn by the student and the content must be specific (Dahlia et al., 2024). Finally, each group presents their thoughts and conclusions to the whole class, providing an opportunity to discuss everything that has been said (Dahlia et al., 2024).

Table 8 shows the elements, characteristics, role of the teacher and results of using the method.

Flipped classroom

The flipped classroom is a pedagogical method based on active learning (Heystek, 2021) and the principles of constructivist learning models (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). First implemented in higher education in 1990 (Kilipiris et al., 2024), it subsequently gained ground in secondary education (Galindo-Dominguez, 2021; Ölmefors & Scheffel, 2021). Technological progress has aided the establishment of the flipped classroom by providing students and teachers with the necessary tools to implement it (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024).

When this method is employed, processes that would traditionally take place in the classroom are now carried out at home. Traditionally, the teacher delivers the theory and the students carry out the activities at home. In the flipped classroom, the opposite happens, with the most interesting stage of the activities taking place in the classroom (Galindo-Dominguez, 2021; Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). Students therefore watch their teacher's lectures, which are recorded at home (Heystek, 2021; Nielsen, 2023; Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). They can use websites, social media, YouTube videos and educational games (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). In the classroom, active teaching methods such as discussions, exercises and group work can be used (Heystek, 2021; Nielsen, 2023). It should be noted that the difference relates to lesson preparation rather than the way lessons are taught (Galindo-Dominguez, 2021). Furthermore, the intention is not to replace the role of the teacher, but rather to enable closer contact with students while they are in class (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024).

The phases of flipped classroom teaching can be divided into two components:

- The asynchronous phase: during this process, students watch video lectures or work on material provided by the teacher. Students then engage with the specific issue in class after spending time processing the material.
- The synchronous phase involves all activities taking place in the classroom with the teacher's help. Students are actively involved in group work, discussions, etc (Kilipiris et al., 2024).

In this way, students acquire knowledge with the support of technology in the first stage, while consolidation takes place with the support of the teacher and the whole class in the second stage (Kilipiris et al., 2024). The preparatory material may include assignments to help students perform better in class (Ölmefors & Scheffel, 2021). It is recommended that students work in groups to complete this process (Nielsen, 2023).

Table 9 shows the data, characteristics, teacher role and results of using this method.

Due to the lack of documented scientific evidence, the flipped classroom is proposed as a pedagogical tool for specific cases throughout the year, rather than as an approach to be applied across the entire curriculum (Ölmefors & Scheffel, 2021).

Table 8. The characteristics, the role of the teacher, and the educational goals achieved when using the six thinking hats.

Elements/ Characteristics	Teacher's role	Results
• Applied individually or in groups (Dahlia et al., 2024). • Students' thoughts are broken down into components to make them easier to understand (Dahlia et al., 2024)..	• Good lesson planning is required (Dahlia et al., 2024). • Providers support (Dahlia et al., 2024). • Students must be given time to become familiar with using the hats (Dahlia et al., 2024).	• Development of 21st-century skills: collaboration (GÃ¼rsoy & Ã–zcan, 2022; Mansurova, 2024) , creativity (GÃ¼rsoy & Ã–zcan, 2022; Huang et al., 2021), lifelong learning (Mansurova, 2024) , problem solving (Huang et al., 2021; Elbilgahy & Alanazi, 2025), critical thinking (Elbilgahy & Alanazi, 2025) • Development of team spirit (Dahlia et al., 2024). • Development of self-esteem (Dahlia et al., 2024). • Learning to approach the same issue from different perspectives (GÃ¼rsoy & Ã–zcan, 2022; Huang et al., 2021; Dahlia et al., 2024; Elbilgahy & Alanazi, 2025). • Improvement of academic performance (Huang et al., 2021). • Drawing reliable conclusions (Mansurova, 2024). • Development of active citizenship (Mansurova, 2024).

Table 9. The characteristics, the role of the teacher, and the educational goals achieved when using the flipped classroom.

Elements/ Characteristics	Teacher's role	Results
• Active student participation (Petre, 2020). • Valuable classroom time is saved (Petre, 2020; Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024) (Nielsen, 2023; Canonio & Valdez, 2025). • Teacher-student interaction in the classroom is promoted (Ölmefors & Scheffel, 2021; Canonio & Valdez, 2025). • Students come to class having already mastered the theoretical framework, enabling them to solve more difficult problems in class (Ölmefors & Scheffel, 2021) (Petre, 2020). • Digital equipment and an internet connection are required (Galindo-Dominguez, 2021; Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). • Students can watch the video as many times as they want until they understand it (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024).	• Determines how to structure the material to make it attractive to students (Ölmefors & Scheffel, 2021) and contribute to achieving the final learning objectives (Nielsen, 2023). • The structure of the material takes into account the specific needs of each student (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among	• Development of 21st century skills (Ölmefors & Scheffel, 2021; Canonio & Valdez, 2025) (critical thinking, collaboration, adaptability, and lifelong learning (Gündüz, 2023),). • Acquisition of higher-order skills through collaborative classroom methods (Galindo-Dominguez, 2021). • Establishment of strong relationships between teachers and students through continuous interaction (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). • Students organize their thoughts through the notes they take while studying the material (Egara & Mosimege, Effect of flipped classroom learning approach on

• Using video reduces the cognitive load on students (Nielsen, 2023). • Students have a heavy workload at home (watching videos and doing homework) (Galindo-Dominguez, 2021; Ölmefors & Scheffel, 2021; Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). • There is no possibility of immediately resolving questions arising from the videos (Galindo-Dominguez, 2021; Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). • Students are often distracted by digital devices and spend more time online (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). • There are issues regarding the inclusion of all students (Ölmefors & Scheffel, 2021). • Even if one student has not completed the required homework, this can cause problems for the whole class (Ölmefors & Scheffel, 2021; Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024)	secondary school students., 2024). • Selects student-centered methods for the second stage (Nielsen, 2023; Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). • Guides students in the classroom (Petre, 2020). • Monitors whether students have completed the necessary work, both at home and in class (Ölmefors & Scheffel, 2021).	mathematics achievement and interest among secondary school students., 2024). • Students' knowledge is expanded through the activities they complete (Petre, 2020). • Students acquire a sense of responsibility towards other group members (Nielsen, 2023). • Academic performance increases (Nielsen, 2023; Galindo-Dominguez, 2021) (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). • Self-confidence is developed (Nielsen, 2023). • Students become more autonomous as they must study the material at home independently and in any way, they want (Galindo-Dominguez, 2021).

Differentiated Teaching

Another new educational approach is differentiated teaching, also known as the differentiation classroom. This approach is a result of the global goal to achieve Education for All without exclusions (Eikeland & Ohna, 2022; Lindner & Schwab, 2020) . Carol Ann Tomlinson is considered the founder of this teaching method (Kuhr, 2023). Its ultimate goal is to ensure that students with different needs receive an appropriate education (Lindner & Schwab, 2020). Undoubtedly, modern classrooms comprise students who differ in characteristics such as cognitive level, cultural background, religion (Tomlinson & Strickland, 2005) and disability (Lindner & Schwab, 2020). This is mainly due to the fact that most classes are divided based on age (Tomlinson & Strickland, 2005). In such a diverse classroom, all students are called upon to acquire new knowledge together and reap the benefits of education (Eikeland & Ohna, 2022).

Given these conditions, differentiated teaching is required (Altangerel et al., 2022; Eikeland & Ohna, 2022; Kuhr, 2023), as it responds to the different learning needs (Eikeland & Ohna, 2022; Kuhr, 2023), characteristics and levels of readiness of students (Kuhr, 2023). This approach puts the students' skills, interests and prior knowledge at the center, increasing their motivation to learn (Altangerel et al., 2022). The ultimate goal of the process is to help students achieve their maximum potential through a wide range of learning goals (Eikeland & Ohna, 2022) and their fulfilment (Lindner & Schwab, 2020).

Differentiation in the educational process implies the teaching approach that the teacher will follow in a heterogeneous classroom (Eikeland & Ohna, 2022). According to Dr. Tomlinson, there are three levels of differentiation in teaching (Kuhr, 2023):

- First level: readiness
    - It is related to the students' prior knowledge. Investigating previous knowledge in a class characterized by heterogeneity presents several difficulties.
- Second level: interest
    - At this level, the teacher gives students the opportunity to work on any part of the lesson they wish. Due to the internal motivation developed, they have a greater chance of success.
- Third level: learning profile.
    - At this stage, the teacher is asked to investigate how the students in their class learn. This is mostly influenced by the students' cultural background.

Table 10 shows the elements, characteristics, role of the teacher and results of using the method

Table 10. The characteristics, the role of the teacher, and the educational goals achieved when using differentiated teaching.

Elements/ Characteristics	Teacher's role	Results
• It is not individualized learning (Eikeland & Ohna, 2022; Kuhr, 2023). • There are many different activities, and each student chooses those that suit them (Eikeland & Ohna, 2022). • The content is simplified so that all students can master the learning objectives (Lindner & Schwab, 2020). • Groups are divided based on interests and abilities (Eikeland & Ohna, 2022). • Multiple learning paths lead to the achievement of learning objectives (Altangerel et al., 2022). • Separating students according to their abilities can negatively affect motivation, relationships and self-esteem (Eikeland & Ohna, 2022).	• Provides a variety of stimuli (Kuhr, 2023; Lindner & Schwab, 2020) (Eikeland & Ohna, 2022) of different characteristics (e.g. content, workload, response rate, complexity) (Eikeland & Ohna, 2022). • Plans lessons taking into account the individual differences of each student (Eikeland & Ohna, 2022). • When planning lessons, students' level of knowledge and preferences are taken into account (Tomlinson & Strickland, 2005). • Time is required at home to prepare the material (Lindner & Schwab, 2020). • Guides (Kuhr, 2023). • When evaluating the results, it is possible to observe the students and ask them questions (Kuhr, 2023). • Creates a supportive climate (Kuhr, 2023).	• Students learn to respect diversity (Eikeland & Ohna, 2022). • The gap between students with and without access to digital resources is reduced (Lindner & Schwab, 2020). • Multiple goals lead to maximizing the potential of each student (Tomlinson & Strickland, 2005).

RESULTS

It is imperative that the school be functional in the 21st century, as it is necessary to disengage from the limitations set by the traditional school. In order to adequately address the challenges that will inevitably arise, it is imperative to implement educational methodologies that are tailored to the demands of the 21st century (Razali et al., 2022).

The teaching method selected by the instructor is a significant determinant of students' interest in the subject matter. Interest, as an internal factor related to students' desire to learn, has been demonstrated to exert a significant influence on the achievement of educational goals (Egara & Mosimege, Effect of blended learning approach on secondary school learners' mathematics achievement and retention., 2024). It is evident that the selection of an appropriate educational methodology is of paramount importance and forms the foundation of the educational process.

This review has achieved the initial objective of the article, namely to collate contemporary educational methodologies that prioritise the student as the focal point, facilitating the acquisition of the requisite skills for the 21st century. The fundamental tenets of each methodology are delineated, along with an exposition of its merits and shortcomings. With regard to the second research question, a critical analysis of each method is presented in accordance with the three criteria identified by teachers as obstacles to the implementation of STEM education. These are:

- The time required for the teacher to prepare for the lesson
- The time required for the lesson itself
- Access to resources, whether these are in-school workshops or out-of-school digital resources for students.

It should be noted that the authors of this article concur with the assertion put forth by (Koh et al., 2015), namely that the overarching policy will ultimately determine the educational methods that can be employed to achieve the desired outcomes. In order for educators to implement the aforementioned pedagogical approaches, it is essential that they are afforded the requisite autonomy from the confines of the curriculum.

A summary table (table 11) is then presented, in which the pedagogical methods mentioned are related to the three criteria that have been set. It should be noted that with regard to the preparation time required by the teacher prior to the lesson, it is assumed that each teacher addresses the following day's lesson at home. Accordingly, a lengthy preparation period is defined as one that exceeds the time typically dedicated to preparing a conventional, traditional course. The designation "NO" in the table does not indicate that no preparation is necessary; rather, it signifies that the preparation required does not exceed the typical preparation associated with a standard, traditional course.

Table 11. Correlation between the teacher's preparation time, the classroom time needed for implementation and the materials needed for each of the pedagogical methods mentioned in the article.

		The time required to prepare lesson		The time required lesson itself		Access to resources	
Research Learning	Based	NO	The research question should be clearly stated and prepared in the same amount of time as a standard lesson	NO	Students may opt to process the material at their own pace outside of scheduled class time. The findings are then presented to the class	YES	It is necessary to have access to the Internet.
Inquiry Learning	Based	No	The research question should be clearly stated and prepared in the same amount of time as a standard lesson.	YES	The four stages of the process cannot be completed in a single lesson. In order to confirm the hypothesis through experimentation, a distinct methodology must be employed within the school laboratory.	YES	The confirmation of findings through experimentation represents an essential component of the investigative process. The establishment of a laboratory within the educational institution is therefore a crucial element in this regard. It is essential to have access to information during the investigative process
Problem Learning	Based	YES	It is essential that the issue is presented in a well-	NO	Students may opt to process the material at their own	YES	It is necessary to have access to the Internet.

		structured manner, with the teacher having conducted prior research into potential solutions		pace outside of scheduled class time. The findings are then presented to the class.		
Project Based Learning	YES	It is imperative that alternative methodologies be employed.	YES	It is also necessary to employ alternative pedagogical techniques.	YES	It is not sufficient to have access to the internet; other technological resources must also be available
Design Thinking	NO	In this approach, students are presented with problems that are often not fully defined or described in sufficient detail.	YES	It is recommended that the group undertake comprehensive research into a range of perspectives on the issue. A single teaching hour is insufficient to complete the process. It is essential to verify each assumption made by students at each stage of the process.	YES	It is essential that each hypothesis proposed by the students be subjected to experimental testing. It is therefore evident that the provision of a school laboratory is essential.
Brainstorming	YES	It is essential that educators employ alternative methodologies, and thus it falls upon	NO	The process of brainstorming does not necessitate an extensive period of time within the classroom setting, as it	NO	The opinions and perceptions of students regarding the subject matter are documented, obviating the necessity for any further research.

		them to identify the most suitable approaches and to equip themselves with the requisite knowledge to implement them effectively.		primarily involves the initial documentation of students' ideas.		
Cooperative Learning	YES	It is imperative that alternative methodologies be employed.	YES	It is not feasible to establish a definitive timeframe for the completion of the work.	YES	The utilization of novel technologies is imperative.
Six Thinking Hats	YES	It is necessary to prepare the hats in advance. It is essential to meticulously prepare the questions that will be posed to the students in order to provide them with effective guidance	YES	The teacher must allow sufficient time for the students to understand the function of the hats. It is essential to allow students sufficient time to articulate their thoughts. It is essential that sufficient time is allocated for each student or group of students to engage with each hat and express their own thoughts.	NO	The students are able to engage in the cognitive processes associated with the task while wearing the hat, thereby obviating the need for access to new technologies

Flipped Classroom	YES	It is obligatory for the instructor to record the lessons outside of the scheduled class time. It is essential to have a platform on which to upload the material. It is essential to undertake the requisite preparatory work. It is essential to provide feedback on the preparatory work. It is essential to prepare the activities that will be conducted within the classroom setting.	NO	The delivery of theory is expedited, thereby allowing for a more productive use of time in the classroom	YES	It is necessary to have access to the internet and an educational platform. It should be noted that the aforementioned access is to educational material; as such, it cannot be replaced by access to a library.
Differentiation Classroom	YES	It is essential to define a set of educational	NO	The allotted time for completion of the	NO	It is not necessary for students to have access to any type of resource.

	objectives. It is essential to develop educational materials that can be tailored to the specific needs of each student in the class	application process in the classroom is relatively brief.

As can be seen from the comparative table above, the preparation time required by the teacher for inquiry-based learning is relatively minimal. The majority of the process can be completed by students at home, thus conserving valuable classroom time. The only aspect of the process that should be conducted in the classroom is the presentation of the conclusions of each group. Each of the two options presents a unique set of advantages and disadvantages. Should the entire process be conducted within the classroom, it would necessitate allocating several teaching hours. However, this approach allows the teacher to oversee and regulate the students' progress. Furthermore, students have access to information through the internet and the school library. This approach serves to reduce the digital divide between students. In the event that the process is conducted outside the school environment, time is saved within the classroom setting; however, disparities exist among students regarding their access to technological resources.

The implementation of problem-based learning necessitates the allocation of preparation time on the part of the educator, as the problem ultimately assigned to the students must be meticulously structured. It is proposed that the problem should have more than one solution, thus allowing students to select the solution they consider most appropriate. It is therefore recommended that the teacher should have explored possible solutions themselves, while also clearly expressing the problem and objectives. It is evident that a substantial investment of time is necessary for its preparation. Furthermore, this approach allows students to engage in the process outside the classroom. Therefore, the advantages and disadvantages previously outlined in the context of inquiry-based learning remain applicable.

The implementation of project-based research necessitates the concurrent utilisation of alternative pedagogical techniques. It is the responsibility of the teacher to select the most appropriate additional methods to combine with this approach. Therefore, they must undergo thorough preparation before the lesson. The time required for implementation within the classroom context depends on the method selected. The utilisation of novel technologies is essential for the retrieval of requisite information.

In the pedagogical method of design thinking, the problem must be clearly defined. Therefore, the teacher should design it in such a way that there is no room for misinterpretation. This indicates that the subject matter should have been studied initially. The implementation of this method is time-consuming, as the group must express a multitude of ideas, which must then be tested individually. A single teaching hour is insufficient to complete the task. The verification of hypotheses necessitates the implementation of an experiment, which consequently entails the same limitations pertaining to the utilisation of classroom time and access to resources.

As with project-based learning, the application of other educational methods is required for the implementation of brainstorming and collaborative learning. The act of brainstorming does not necessitate the use of classroom time,

as it is merely a method of recording spontaneous ideas. It is not possible to define the time required in the classroom for collaborative learning in advance, as there is no defined time frame.

Prior to the lesson, teachers must undertake preparation at various levels to facilitate the six Thinking Hats. Firstly, the educator must prepare the hats themselves, then the guiding questions that will be posed to the students to facilitate their engagement. The questions must be specific and well-structured. Furthermore, the method is also time-consuming to implement in the classroom. At the outset, the teacher must invest time in elucidating to their students the specificities of the process, which diverges from other methodologies. They must also demonstrate how students should engage with the process when they are wearing each of the hats. The act of donning the metaphorical hat requires the student to engage in a period of contemplation and articulation. Furthermore, each student requires an adequate amount of time to complete the process of going through all the thinking hats and expressing their ideas as much as they wish. The fundamental principle of the flipped classroom is the saving of productive time in the school. Consequently, a considerable amount of time must be dedicated to teacher preparation prior to the lesson. In particular, the educator must undertake preparatory work prior to the creation of each video in order to ascertain the optimal configuration. The creation, editing and uploading of the video to the platform accessible to students requires a significant investment of time. It is essential to allow for sufficient preparation time to create the preparatory activities and assignments and to correct them, which must be completed before the classroom lesson. This allows the teacher to gain insight into the areas where students may require further guidance. A further significant disadvantage is the necessity for students to have access to the internet and digital tools. In the absence of the resources, it is not possible for students to participate in the lesson, as the subject matter extends beyond the scope of traditional library resources. The implementation of differentiated teaching necessitates the formulation of a diverse range of cognitive objectives for each student, as the preparation of the lesson requires consideration of the individual characteristics and needs of each learner. It is essential that teaching materials, classroom activities and homework assignments are designed with consideration for the diverse needs of students. It is evident that the preparation of a lesson is a time-consuming process that necessitates meticulous planning. However, it does not necessitate an extension of the classroom period or access to technologies beyond those required for a traditional lesson. In conclusion, the teaching methods that necessitate a greater investment of time on the part of the educator in lesson preparation are as follows: The aforementioned pedagogical approaches include:

- Problem-based learning
- Project-based learning
- The project-based method

- Project-based learning
- Collaborative learning
- The six thinking hats
- The inverted classroom
- Differentiated teaching

In light of the time constraints typically faced by teachers, the following methods are proposed as potential solutions:

- Teaching based on research
- Design thinking

The methods that require comparatively less time to implement in the classroom are as follows:

- Teaching based on research
- Problem-based learning
- Brainstorming
- Inverted classroom
- Differentiated teaching

The only methods that do not necessitate access to digital resources and information are:

- Brainstorming
- The Six Thinking Hats

It is pertinent to note that there are methods that do not necessitate internet and digital tool access. In this regard, the provision of computer and tablet access within the educational establishment represents a laudable practice. Furthermore, municipalities may facilitate access to students in designated areas, such as libraries, where internet and other digital resources can be made available. In this case, the implementation of inquiry-based teaching becomes a more viable option. During the students' involvement in a scenario-based problem-solving activity, it was observed that students initially sought information from social networks, as they are familiar with using them (Pozuelo-Muñoz, Calvo-Zueco, Sánchez-Sánchez, & Zucco, 2023). It is evident that students should become able to distinguish between valid and invalid sources before starting to apply any method.

DISCUSSION AND CONCLUSIONS

In the context of the 21st-century student-cantered school, selecting an appropriate educational method is a crucial element in achieving learning objectives. Educators are confronted with a plethora of academic methods, the selection of which is contingent upon several factors, including the time available for lesson preparation, the time allocated in the classroom, the availability of digital resources, and the level of the students. This article examines a selection of contemporary educational methods. Following a critical analysis, the methods

were categorised in order to facilitate the selection of an appropriate approach by teachers.

Research-based teaching, and design thinking can be employed by educators who lack the opportunity to prepare in advance but have the capacity to implement these approaches in the classroom setting, with students having access to digital resources.

Project-based learning, design thinking, collaborative learning and the six hats of thinking can be implemented by teachers whose curriculum allows for the requisite classroom implementation time. The utilisation of techniques such as brainstorming, the Six Hats of Thinking and differentiated instruction allows students who lack access to digital resources to develop their abilities. It is evident that these methods can mitigate the digital divide and provide all students with the chance to gain knowledge. It is also important to recall that equitable education is one of the United Nations Sustainable Development Goals.

IMPLICATIONS

The present study makes a significant contribution to the implementation of appropriate teaching methods by teachers. It is important to acknowledge that educators are uniquely positioned to consider the conditions that prevail in their classrooms, as well as the time available to them, their students, and the curriculum. The findings of this research provide a substantial contribution to the selection of the most suitable teaching method, with the objective of optimizing the respective educational goals.

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