Review

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An Overview and Evaluation of Pedagogical Methods for 21st Century STEM Education

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Abstracts: The period of time spent in secondary education is of great consequence, as the interests and skills acquired during this period can have a significant impact on the development of the individual as an active citizen and as a professional. In this study, methods centred on the learner and designed 3 to facilitate the acquisition of 21st-century skills were identified. Subsequently, a critical analysis of 4 these methods was conducted. This critical analysis was based on the findings of a survey of teachers' views on the difficulties they face in implementing STEM education. In particular, the criteria under consideration are the time required for lesson preparation, the time needed for classroom activities, and the availability of digital resources. The results of the survey indicate that each teacher is at liberty to select the methodology that aligns with their pedagogical approach and the characteristics of their classroom.

Keywords: constructivism; research- based learning; problem- based learning; project based learning; design thinking; brainstorming; cooperative learning; Six thinking hats; flipped classroom; differentiation classroom

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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 is contingent upon 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 in order 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 facilitate the attainment 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 make a reference to these techniques while exploring the educational objectives achieved in each case.

In the studies (Permanasari, Rubini, & Nugroho, 2021; El-Deghaidy & Mansour , 2015; Thi To Khuyen, Van Bien, Lin P-L, Lin J, & Chang C-Y, 2020) 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, Rubini, & Nugroho, 2021; Rifandi, Rahmi , Widya, & Indrawati, 2020; Bell, Morrison-Love, Wooff, & et al., 2018; Ampartzaki, Kalogiannakis, Papadakis, & Giannakou, 2022), 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, Van Bien, Lin P-L, Lin J, & Chang C-Y, 2020; Yildirim & Türk, 2018; Hackman, Zhang, & He, 2021). Insufficient infrastructure and equipment in schools (Permanasari, Rubini, & Nugroho, 2021; Rifandi, Rahmi , Widya, & Indrawati, 2020; Ampartzaki, Kalogiannakis, Papadakis, & Giannakou, 2022; Yildirim & Türk, 2018). Similarly, the research summary by (Aidoo, 2023) also identifies these issues with regard to the implementation of problem-based learning. In the studies by (El-Deghaidy & Mansour , 2015; Ampartzaki, Kalogiannakis, Papadakis, & Giannakou, 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 objective 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. In light of the challenges encountered by educators when integrating STEM education, and the corresponding pedagogical approaches, an effort is made to identify and select those methods that effectively address these challenges. A critical analysis will therefore be conducted of each of the methods in question, with regard to the following characteristics:
    a. The time required for lesson preparation by the teacher prior to the lesson itself.
    b. The time required for the lesson to be carried out in the classroom.
    c. The resources required for the lesson

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). The selection of 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, Suhendri, Zailani, & Hardivizon, 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 important 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, Maslova, & Gallyamova, 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, Maslova, & Gallyamova, 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, Herman, Nurlaelah, & Mustikasari, 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).

Cunstructivism

The prevailing pedagogical approaches are largely founded upon the principles of memorisation, imitation and modelling (Oon-Seng, 2023). Such methods result in the accumulation of knowledge, which students are required to recall from memory. The achievement of educational objectives is typically assessed through a series of examinations (Oon-Seng, 2023). The next key element of traditional teaching methods is the lecture, which reduces the role of the student to that of a passive listener, thereby limiting the potential for the development of leadership characteristics (Petre, 2020).

These processes fail to motivate students to develop their skills, which ultimately results in poor performance (Syamsu, Suhendri, Zailani, & Hardivizon, 2022). To implement innovative learning, educational methods should be applied which require students to face real challenges, use higher-order reasoning, approach interdisciplinary, find and manage information, and finally work in teams and communicate with other team members (Oon-Seng, 2023).

Constructivist models of learning are those that elucidate the processes through which knowledge is produced and the manner in which students, as human beings, learn and comprehend (Shah, 2019; Heystek, 2021). In the context of STEM education, the adoption of constructivist pedagogical approaches that are learner-centred has been demonstrated to facilitate the development of the 21st-century skills that are currently in high demand (Keiler, 2018). Further- more, it aligns with the fundamental principles of effective pedagogy, including engaging students, fostering a collaborative learning environment, and incorporating democratic processes (Zavlanos, 2003). Such pedagogical approaches facilitate the development of critical thinking and intellectual dispositions, which cannot be achieved through mere repetition of actions and unquestioning acceptance of outcomes (Ellerton & Kelly, 2021). Such pedagogical approaches facilitate positive interactions and collaboration among students, enabling them to acquire new knowledge from available resources (Afzal, 2020). Furthermore, they facilitate the acquisition of motivation among students, establish a more direct connection to real-life situations (which is of primary importance in STEM education), and ultimately enhance students’ academic performance and examination outcomes (Goodwin, 2024).

For the teacher, effective teaching necessitates a commitment to staying abreast of developments in the field of science being taught (Zavlanos, 2003). Furthermore, the utilisation of an intelligent learning environment is also considered to be an indispensable element. A smart learning environment may be defined as one that makes use of technology and contains innovative features, which in turn facilitate the achievement of learning objectives. In this context, it is essential for teachers to possess the capacity for adaptability and the ability to personalise instruction (Spector, 2014). In this pedagogical approach, the instructor's role is to equip students with the fundamental knowledge and key concepts related to the topic under discussion, equipping them with the tools to engage with the subject matter (Goodwin, 2024).

These constructivist methods are endorsed by a number of models that emphasise collaboration, problem-solving, discovery and practical application (Susiani, Hidayah, Suhartono, & Salimi, 2019). In essence, the role of the teacher is to act as a guide for students, facilitating the construction of knowledge. Furthermore, they structure their teaching in a manner that is closely aligned with the lived experiences of their students (Heystek, 2021). The collaborative methods employed to address these needs have been demonstrated to be effective in facilitating the acquisition of 21st-century skills (Gündüz, 2023). These are the methods that STEM teachers are required to implement in their classrooms in order to achieve the desired outcome.

In contemporary pedagogical theory, the focus of the educational process is the student, rather than the teacher as was the case in the past. Furthermore, the purpose of education is to facilitate learning, rather than merely to transmit knowledge (Heystek, 2021; Zavlanos, 2003). In a student-centred pedagogical approach, the primary objective is to facilitate active student engagement with the subject matter being taught (Heystek, 2021; Brown, 2008). Students are encouraged to pose questions and to pursue solutions with the guidance of the teacher. Rather than providing direct answers, the teacher's role is to facilitate students' independent discovery (Brown, 2008). Additionally, students are afforded sufficient time to reflect on their actions and processes (Heystek, 2021). Both the planning and the teaching are conducted in a student-centred manner (Brown, 2008).

The planning phase encompasses activities that are resolved through group discussion. In more complex activities, the task is related to a problem encountered in everyday life (Heystek, 2021). The teacher assigns responsibilities to the students and allows them to engage in independent exploration and discovery. This does not, however, imply that the teacher relinquishes control of the classroom. Concurrently, students may cultivate their own methodologies for resolving a given issue, which the instructor then observes and facilitates, thus enabling them to learn in a novel manner. Such pedagogical methods facilitate students' autonomy and enhance their critical thinking abilities (Brown, 2008).

Furthermore, the fostering of creativity is facilitated when students are divided into groups, as it becomes easier for them to express their opinions without concern for the potential negative reaction of their peers in the event of an incorrect response. Naturally, in order to attain this objective, it is essential that the educator devises suitable activities (Jones, 2007). The role of the teacher is that of a facilitator, providing guidance and support without offering definitive solutions. Furthermore, students can develop communication skills through this pedagogical approach, as they learn that collaboration is essential for finding solutions (Brown, 2008). In a group problem-solving setting, each student has more opportunity to engage in discussion than they would in a teacher-centred classroom. Consequently, the individual's abilities in speaking (Jones, 2007) and communication are enhanced.

Active learning facilitates the potential for higher-order reasoning (Heystek, 2021). Learner centred teaching may employ a variety of pedagogical methods, some of which are discussed below. The interaction of group members can facilitate the breakdown of various prejudices that may exist. Conversely, the input of each individual can facilitate the attainment of the desired solution and the optimal outcome. Conversely, the feedback provided by either a team member to another or by the teacher to the team can validate the unsuitability of a thought (Ellerton & Kelly, 2021).

Research- Based Learning

Research-based learning employs research as a pedagogical tool, enabling students to not only learn from and through research but also to gain an understanding of the research process itself (Dekker & Walsarie Wolff, 2016). Furthermore, when combined with a learner-centred approach to instruction, it facilitates the acquisition of STEM skills, including critical thinking, which is a cornerstone of inquiry (Ellerton & Kelly, 2021), as well as questioning (Ellerton & Kelly, 2021; Wang & Jia, 2023).

In this instance, research constitutes the core of the learning process, forming an integral part of the entire procedure (Susiani, Hidayah, Suhartono, & Salimi, 2019).

The utilisation of this methodology facilitates the advancement of children's critical thinking abilities, as it cultivates curiosity and intellectual curiosity (Reyk, Leasa, Talakua, & Batlona, 2022). Furthermore, it offers the gratification of contributing to the advancement of knowledge and the development of novel research areas. In order to achieve inquiry, it is necessary to observe, participate actively and make use of cutting-edge technologies (Dekker & Walsarie Wolff, 2016). In the inquiry-based pedagogical method, as in many of the student-centred methods discussed below, students are required to source information from the internet, analyse it and either summarise it or select a portion of it. It is evident that students encounter difficulties in attaining this objective. To surmount this challenge, the cultivation of critical thinking is imperative (Meirbekov, Maslova, & Gallyamova, 2022).

Inquiry-based teaching is closely related to inquiry-based learning (IBL). The teacher initially provides guidance to students as they navigate the classroom in search of answers. Over time, students must progressively demonstrate autonomy while responding to increasingly sophisticated inquiries (Goodwin, 2024). The processes undergone by students are analogous to those undertaken by professional researchers (Pedaste, et al., 2015). Subsequently, the student or group of students will be required to either confirm or reject the hypothesis formulated following the conclusion of the experiment (Pedaste, et al., 2015).

Technological developments that involve e-learning environments facilitate the implementation and expansion of inquiry learning (Pedaste, et al., 2015).

In the context of exploratory learning, the initial stage is orientation, whereby the students become aware of the problem to be solved. Subsequently, the Conceptualisation phase ensues, wherein the students, based on the preceding theory, formulate hypotheses and questions. The primary stage of the process is the Investigation phase, during which students engage in exploration, experimentation, data collection, and subsequent analysis. Subsequently, the summary (conclusion) is presented, wherein the conclusions are drawn and compared with the initial assumptions and research questions. The final stage is the discussion, in which the student or group presents the results to the plenary and is invited to engage in discourse and interaction with other groups (Pedaste, et al., 2015).

Inquiry-based learning is a fundamental aspect of both problem-based and project-based learning. It is a prerequisite for the application of the other two processes (Aidoo, 2023). Exploratory learning represents a problem-solving method (Pedaste, et al., 2015).

Problem- Based Learning

The fundamental premise of problem-based learning is the formation of student groups tasked with solving a tangible, real-world problem (Keiler, 2018). This approach represents the inaugural stage of the learning process (Heystek, 2021; Goodwin, 2024). It is recommended that groups be kept relatively small (Pozuelo-Muñoz, Calvo-Zueco, Sánchez-Sánchez, & Cascarosa-Salillas, 2023). In these working conditions, which simulate real-world scenarios, the teacher assumes the role of coordinator, while students are actively engaged in an open-ended task with multiple solutions (Aidoo, 2023; Heystek, 2021; Goodwin, 2024; Sirotiak & Sharma, 2019). The students are positioned at the core of the process, thereby assuming full responsibility for the completion of the requisite procedures to achieve a desired outcome (Alt & Raichel, 2022). The role of the teacher is to facilitate the process, rather than to provide definitive solutions and answers to students (Goodwin, 2024). The group is constituted as a collective of equal members, thereby fostering a self-directed approach to learning (Oon-Seng, 2023).

The initial task assigned to the teacher is to present a problem in the classroom (Asghar, Ellington, Rice, Johnson, & Prime, 2012). The problem must be structured in a way that prompts the students to ask questions that will lead to the acquisition of new knowledge (Aidoo, 2023; Pozuelo-Muñoz, Calvo-Zueco, Sánchez-Sánchez, & Cascarosa-Salillas, 2023). The subsequent step is to compile a list of the subject matter they have already acquired (data collection) (Heystek, 2021) regarding the problem, as well as the actions they must undertake in order to resolve it (Asghar, Ellington, Rice, Johnson, & Prime, 2012). It is also noteworthy that the majority of real-world problems necessitate the application of knowledge from a multitude of disciplines. It is therefore incumbent upon students to be able to synthesise knowledge from these disparate fields (Asghar, Ellington, Rice, Johnson, & Prime, 2012). In practice, it is the real-world scenario that enables students to interpret the data and construct models (Aidoo, 2023). During the learning process, students may identify a gap in their initial goals, necessitating the collection of further data and the commencement of the cycle anew (Heystek, 2021). The solution proposed by the students should be a collective one, rather than the output of a single individual. This approach fosters a sense of collaboration and enhances communication skills, both written and verbal (Jones, 2007). It is essential that at the conclusion of the process, students are able to demonstrate an understanding of the new knowledge they have acquired (Heystek, 2021).

It is through their interaction with the environment and the real world that students gain an understanding of the problem, the management of the data, and the mathematical and physical constraints that exist (Pohan, Asmin, & Menanti, 2020). Ultimately, students utilise the knowledge acquired throughout the process and the final outcome as a framework for attaining the learning objective (Pohan, Asmin, & Menanti, 2020). Upon completion of the process, students have the opportunity to refine their knowledge base, integrating new insights and experiences alongside their existing knowledge (Oon-Seng, 2023). The teacher provides support, guidance and encouragement to their students throughout the learning process (Aidoo, 2023; Pozuelo-Muñoz, Calvo-Zueco, Sánchez-Sánchez, & Cascarosa-Salillas, 2023; Alt & Raichel, 2022).

The implementation of problem-based learning requires students to engage with the problem at hand through active participation (Aidoo, 2023; Heystek, 2021; Katsaounos, Zachos, & Siolou , 2014). This approach enables students to identify the knowledge necessary to develop a solution (Heystek, 2021; Katsaounos, Zachos, & Siolou , 2014). Consequently, theory is integrated into practice, and students' skills are utilized to ensure the sustainability of the solution (Heystek, 2021). One potential outcome of this process is the emergence of diverse and innovative solutions, as proposed by (Katsaounos, Zachos, & Siolou , 2014). The attainment of the objective is contingent upon the existence of knowledge drawn from a multitude of disciplinary domains (Katsaounos, Zachos, & Siolou , 2014). In a survey conducted in US schools, it was found that the frequent use of this pedagogical method contributes to the development of students' creativity (Lasky & Yoon, 2020).

At this juncture, the distinction between conventional techniques, wherein educators present a multitude of examples in the classroom and provide detailed instructions for their resolution, also becomes evident. The students are then required to replicate these steps in the exercises that they will complete independently at home. This process, as carried out by the students, cannot be considered to constitute problem-solving, but rather exercises (Oon-Seng, 2023). In the majority of cases, there is only one solution, thereby precluding the possibility of identifying a creative one.

The objective of establishing a connection with everyday life is twofold: firstly, to stimulate interest among students (Heystek, 2021; Katsaounos, Zachos, & Siolou , 2014) and secondly, to facilitate a deeper understanding of the concepts with which they interact (Aidoo, 2023). Furthermore, it facilitates the acquisition of knowledge and the advancement of students' critical thinking (Keiler, 2018; Gafour & Gafour, 2020; Alsaleh, 2020). This knowledge is not innate but is uncovered by the students during their attempt to resolve the problem (Katsaounos, Zachos, & Siolou , 2014). Consequently, the optimal circumstances are established for students to construct their own understanding through collaboration and teamwork within the group (Oon-Seng, 2023). Furthermore, the encouragement of knowledge acquisition is accompanied by the subsequent application of that knowledge (Aidoo, 2023). Concurrently, the value of lifelong learning is reinforced among students (Alt & Raichel, 2022), and the provision of appropriate resources facilitates its acquisition through he cultivation of critical thinking, collaboration and adaptability (Gündüz, 2023) .

To arrive at a solution to the problem, students must first investigate the problem by seeking out relevant sources of information. They must then evaluate the information they have found, discarding any that is not useful (Oon-Seng, 2023; Pohan, Asmin, & Menanti, 2020). They should then compare, classify and draw conclusions from the remaining information (Oon-Seng, 2023). Subsequently, an analysis should be conducted in order to identify an appropriate solution (Pohan, Asmin, & Menanti, 2020). It is evident that the stages of problem-solving are analogous to the stages through which an individual must progress in order to develop critical thinking, as outlined by (Aidoo, 2023). The following sources were consulted (Meirbekov, Maslova, & Gallyamova, 2022; Heystek, 2021; Ellerton & Kelly, 2021; Wang & Jia, 2023; Gafour & Gafour, 2020; van der Zanden, Denessen, Cillessen, & Meijer, 2020), The capacity to evaluate information and identify suitable learning resources (Heystek, 2021) is not only associated with the development of critical thinking (Meirbekov, Maslova, & Gallyamova, 2022; Heystek, 2021) but also with the recognition of the enduring value of learning (Heystek, 2021).

This method enables students to achieve the desired outcome through a process of interaction between the problem and the surrounding environment. The aspiration to gain knowledge is kindled through the individual's engagement with the problem. The integration of problem-solving with a collaborative approach facilitates the acquisition of knowledge and enables the assessment of its applicability and potential benefits (Oon-Seng, 2023).

A further essential element is the necessity for students to address a genuine, practical issue, which is a fundamental aspect of STEM education. It can be seen, therefore, that this particular method forms an integral part of STEM education (van Gog, Hoogerheide, & van Harsel, 2020), and it is therefore desirable for teachers to be able to apply it. In order to apply this method, it is necessary to adopt a holistic and interdisciplinary approach (Alt & Raichel, 2022; Katsaounos, Zachos, & Siolou , 2014; Navy & Kaya, 2020). The role of the teacher is that of a guide, and they are also able to facilitate their students in the event that the latter find themselves at a dead end (Heystek, 2021; Asghar, Ellington, Rice, Johnson, & Prime, 2012). This method facilitates the acquisition of the following skills:

- The method facilitates essential learning,
- enabling students to acquire knowledge,
- act,
- motivate the team,
- learn how to learn,
- communicate with the group and learn together (Pohan, Asmin, & Menanti, 2020).
- It also provides students with the opportunity to acquire skills and learn general problem-solving strategies (Oon-Seng, 2023)
- in the development of the individual's adaptability (Sirotiak & Sharma, 2019)
- improving student performance (Aidoo, 2023)
- acquiring research skills
- internalising the new knowledge (Pozuelo-Muñoz, Calvo-Zueco, Sánchez-Sánchez, & Cascarosa-Salillas, 2023)

Asghar et al. (2012) posit that the problem-based learning model can contribute to a greater degree than other models in achieving the goals of STEM education. Furthermore, the potential advantages of integrating problem-based learning into STEM education were examined. The principal benefits are as follows:

- Facilitating the acquisition of comprehensive knowledge across disparate scientific disciplines.
- Stimulation of curiosity
- Use of imagination
- Understanding the process of scientific research
- Encourages cooperation as the final solution will be determined by the entire team
- It helps the involved members to identify the knowledge they should require
- Thoughts on resolution must be actionable
- Enhances the student's interest in achieving the final goal
- Develops the ability to extend students' knowledge (Asghar, Ellington, Rice, Johnson, & Prime, 2012).

Furthermore, the ability to plan and design is integrated into the problem-solving process, allowing teams to apply their creative and critical thinking skills. Design thinking is a prominent feature of engineering and technology, yet it is also evident in the fields of mathematics and natural sciences. It is thus a component of problem-solving directly related to STEM education (Li, Schoenfeld, diSessa, & et al., 2019). This specific approach can serve as a conduit between theoretical and practical knowledge, addressing the primary drawback of conventional methods wherein students amass knowledge but lack the ability to apply it to novel problems. In contrast, in problem-based learning, new ideas pertaining to the issue under study are linked with existing knowledge, experiences, and perceptions (Oon-Seng, 2023). A further advantage of problem-based learning over traditional techniques is that students are able to retain theoretical concepts encountered during the course of the process for a longer period of time (Alt & Raichel, 2022). In the article by (Pohan, Asmin, & Menanti, 2020), a study was conducted to investigate the contribution of problem-solving abilities to student achievement in mathematics. The results indicated a positive outcome for students who were taught through problem-based methods in comparison to those who were taught through conventional methods. The utilisation of problems in the learning process is corroborated by a plethora of contemporary scientific disciplines, including neuroscience (Oon-Seng, 2023).

The implementation of this specific approach necessitates its incorporation into the curriculum. The complexity of the problem should be aligned with the cognitive abilities and age of the students. Furthermore, previous experiences are a significant contributing factor (Oon-Seng, 2023). It is therefore incumbent upon the curriculum to anticipate the utilisation of novel technologies, thereby ensuring that students are able to access information that extends beyond the scope of that provided by the teacher (Aidoo, 2023).

Project Based Learning

Furthermore, project-based learning is centred on the student and has been linked to both the development of critical thinking and the success of STEM classroom projects (Keiler, 2018). As previously stated by Zavlanos, this methodology was initially conceptualised by Dewey and subsequently by Kilpatrick. The initial focus was on enabling students to gain authentic, real-world experiences. Subsequently, it was linked to the active and enthusiastic participation of students in the entire process (Zavlanos, 2003). It is appropriate to analyse this pedagogical method as it is considered to contribute to the acquisition of 21st-century skills by students (Zulyusri, Elfira, Lufri, & Santosa, 2023).

In the initial stages of the project method, the stimulus for action is presented to the relevant parties, after which a proposal for action is formulated (Vaina). The initial stage may be initiated with a question that will direct the students on the appropriate course of action (Goodwin, 2024). The subsequent phase is the finalisation of the decision. Team members engage in forward planning, establishing schedules and deadlines (Zulyusri, Elfira, Lufri, & Santosa, 2023), and then distribute responsibilities (Alt & Raichel, 2022). During the implementation phase, students receive feedback at designated intervals (Alt & Raichel, 2022). Additionally, the utilisation of technology and other tools

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is imperative (Goodwin, 2024). Nevertheless, they must be able to justify their selection of the aforementioned method (Zulyusri, Elfira, Lufri, & Santosa, 2023). The presentation of the outcomes achieved by group members signifies the conclusion of the process (Alt & Raichel, 2022). At the conclusion of the process, the group presents its findings and conclusions to the entire class or community (Goodwin, 2024). The entire process typically spans weeks or even months and frequently encompasses multiple issues (Goodwin, 2024).

The class can be divided into groups, each initially working on the same issue and proposing their own solutions. In contrast, the groups initially operate independently and subsequently collaborate to attain the ultimate objective (Vaina). In the second case, there is a possibility that the group responsible for developing a solution to the problem may differ from the group responsible for implementing it (Gafour & Gafour, 2020). As part of this process, students engage in research, evaluate sources, and compose reports about the results of their research for their teacher. This approach makes the lesson more engaging (Zulyusri, Elfira, Lufri, & Santosa, 2023).

Characteristic of this method is the fact that it has a predetermined and clear purpose which is connected to situations of everyday life and is carried out in a natural environment (Zavlanos, 2003) through the interdisciplinary approach (Vaina). While the resolution must be done with respect to the real world (Zulyusri, Elfira, Lufri, & Santosa, 2023) and the principles of sustainability. It becomes clear that during the specific educational method other student-cantered teaching methods should be used (Goodwin, 2024). At the same time, it has as its focus the solution of a problem and requires the cooperation between the members of the group that will undertake to carry out the work.

Through the freedom provided to the students, the latter become responsible for the correct planning and elaboration of their work (Zavlanos, 2003) while simultaneously developing their creativity (Almazroui, 2023), critical thinking and the ability to solve problems, all of this under the grounds of the individual’s imagination (Zulyusri, Elfira, Lufri, & Santosa, 2023; Wu & Wu, 2020). Critical thinking is strengthened as initially students must collect information, analyse it and then develop through new skills that will lead them to solve the problem given to them (Meirbekov, Maslova, & Gallyamova, 2022). By focusing on solving a problem through research, they escape the framework of memorization (Zulyusri, Elfira, Lufri, & Santosa, 2023).

In this method learning occurs through the active participation of students (Zulyusri, Elfira, Lufri, & Santosa, 2023; Almazroui, 2023) in the process and social interaction (Almazroui, 2023). The advantage of active student participation is the impetus given to them to gather as much information as possible (Zulyusri, Elfira, Lufri, & Santosa, 2023), thus leading to an in-depth investigation. While the solution comes from the control of assumptions that arise from experience (Almazroui, 2023). Processes such as asking questions, participating in activities, using technological media, creating a derivative, and collaborating among members of a group are used to achieve the ultimate learning goals. The final product that will be produced by the group of students is unique (Almazroui, 2023), so it can also be linked to the term innovation.

While individual creativity is stimulated through the discussion required to achieve the goal as group members must be able to express their personal opinion and then discuss it with the group. This ability is one of those that characterize a person as creative (Wu & Wu, 2020). When engaging in this pedagogical method, students may gain significant motivation to learn as in order to be able to provide a solution to the problem they should first improve their skills (Zulyusri, Elfira, Lufri, & Santosa, 2023).

Concurrently, the educator must demonstrate a willingness to collaborate with the learners, providing them with the necessary support and guidance while avoiding undue imposition. For the method to be successful, it is essential that the teacher dedicates a significant amount of personal time to lesson preparation. Concurrently, the teacher is obliged to pursue continuous professional development (Almazroui, 2023). This method is put forth for its implementation in the context of STEM education, as outlined in the reference (Li, Schoenfeld, diSessa, & et al., 2019).

In all of these methods, where the student is positioned at the centre of the process, the teacher is required, in accordance with democratic principles, to relinquish some of their authority and share

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power with their students. The role of the teacher is to provide guidance to students, neither offering a pre-prepared solution nor imposing it upon them (Keiler, 2018). Furthermore, students are divided into groups with the objective of achieving the learning outcomes. This technique is particularly effective in fostering the development of two fundamental competencies that are essential in the 21st century: communication and cooperation.

Design Thinking

Design thinking is a pedagogical approach that is aligned with constructivist principles and is grounded in interdisciplinary collaboration (Seevaratnam, Gannaway , & Lodge, 2023). The term 'design thinking' refers to the mental process that an individual follows in order to accomplish the assigned task, rather than the final product (Razali, Ali, Safiyuddin, & Khalid, 2022). It is deemed an appropriate methodology for addressing problems that are not fully determinate, as well as those that are not fully describable (Razali, Ali, Safiyuddin, & Khalid, 2022; Koh, Chai, Wong, & Hong, 2015). This is due to the fact that the outcome of design thinking is capable of adapting to the ever-changing environment (Koh, Chai, Wong, & Hong, 2015).

One of the key advantages of this approach is the potential to acquire 21st-century skills (Seevaratnam, Gannaway , & Lodge, 2023; Razali, Ali, Safiyuddin, & Khalid, 2022), which can equip future workers with the necessary resources (Seevaratnam, Gannaway , & Lodge, 2023). The objective of this educational process is to enable individuals to approach a problem in a novel manner while also recognising the opportunities that exist beyond the immediate solution. The primary objective is to design a product that will comprehensively address the user's needs (Samrat, et al., 2024). Achieving this necessitates the individual's capacity to perceive the intricacy of the issues to be considered in order to identify a solution, which may encompass social, economic and political concerns (Koh, Chai, Wong, & Hong, 2015).

In the context of the school, it is recommended that students be divided into groups. This approach has been shown to have multiple benefits, including fostering team spirit and communication between group members (Razali, Ali, Safiyuddin, & Khalid, 2022). Prior to the commencement of the solution-seeking process, it is essential for the team to conduct an investigation of the contextual environment and identify the factors that could potentially influence it. This is in accordance with the recommendations set forth by (Razali, Ali, Safiyuddin, & Khalid, 2022; Koh, Chai, Wong, & Hong, 2015). Additionally, it is crucial to ascertain who will stand to benefit from the proposed solution. This information is vital for ensuring that the solution aligns with the needs and interests of the intended beneficiaries (Razali, Ali, Safiyuddin, & Khalid, 2022). In order to arrive at the optimal solution, the team should consider a multitude of potential ideas, test them in practice, and evaluate which will best satisfy the user (Samrat, et al., 2024). Students are encouraged to propose ideas freely and then evaluate them in order to further investigate those that have taken into account the social context (Koh, Chai, Wong, & Hong, 2015). In order to select the optimal solution, the group of students should repeat a sequence of verification steps for each sentence collected (Razali, Ali, Safiyuddin, & Khalid, 2022). This process allows for the solution to be identified for each aspect of the problem individually, before finally forming the complete solution (Razali, Ali, Safiyuddin, & Khalid, 2022). During this process, the student develops their critical thinking abilities, as they are required to navigate complex situations (Koh, Chai, Wong, & Hong, 2015). At this juncture, the students receive feedback from an expert, and it is recommended that they seek a second opinion (Razali, Ali, Safiyuddin, & Khalid, 2022). Following this feedback, the optimal solution is selected by the plenary. In the final stage, students present their work (Razali, Ali, Safiyuddin, & Khalid, 2022).

Its connection with interdisciplinarity (Seevaratnam, Gannaway , & Lodge, 2023; Razali, Ali, Safiyuddin, & Khalid, 2022; Koh, Chai, Wong, & Hong, 2015) gives rise to creative and innovative solutions (Seevaratnam, Gannaway , & Lodge, 2023; Razali, Ali, Safiyuddin, & Khalid, 2022; Samrat, et al., 2024), while necessitating the involvement of creative individuals (Razali, Ali, Safiyuddin, & Khalid, 2022; Koh, Chai, Wong, & Hong, 2015; Samrat, et al., 2024). Furthermore, it is evident that design thinking is pertinent to the resolution of problems encountered in everyday life (Razali, Ali,

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Safiyuddin, & Khalid, 2022; Koh, Chai, Wong, & Hong, 2015; Samrat, et al., 2024). It is evident that there is a clear connection to STEM education, as both interdisciplinary work and creativity and innovation are fundamental aspects of its foundation.

One disadvantage of this method is the lengthy time required for completion, which is incompatible with the constraints of a single teaching hour (Razali, Ali, Safiyuddin, & Khalid, 2022). The application of design thinking is hindered by several factors, including a lack of knowledge about its implementation among educators, inadequate resources, and time constraints (Razali, Ali, Safiyuddin, & Khalid, 2022).

Brainstorming

Another prevalent pedagogical approach that situates the learner at the core of the educational process (Doğan & Batdı, 2021) and can facilitate the acquisition of the requisite competencies is brainstorming (Doğan & Batdı, 2021). In this method, students are required to express their thoughts about an issue or problem in an uninhibited manner, without any constraints (Doğan & Batdı, 2021; Page, 2021). The instructor provides a variety of forms of encouragement in this regard (Doğan & Batdı, 2021). The primary objective is to identify an expedient solution to the problem. The method in question is one of group idea generation, whereby group members engage in communication and interaction (Gong, Lee, Soomro, Nanjappan, & Georgiev, 2022). The teacher records these ideas without initially offering any corrective feedback, commentary, or comparisons (Doğan & Batdı, 2021; Page, 2021). It is essential that the teacher establishes a trusting environment in order to facilitate students' comfort in expressing their opinions (Page, 2021).

The method's primary feature is the significant role of the thinking process on behalf of the students, with each individual receiving promotion in a different manner (Gafour & Gafour, 2020). This educational method is not structured (Gafour & Gafour, 2020), yet it is effective in stimulating creative thinking (Gafour & Gafour, 2020; Doğan & Batdı, 2021). It encourages students to express any ideas they may have, some of which may be unconventional and innovative, ultimately leading to the achievement of the final goal (Gafour & Gafour, 2020). During the process, a considerable number of ideas are recorded, some of which are subsequently rejected by the students themselves. The remaining proposals will be discussed in the plenary session of the class. At this juncture, the instructor assumes the role of facilitator, while the final evaluation is conducted by the students themselves. A prerequisite for success at this stage is the essential interaction between students, as proposed by (Ghavifekr, 2020).

From the multitude of ideas that will be recorded, it is anticipated that one will emerge that is not only innovative but also implementable. Additionally, the interaction within the group can facilitate the further development of an idea by one member in collaboration with another. In such instances, the introduction of a new element can result in alterations and, consequently, the emergence of innovative concepts (Gong, Lee, Soomro, Nanjappan, & Georgiev, 2022). At this juncture, it seems that cooperative learning is associated with brainstorming (Ghavifekr, 2020).

Consequently, throughout the process, students must remain alert in order to participate and to reconstruct previous knowledge (Doğan & Batdı, 2021). The positive emotional state experienced by students during the ideation process can facilitate the formation of a positive attitude towards the lesson, which is a crucial element in any educational system (Doğan & Batdı, 2021) .

In order to evaluate the ideas, it is necessary to carry out a mental mapping exercise, in which the necessary correlations are identified (Gafour & Gafour, 2020), in order to distinguish between those solutions that are applicable and those that are not. Furthermore, an innovative solution can be identified and isolated.

Furthermore, a combination of brainstorming can be conducted with the Lotus Blossom technique. In this instance, the initial concept is retained as the primary focus, with subsequent ideas (or 'petals') emerging from it and becoming increasingly detailed. Subsequently, novel concepts are established as the focal point, providing a foundation for subsequent ideation (Gafour & Gafour,

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2020). Consequently, even an initially unclassified concept may ultimately be identified as an innovation.

Once the aforementioned methods have been completed, it is essential to differentiate between ideas that can be implemented and those that cannot, while also identifying the most innovative concepts. One such method is the New-Useful-Feasible (NUF) test, in which the original ideas are evaluated based on the existence of three characteristics (Gafour & Gafour, 2020).

A novel approach to brainstorming is that of virtual brainstorming. During this process, the rules of brainstorming previously outlined are applied, albeit with the caveat that participants are represented by avatars within a digital environment. One advantage of this process is that it is anonymous, which ensures that participants are able to express their views without fear of recrimination. Consequently, the number of listed ideas has increased. (Gong, Lee, Soomro, Nanjappan, & Georgiev, 2022).

Cooperative Learning

The majority of the aforementioned methods can be classified as forms of cooperative learning, as they necessitate the collaboration of students in groups. Through this collaborative process, the desired learning outcomes can be achieved. This method is regarded as being of such benefit to students that it is regarded as a means of improving the quality of national education (Ghavifekr, 2020). In this case, students are required to work in groups, thereby necessitating not only the cooperation of group members but also the ability to engage with and respond to diverse perspectives on a given issue. Additionally, students must demonstrate the capacity to construct a rationale in support of their own position in relation to those of their peers (Goodwin, 2024). It is essential that groups possess the following characteristics:

- The groups should be of a relatively small size,
- have a clear structure
- comprise individuals with diverse backgrounds and perspectives (Zhou & Colomer, 2024).

While its implementation requires its combination with other methods (Goodwin, 2024; Norris, Taylor, & Lummis, 2023) such as problem solving, (Norris, Taylor, & Lummis, 2023) inquiry-based learning (Goodwin, 2024; Norris, Taylor, & Lummis, 2023). Therefore, in the cooperative method, the constructivist educational methods that have already been mentioned can be applied. In this way, students reap the full range of skills that these teaching methods can bring. While the teacher can plan more precisely the educational activities to be carried out in the classrooms (Zhou & Colomer, 2024). The responsibility of creating an appropriate environment burdens the teacher and requires him to leave room for his students to discuss during the lesson, at the same time it will allow the students to stay fully focused (Afzal, 2020).

The teacher is there to help differentiate the goals for each student, as groups should be structured in such a way as to promote the strengths of each group member (Goodwin, 2024). The group should be heterogeneous (Zhou & Colomer, 2024), as the combination of the different positive characteristics of each student will lead to the fulfilment of the goals. At the same time, the ability to share knowledge between team members is enhanced as each one has different knowledge (Zhou & Colomer, 2024).

In the form of such methods, students acquire a series of skills that will be useful to them in their adult life, such as leadership skills, critical thinking (Petre, 2020; Zhou & Colomer, 2024), the ability to communicate and cooperation (Petre, 2020; Zhou & Colomer, 2024) , the acquisition of a sense of responsibility, active participation, the ability to manage disagreements (Petre, 2020) and the enhancement of motor skills (Zhou & Colomer, 2024). The success of one student is related to the success of another, therefore there is interdependence between the members of the group which has a positive sign (Goodwin, 2024). In this direction, continuous cooperation between the members is required, as well as the correct distribution of tasks among them (Zhou & Colomer, 2024). In addition, the climate among the students in the class improves, their academic performance (Ghavifekr, 2020) but also the individual sense of responsibility towards the group (Zhou & Colomer, 2024). While through the process of collaboration, cultural and racial differences between team members are mitigated and stress levels of team members are reduced (Zhou & Colomer, 2024). It becomes possible to retain knowledge for a long time after the person's first contact with it (Petre, 2020) but also to understand it more deeply so that they can apply it (Zhou & Colomer, 2024). At the same time, they also work in favour of the teacher as they help him manage his class (Szewki, Nussbaum, Rosen, & et al., 2011).

The result of this is the possibility of applying knowledge to solving a problem (Petre, 2020; Ghavifekr, 2020) even after a long time. So we are talking about the acquisition of essential knowledge which is the property of the individual. Over time, with the maturity it brings, this knowledge can evolve (Petre, 2020). Thus, from the small creativity of the student years, it is possible for the person to pass to the great creativity during his adult-professional life.

Good practice of implementing cooperative learning at the classroom level can be considered the participation in the cooperative network e-Twinninig which contributes to the development of multiple skills such as creativity, entrepreneurship and cooperation (Ghavifekr, 2020).

Among the disadvantages of this method of method could be classified the fact that the completion of a task does not have a strictly defined time frame (Goodwin, 2024)[30]. This fact is consistent with the main problems that have been recorded regarding the views of the teachers who report the lack of time in the classroom but also on behalf of the students, as already mentioned. Also, the need for communication between students of different cultural backgrounds may increase the digital divide between students as not all have access to digital tools which may lead to the marginalization of some group members (Zhou & Colomer, 2024).

Six Thinking Hats

The six thinking hats represent a pedagogical method that is designed to facilitate students' ability to consider a specific topic from a variety of perspectives. The concept was first proposed by Edward de Bono in the 1980s (GÃ¼rsoy & Ã–zcan, 2022), based on the assumption that thinking represents the pinnacle of human cognitive abilities (GÃ¼rsoy & Ã–zcan, 2022; Dahlia, Iskandar, & Muhayyang, 2024). Conversely, it is a skill that can be developed through the implementation of suitable processes (Mansurova, 2024). The method may be applied either individually or in groups (Dahlia, Iskandar, & Muhayyang, 2024). The core of this pedagogical approach is the systematic analysis of students' thought processes, whereby these processes are divided into components that are more readily comprehensible in terms of their objectives (Dahlia, Iskandar, & Muhayyang, 2024). In this pedagogical approach, the classroom is populated by six metaphorical hats, which represent different modes of thinking. Each of the hats is associated with a distinct colour, which symbolises a different mode of thought. To elaborate further:

- The white hat represents objective thinking and is based mainly on objects and numbers
  - It relates to the information we already have, the information we need to solve the problem, the information we lack and how we will find it.
- The red hat indicates emotions such as anger and rage and is intended for the student wearing it to express their feelings.
  - Here students express their opinions and impressions. At this stage there is no 604 need to document what is stated.
- The black hat represents reticence and the student who wears it looks for the weaknesses, the gaps that may exist in the ideas that have already been formulated.
  - The problems and difficulties that exist are identified until the solution is found. The mistakes

and omissions made in the previous stages of thinking are identified.

- The yellow hat indicates positive thinking and feelings such as optimism.

o The student wearing the yellow hat focuses on the benefits.

- The green hat indicates creativity and the expression of new ideas.

o The student who wears the green hat tends to go beyond what he already knows, to apply new ideas.

- The blue hat is related to organizing thought and checking what has been said by the other hats

o What was recorded while the students were wearing the other hats is attached in order for the student who wears it to reach conclusions and also to supervise the observance of the rules during the process (DeBono, 2006).

In this approach, the role of the teacher is that of a facilitator, providing guidance and support to learners. It is essential to plan meticulously in advance in order to ensure the success of the course. The teacher is responsible for selecting the topic and presenting it to the class. Subsequently, the students are divided into groups. Each group assumes a different role, and then takes turns assuming each role. Each group records their thoughts (Dahlia, Iskandar, & Muhayyang, 2024). The hats may be used individually when a specific mode of thinking is required, or in sequence when a topic necessitates exploration from multiple perspectives (DeBono, 2006). In the context of educational practice, the teacher refers to the hats by colour, rather than function. This is because it is more straightforward to instruct students to remove the yellow hat than to instruct them to cease positive thinking (DeBono, 2006). The teacher poses questions that must have specific content and be related each time to the corresponding colour of the hat worn by the student (Dahlia, Iskandar, & Muhayyang, 2024). Subsequently, each group presents their thoughts and conclusions in plenary, where a discussion may be held regarding the content of the presentations (Dahlia, Iskandar, & Muhayyang, 2024).

Students wearing thinking hats are required to approach the same topic from a different perspective, and this goal can only be accomplished through teamwork (GÃ¼rsoy & Ã–zcan, 2022; Dahlia, Iskandar, & Muhayyang, 2024; Huang, Ko, Lin, Dai, & Chen, 2021) . Consequently, it is feasible to cultivate competencies such as collaboration (GÃ¼rsoy & Ã–zcan, 2022; Mansurova, 2024), the nurturing of creative thinking (GÃ¼rsoy & Ã–zcan, 2022; Huang, Ko, Lin, Dai, & Chen, 2021) and lifelong learning (Mansurova, 2024). The development of each member's thinking is employed for the benefit of the group, thereby fostering a sense of collective identity and higher levels of self-esteem (Dahlia, Iskandar, & Muhayyang, 2024). Each student contributes to the group by drawing on their collective knowledge and previous experiences (Dahlia, Iskandar, & Muhayyang, 2024). Furthermore, it enhances problem-solving abilities, improves academic performance (Huang, Ko, Lin, Dai, & Chen, 2021), and facilitates the completion of a case study (Mansurova, 2024). The study (Huang, Ko, Lin, Dai, & Chen, 2021) demonstrated that students, with the assistance of the Six Thinking Hats model, were able to effectively alter their thought processes regarding a specific issue within a relatively short timeframe. Furthermore, the thoughts of the members are effective (Dahlia, Iskandar, & Muhayyang, 2024) and the communication between them is productive (Mansurova, 2024). The conclusions presented are deemed reliable due to the application of techniques such as dialogue and questioning throughout the process (Mansurova, 2024).

By engaging in critical thinking about a given issue from multiple perspectives, students develop the capacity to evaluate information and ideas in a way that encourages active citizenship (Mansurova, 2024). Information is processed in an objective manner, as students have observed it from disparate perspectives, thereby facilitating comprehension of complex topics in depth (Mansurova, 2024). One potential drawback of this approach is the time investment required for

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students to become proficient in the use of the six thinking hats. The time spent in the classroom is not as productive as it could be (Dahlia, Iskandar, & Muhayyang, 2024).

Flipped Classroom

The flipped classroom is also a pedagogical method based on active learning (Heystek, 2021) and the principles of constructive learning models (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). The flipped classroom was first implemented in higher education in 1990 (Kilipiris, Avdimiotis, Christou, Tragouda, & Konstantinidis, 2024), and subsequently adopted by secondary education (Galindo-Dominguez, 2021; Ölmefors & Scheffel, 2021). The continuous technological progress that is occurring provides the necessary tools for both students and teachers to implement the flipped classroom effectively (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024).

The application of this method entails the transfer of processes that were traditionally conducted within the classroom setting to an alternative, domestic environment. In the conventional approach, the instructor presents the theoretical content, while the students engage in the corresponding activities outside the classroom. In contrast, the flipped classroom approach reverses this sequence, reserving the most engaging aspects of the activities for the classroom setting (Galindo-Dominguez, 2021; Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). Consequently, students view their instructor's recorded lectures at home (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024; Heystek, 2021; Nielsen, 2023). Furthermore, the utilisation of online resources, such as websites, social media platforms, and educational videos from platforms like YouTube, in conjunction with digital games, can also be employed (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). While in the classroom, it is possible to employ active teaching methods such as discussions (Heystek, 2021; Nielsen, 2023) and the application of exercises and group work (Galindo-Dominguez, 2021). It is noteworthy that the distinction between this approach and the traditional classroom lies in the preparation of the lesson, rather than in the manner of its delivery. Furthermore, there is no intention to supplant the role of the teacher; rather, the objective is to foster more intimate interactions with students during their time in the classroom (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024).

The flipped classroom teaching method comprises two distinct phases:

- The asynchronous phase comprises students engaging with video lectures or processing material already provided by the instructor. The period during which students engage in processing occurs prior to their engagement with the specific issue in the classroom.
- The contemporary phase is characterised by the implementation of all activities within the classroom setting, with the guidance and instruction of the teacher. Student 683 participation is active, encompassing activities such as following, discussing, and engaging in group work (Kilipiris, Avdimiotis, Christou, Tragouda, & Konstantinidis, 2024; Malkoc, Steinmaurer, Gütl, Luttenberger, & Paechter, 2024).

In this manner, the student gains knowledge during the initial stage with the assistance of technology, while its consolidation occurs during the subsequent stage with the support of the teacher and the entire class (Kilipiris, Avdimiotis, Christou, Tragouda, & Konstantinidis, 2024). The educator is responsible for selecting the method of presentation of the material to be utilized with their students, ensuring that it is engaging and motivating (Ölmefors & Scheffel, 2021). While studying the material, students may take notes, which can assist them in organising their thoughts and new knowledge. This enables the new knowledge to be readily available during the second phase, when it can be utilised. It is evident that the second phase is centred on the students, and thus the corresponding educational methods must be selected (Nielsen, 2023) in order to achieve the desired learning outcomes and competencies. Prior to their attendance at the classroom, students have already achieved a sufficient level of theoretical understanding, thereby enabling them to address more complex problems within the classroom setting (Ölmefors & Scheffel, 2021). This is beneficial for the educational process. This finding is corroborated (Ölmefors & Scheffel, 2021) in secondary schools in Sweden. In Nigeria, the use of a flipped classroom has been shown to result in higher performance in mathematics (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024)[. It is the responsibility of the teacher to ascertain whether their students have completed the tasks set for them at home and in the classroom (Ölmefors & Scheffel, 2021).

The process allows for the saving of productive time in the classroom (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024; Petre, 2020), which can be considered extremely beneficial. The existence of productive working time in the classroom allows for the interaction of the teacher and the student, which is the most basic success factor of an educational goal (Ölmefors & Scheffel, 2021). Concurrently, it facilitates the formation of more robust relationships between teacher and student, as they interact in a more efficacious manner (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). Consequently, a multitude of activities can be undertaken in which students engage actively under the guidance of the teacher, having first acquired the requisite theoretical knowledge from the video lectures (Petre, 2020) which are typically accessible on a dedicated platform (Galindo-Dominguez, 2021). It is feasible for the preparatory material to comprise tasks that will assist students in performing better in class (Ölmefors & Scheffel, 2021). To conclude, it is advised that students engage in group work (Nielsen, 2023). Such activities facilitate the expansion of their knowledge (Petre, 2020), while simultaneously reducing the time spent on lectures in the classroom, which often fail to capture the students' attention (Nielsen, 2023). The teacher is afforded the opportunity, during the time spent with their students, to organise well-structured tasks that will have multiple benefits in terms of achieving the final goals (Nielsen, 2023). The lesson commences with the teacher's assessment of the students' comprehension of the material they have been required to process (Egara & Mosimege, Effect of blended learning approach on secondary school learners' mathematics achievement and retention., 2024). Conversely, students develop a sense of responsibility towards the group and are committed to success (Nielsen, 2023).

This method, through the cultivation of critical thinking, cooperation and adaptability, facilitates the individual's development into a lifelong learner (Gündüz, 2023), while also enabling the acquisition of skills (Ölmefors & Scheffel, 2021), with a particular emphasis on self-directed learning (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024; Malkoc, Steinmaurer, Gütl, Luttenberger, & Paechter, 2024). The studies summarised in (Aidoo, 2023; Nielsen, 2023) demonstrate an increase in student performance and self-confidence as students realise that they can cope with the material they have been given to study at home and through the autonomy given during this process. The material is structured in a way that allows for the unique needs of each student to be met (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024), ensuring that all students have the opportunity to respond. Students are required to work independently at home, thereby enhancing their autonomy and sense of responsibility. It is incumbent upon the students themselves to ensure they are adequately prepared for the subsequent lesson. They may do so asynchronously at any time prior to the commencement of their next class meeting (Galindo-Dominguez, 2021). Students are permitted to proceed at their own pace and at their own convenience, allowing them to view the video lecture as often as they wish or to revisit any portion that they find challenging to comprehend (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). Furthermore, the use of videos during students'

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independent study at home has been shown to reduce the cognitive load they are required to process (Nielsen, 2023). While collaborative methods applied during the presence of students in the classroom facilitate the acquisition of higher-order skills (Galindo-Dominguez, 2021).

In contrast, the disadvantages of this method include the lengthy time required for students to view the video lectures. When combined with homework, students are faced with a considerable workload (Galindo-Dominguez, 2021; Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024; Ölmefors & Scheffel, 2021) . Nevertheless, it is evident that the use of videos cannot entirely substitute for the direct interaction between students and teachers that is inherent to the physical classroom setting (Ölmefors & Scheffel, 2021). Furthermore, if the videos are lengthy students may be unable to maintain the requisite attention span to pose their queries promptly, resulting in delayed resolution and potential disruption to the learning process (Galindo-Dominguez, 2021; Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). This can cause them anxiety (Ölmefors & Scheffel, 2021). In many cases, the necessity of using a device with internet access diverts students' attention from the material being presented, causing them to instead engage with content from other websites or social media platforms (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). An additional challenge associated with the flipped classroom approach is the potential for including all students in the educational process. High-achieving students may be inclined to neglect preparation at home, while students with learning difficulties may face difficulties adapting to the shifts between synchronous and asynchronous teaching (Ölmefors & Scheffel, 2021). The failure of even one student to study the preparatory material can result in malfunctions during the second stage of the lesson in the classroom (Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024; Ölmefors & Scheffel, 2021). Furthermore, another significant challenge is the availability of digital resources and internet access at home (Galindo-Dominguez, 2021; Egara & Mosimege, Effect of flipped classroom learning approach on mathematics achievement and interest among secondary school students., 2024). In view of the dearth of documented scientific evidence, the flipped classroom is put forward as a pedagogical instrument in specific instances throughout the academic year, rather than as a pedagogical method to be applied across the entire subject matter (Ölmefors & Scheffel, 2021).

Differentiation Classroom

A further novel pedagogical approach is that of differentiated teaching (differentiation classroom), which has emerged as a consequence of the global objective to achieve Education for All inclusively (Eikeland & Ohna, 2022; Lindner & Schwab, 2020). Carol Ann Tomlinson is regarded as the originator of this pedagogical approach (Kuhr, 2023). The ultimate objective of this approach is to ensure that all students receive an equitable education, regardless of their individual differences (Lindner & Schwab, 2020). It is indisputable that in the contemporary classroom, students exhibit a range of characteristics that differentiate them from one another. These include, but are not limited to, cognitive level, cultural background, religion, and disability (Lindner & Schwab, 2020; Tomlinson & Strickland, 2005). The primary rationale for this is that the majority of classes are organised on the basis of age (Tomlinson & Strickland, 2005). In a class comprising such a diverse cohort, all students will be invited to acquire new knowledge together and reap the benefits of education (Eikeland & Ohna, 2022).

In light of these circumstances, differentiated teaching is imperative, as it addresses the disparate learning requirements (Eikeland & Ohna, 2022; Kuhr, 2023; Altangerel , Tsolmon, & Khulan , 2022), the varied characteristics of the students (Eikeland & Ohna, 2022; Kuhr, 2023) and their disparate levels of preparedness (Kuhr, 2023) . This approach, which prioritises students' skills, interests and prior knowledge, has been shown to enhance students' motivation to learn (Altangerel , Tsolmon, & Khulan , 2022). The overarching objective of this process is to facilitate the optimal attainment of a

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student's potential (Eikeland & Ohna, 2022), through the pursuit of a multitude of objectives and their realisation (Lindner & Schwab, 2020).

The term 'differentiation in terms of the educational process' refers to the teaching approach that a teacher will adopt in a class comprising students of varying abilities (Eikeland & Ohna, 2022). In the work of (Kuhr, 2023), the three levels of differentiation in teaching are outlined according to Dr. Tomlinson. These are as follows:

- The first level of differentiation is that of preparedness, which pertains to the prior knowledge of the students in the class. The investigation of prior knowledge in a classroom characterised by heterogeneity presents a number of challenges.
- The second level of differentiation is based on interest. At this level, the teacher allows students to engage with any aspect of the lesson that piques their interest, thereby fostering intrinsic motivation and increasing the likelihood of success.
- The third level is that of the learning profile. At this stage, the teacher is required to investigate the various ways in which the students in his or her class learn. This approach is largely contingent upon the cultural background of the students.

The instructor in such a class provides a plethora of diverse stimuli, each of which pertains to a distinct content area, workload, response rate, and complexity (Eikeland & Ohna, 2022). In his lesson planning, the teacher considers the individual differences among students, with the focus shifting from the group to the unique characteristics of each student (Eikeland & Ohna, 2022). As is the case with the majority of student-centred practices, the teacher assumes the role of guide (Kuhr, 2023), with the students' needs occupying a central position (Lindner & Schwab, 2020). It should be noted that this is not individualised teaching (Eikeland & Ohna, 2022; Kuhr, 2023). Rather, it is based on the provision of a range of activities from which the student can select the one that best suits their needs (Eikeland & Ohna, 2022).

The primary objective is to present the content in a simplified manner, ensuring its accessibility for all students. This does not imply that the teaching objectives are restricted or that the students are required to undertake less work to achieve them (Lindner & Schwab, 2020). In planning a lesson based on differentiated teaching, the teacher must consider the students' level of knowledge and their preferences (Tomlinson & Strickland, 2005). The teacher must foster a supportive classroom climate and provide ample stimuli to engage students (Lindner & Schwab, 2020; Kuhr, 2023).

Students are divided into groups based on their interests and abilities. The large number of stimuli and activities offered to the entire group provide numerous opportunities for learning and engagement (Eikeland & Ohna, 2022). The grouping of students is based on the assumption that each individual can contribute to the group's objectives and the learning processes of their fellow group members in their own unique way (Lindner & Schwab, 2020).

The diversity of the class, which in classical methods acts as an inhibiting factor in differentiated teaching, is leveraged to facilitate the attainment of the desired outcomes (Altangerel , Tsolmon, & Khulan , 2022). In a differentiated classroom, multiple learning objectives can be set, enabling each student to achieve goals that are directly related to their general background. This approach allows for the optimal performance of each student (Tomlinson & Strickland, 2005). The implementation of differentiated teaching methodologies facilitates the creation of multiple learning pathways, each of which is designed to lead to the achievement of specific learning outcomes (Altangerel , Tsolmon, & Khulan , 2022).

The student is placed at the centre of the educational process (Eikeland & Ohna, 2022), thus reaping the benefits of student-cantered methods (Eikeland & Ohna, 2022). Respect for the diversity of the cultural and family background of each student can contribute to the achievement of high goals at a social level such as the fight against discrimination and exclusion (Eikeland & Ohna, 2022). Another advantage of this practice that makes it stand out from all the others mentioned is the reduction of the gap between students who have access to digital resources and those who do not (Lindner & Schwab, 2020). Through differentiation in instruction the teacher can give different

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homework to each group of students. So for example a student who does not have access to digital resources can be given books from the school library to complete their homework

In order to evaluate the results of his teaching, the teacher can use classic methods 824 such as observing students and asking questions (Kuhr, 2023).

Among the disadvantages of this approach can be classified the increase in the achievement gap between students. Students are divided into groups based on their abilities, which has a negative impact on the relationship between classmates, motivation, self-esteem and students' view of school (Eikeland & Ohna, 2022). Also, in research summarized in (Lindner & Schwab, 2020) as a negative of this method, the fact that more teaching staff is required in order to implement this teaching is recorded. Also, preparation time at home is required on the part of the teacher as the goals are now a spectrum and the material given to the students must correspond to this spectrum (Lindner & Schwab, 2020).

Discussion

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, Ali, Safiyuddin, & Khalid, 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, Chai, Wong, & Hong, 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 1) 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.

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Table 1. 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 Based Learning	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 Based Learning	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 Based Learning	YES	It is essential that the issue is presented in a well-structured manner, with the teacher having conducted prior research into potential solutions	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.
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

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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 them to identify the most suitable approaches and to equip themselves with the requisite knowledge to implement them effectively.	NO	The process of brainstorming does not necessitate an extensive period of time within the classroom setting, as it primarily involves the initial documentation of students' ideas.	NO	The opinions and perceptions of students regarding the subject matter are documented, obviating the necessity for any further research.
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 utilisation 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	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	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

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		effective guidance		essential that sufficient time is allocated for each student or group of students to engage with each hat and express their own thoughts.		
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 objectives. It is essential to develop educational materials that can be tailored to the specific needs of each student in the class	NO	The allotted time for completion of the application process in the classroom is relatively brief.	NO	It is not necessary for students to have access to any type of resource.

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 the allocation of 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 between students with regard to their access to technological resources. The preparation time for an inquiry-based lesson is no greater than that required for a traditional lesson. It is, however, not feasible to complete all four stages of the process within the confines of a single teaching hour. While the verification of students' hypotheses through experimentation necessitates the investment of time and resources to design the experiment, procure the requisite tools, establish the experimental setup, and conduct the requisite measurements. Furthermore, it is not feasible for students to conduct the entire procedure in the domestic environment. Access to resources comparable to those available in school science laboratories is necessary. 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 affording students the opportunity to select the solution they consider most appropriate. It is therefore recommended that the teacher should have explored the possible solutions themselves, while also expressing the problem and objectives in a clear manner. 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, it is essential that they have undergone thorough preparation before the lesson. The time required for implementation within the classroom context is contingent upon the method selected. The utilisation of novel technologies is essential for the retrieval of requisite information. In the pedagogical method of design thinking, it is essential that the problem is 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 in depth 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 akin to inquiry learning, 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 in order 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. It is essential that the questions 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

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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 classroom. 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 aforementioned 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
- Inquiry-based learning
- 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 which 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 on problem solving, it was observed that students initially sought information from social networks, as they are familiar with using them (Pozuelo-Muñoz, Calvo-Zueco, Sánchez-Sánchez, Cascarosa-Salillas, 2023). It is evident that students should become able to distinguish between valid and invalid sources before starting to apply any method.

Conclusions

In the context of the student-centred school of the 21st century, the selection of an appropriate educational method is a crucial element in achieving learning objectives. Educators are confronted with a plethora of educational methods, the selection of which is contingent upon a number of factors, including the time available for lesson preparation, the time available 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, inquiry-based learning, inquiry learning 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. Inquiry-based learning, 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.

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