Brain Based Learning and 21st Century Skills: A descriptive Study of Students Learning at Secondary School Level

Shamim
MS (Scholar), Department of Education
University of Siakot, Sialkot, Punjab, Pakistan
Email: shamim4519998@gmail.com

Syeda Asma Sarwar
MS (Scholar), Department of Education
University of Siakot, Sialkot, Punjab, Pakistan

Email: asma.umair209@gmail.com

Abstract

Secondary school students' ability to acquire skill sets appropriate to the modern world is the focus of this study's investigation of the efficacy of brain-based learning. This research aims to describe how students learn and examine how brain-based learning strategies affect acquiring modern-day essential skills. The study's premise is that students will only be adequately prepared to fulfil the demands of the modern workforce if they acquire skills such as critical thinking, problem-solving, collaboration, communication, and creativity, all of which can be taught in a conventional classroom setting. Secondary school teachers were surveyed using a quantitative techniques approach to get numerical data for the study. Teachers' views on brain-based learning and self-reported proficiency in 21st-century abilities are measured quantitatively through questionnaires. This study adds to what is already known about the effects of brain-based learning on abilities relevant to the modern world. The outcome sheds light on how the concepts of brain-based learning mesh with essential skill development in the secondary school setting. The study also examines the pros and cons of using brain-based learning techniques. This means that the study's findings potentially affect stakeholders, legislators, educators, and curriculum developers. To better equip students for success in the contemporary world, it is essential to understand the effects of brain-based learning on 21st-century abilities. This knowledge can then inform the creation of evidence-based instructional strategies. The findings can inform educational policies and practices to help students acquire the critical thinking abilities they need to succeed in college and beyond.

Introduction

The education landscape is rapidly evolving in the 21st century, driven by technological advancements and a greater emphasis on developing skills that prepare students for the demands of the modern world. As educators work to provide students with the skills they need to thrive in the twenty-first century, brain-based learning has drawn attention as a valuable strategy to improve learning results (Smith, 2022).

Progress in science necessitates changes in teaching strategies. Medical conclusions have revealed the recognition of the human brain and a thorough understanding of how people learn. Due to this, a fresh teaching approach has been implemented. Personal learning is the most effective and long-lasting, according to brain-base, which emphasizes the learner (Tüfekçia & Demirelb, 2009). Positive changes in students' behaviour, motivation, and academic achievement can be achieved when lesson design, course objectives, and delivery align with brain science (Ceylan & Saka, 2022).

The brain-based learning approach puts the Brain-Based learning model's strategies into practice. In order to ensure that students can actively study, this method was created to be compatible with the propensity and best function of each brain. In addition, the study elaborated on the data analysis findings that showed that the conceptual understanding of differentiation among rural secondary school students increased when using the brain-based teaching approach. According to Yatim, Saleh, Zulnaidi, Yew, and Yatim (2021), students' conceptual comprehension of many disciplines has increased due to the Brain-Based Teaching method. Brain-based learning is an interdisciplinary approach to answering the question, "What is the most influential way of the brain's learning mechanism. Brain-based learning (BBL) is the acceptance of how the brain works and the arrangement of data in line with these principles to learn anything worthwhile (Ozden & Gultekin, 2008). BBL stands for brain-based learning. What a teacher teaches his students in terms of style is one of the critical factors in the learning process. This indicates that, compared to the conventional way, the BBL method can more effectively foster higher-order thinking abilities and drive in children (Permana & Kartika, 2021). An individual's experiences build a link between cells influenced by environmental and genetic elements. To produce meaningful learning, each brain system within the overall brain appears to cooperate (Cain & Cain, 2006).

A more complicated society and a rapidly changing technology-based economy provide new and urgent challenges for communities and schools. The development of frameworks with a focus on sustainability is being requested from school systems all around the world. Success in the twenty-first century requires particular abilities, knowledge, and attitudes (Martinez, 2022). The effectiveness of the Brain-Based learning approach for enhancing pupils' reading fluency and comprehension is discussed by Kohar (2022). Numerous studies have been carried out to address the issue of low reading comprehension. One such study by Kohar (2022) revealed that brain-based learning, which promotes reading comprehension among students based on exposition reading structure, is a teaching strategy that prioritizes brain development. Knowledge is the primary source of fulfilling different aspects of life in this modern age (Sukmayas &Sudiana, 2023). The brain-based learning method insists that a person is in the best position to learn when

taught in such a way that his mind is in the most accepting position.

It is a challenging effort to prepare pupils for work, social responsibility, and the difficulties of the 21st century, according to Saavedra and Opfer (2012). For these difficulties, students will require 21st-century abilities. Fatima (2017) asserts that whereas students frequently displayed high levels of inspiration for success, teachers infrequently exhibited encouraging behaviour towards brain-based learning. In contrast to older methods, the BBL approach emphasizes real learning above memorization. Knowledge must be appropriately organized for the brain to learn, and complex or incomplete knowledge is not retained. The brain constantly incorporates meaningful data. Because values and purposes are constantly present in learning, teachers and students should use engaging stories, metaphors, or symbols to connect facts and comprehension to retain learning (Caine & Caine, 1995).

The brain is under pressure when it must perform tasks that require it to use its designing and pattern-finding talents; to do so, it must be in a non-threatening environment. The word "flow" refers specifically to this mental process. They define flow as an experience in which a person loses himself, concentrates on what he is doing, and enjoys it. The patterns left behind by such actions persist eternally and are commonly utilized as the foundation for new theories and solutions to old ones. By setting up ideal conditions, they need to aid students in beginning to flow. Learners need assistance maintaining their growth and updating their goals by safeguarding (Jensen, 1994). The relevant literature shows that when it comes to improving student accomplishment, the Brain-Based learning

strategy outperforms the traditional method (Brodnax, 2004).

According to the BBL concept, learning can only be effective by applying real-world skills. Learning becomes more valuable when the brain supports the search for meaning and patterning (Ozden, 2008). Many words characterize the 21st century. The terms "age of knowledge," "knowledge-based economy," "globalization," "industrial revolution," and other terms with similar meanings are also used to describe the twenty-first century. The twenty-first century has been marked by several abrupt advances that have impacted various industries, including technology, communication, and information (Horoshko et al., 2021).

Every day, much progress is made in science. All individuals must acquire the skills required for this digital age to fulfil the modern world's expectations. Therefore, it is the educational system's responsibility to prepare pupils for the global demands of the twenty-first century. The 21st-century talents are an extension of earlier abilities to absorb new technologies and function in various contexts (Soha et al., 2010). Brain-based learning approaches help students acquire the skills they need to succeed in the twenty-first century. Research suggests brain-based learning improves critical thinking, creativity, problem-solving, teamwork, and communication skills. Incorporating brain-based strategies into educational practices can optimize learning experiences and better prepare students for success in the 21st century.

Statement of the Problem

Brain Based Learning is a key method used in primary, secondary and higher secondary school across the world. The world is shifting

from theory to practice in all the disciplines. There is a dire need to promote 21st century skills among students for their brighten future but the question is how to instill 21st century skills in students. So that student will be able to compete the challenges of modern world. This study intended to examine the effectiveness of Brain Based Learning approach on learning of students of 21st century skills of secondary school. Today's teachers and school are facing challenge-they must transform the traditional classroom into 21st century learning environments to develop 21st century skills among the students (Bellanca, 2010). There is no doubt; this work is anything but simple, as classrooms become laboratories for student engagement in 21st century skills. In this Research, we focus on what research tells us about how students learn 21st century skills and how teachers can effectively teach them. We use the term "21st century skills" because we believe it is currently the most widely recognized and used term internationally. Finally, there is insufficient research on Effects of Brain Based Learning on 21st Century Skills of students learning particularly at secondary level.

Research Objectives

Objectives of the study were as;

1. To investigate the effects of Brain Based Learning on academic achievement of students learning.
2. To examine the existing programs at Secondary School Level in connection with 21st century skills.

Significance of study

Educationalist, consultants and instructors may take benefits from this study by understanding the basic importance of

teachers' attitude towards brain-based learning and its influence on achievement motivation of students. A well-organized literature about brain-based learning and achievement motivation will be obtained through this study due to some reasons. Firstly, this study will provide a historical background about brain-based learning as well as achievement motivation. Secondly, this research work may correspondingly support to broaden the altered dynamics that directly impact on the teachers' attitude towards brain-based learning and may also deduce the personage's assertiveness in the direction of achievement motivation. It may support to educator in curriculum formation and administration associated assessments. This research work may improve the training of genuine education and operative complication of teaching learning process and make an appropriate outline of effective brain-based learning. It is an important study because our graduates have to compete and survive in the present era of technology and media-driven environment characterized by abundance of information. Keeping in view the ongoing rapid changes in technological tools and the ability to navigate the complex life and work environments, our educational institutions in general and universities in particular must equip graduates with 21st century skills and competencies.

In this scenario, it is the top most responsibility of teachers, educational leaders, curriculum planners, higher education commission and planning commission to equip learners with essential skills of 21st century. Hence the beneficiaries of this study include students, teachers, educational leaders, higher education commission, national curriculum revision committee and ministry of planning commissions so that they may guide higher

education to meet the current and future demands of 11 the global economy. Ultimately, our society will benefit from the findings of the study as it will highlight the essential skills needed for students to be skillful and competent in the 21stcentury.

Delimitations

Because of the time constraints, the researchers gathered information from;

- Public sector schools (Female)
- Sialkot district
- Secondary school teachers

Literature Review

Brain-based learning was initially proposed around the end of the twentieth century. This proves that if there is an engaging learning environment, everyone can learn. It encourages learning by allowing students to engage with the educational experience in a positive way (Elsayed, 2015). Brain-based learning is an instructional approach that draws upon principles of neuroscience to optimize students' learning experiences and enhance their acquisition of 21st-century skills. This section provides a detailed overview of brain-based learning in the context of its effect on students' learning of 21st-century skills at the secondary school level. Brain-based learning is grounded in the understanding that the brain is the central organ for learning and that educational practices should align with its natural functioning. By considering the brain's structure and processes, educators can design instructional strategies that capitalize on how the brain learns best. One of the fundamental principles of brain-based learning is the engagement of multiple senses. Neuroscientists suggest that stimulating multiple senses, such as sight, sound, touch,

and movement, during the learning process enhances information processing in the brain (Caine & Caine, 1991).

This principle supports the incorporation of visual aids, manipulative, music, and kinesthetic activities into lessons to activate different areas of the brain simultaneously. Learners must constantly engage in communication, problem solving, teamwork, and critical thinking in order to be productive at school, home, work, and in their free time (Jarvela & Renninger, 2014). Students must develop these abilities in order to contribute to society effectively (McLaughlin, 2008). Through cooperative learning, experiential learning, inquiry-based learning, and problem-based learning, students can learn from their practical experience and experiments through active learning (Cooperstein & Kocevar, 2004). It is connected to the expertise and experience of teachers who use cutting-edge educational techniques (Hussain, 2012).

The term "21st century skills" refers to a set of fundamental abilities that educational institutions must teach in order to get students ready for the new millennium and their role as global citizens. According to Casner and Barrington (2006), the phrase "21st century skills" refers to a structured collection of abilities that are not just important but also necessary for 21st-century learning and life. According to Bashir (2013), educators have recognized the importance of 21st century skills in today's globalized society. Though many of these competences, including creativity and teamwork, have been around for a while, this does not imply that all of these talents and abilities have been established in the twenty-first century.

In today's globalized and knowledge-driven economy, higher education is closely linked

to the economic growth and wealth of the nations. Today, using technology is a must rather than a privilege. Mobile phones, automobiles, applications, laptops, smart houses, and numerous more items that we cannot list here are just a few instances of the profusion of technology in our daily lives. Consequently, the 59% (4.54 billion) of the world's population, according to the "We Are Social - Digital 2020 April Global Statshot" report Internet users make up 49% (3.80 billion) of the total population, while 67% (5.19 billion) utilize social media. Utilize mobile devices (Kemp, 2020). This demonstrates how important technology is to daily life. The educational system is another area where technology is used. The educational system is adaptable to many societal developments. Since the goal of the educational system is to educate students for society and real-life situation (Ozan, 2013).

Higher education institutions are responsible for producing new information as well as ensuring that the next generation has the advanced knowledge and abilities necessary to thrive in the twenty-first century. Higher education elevates and advances a nation's social, scientific, economic, and technical advancement. According to Barnet (1990), higher education is now viewed as a necessary investment for the social and economic growth of any nation. Through a nation's educational system, many values, including religious, moral, and cultural values, are passed on to future generations. The expectations of society and the difficulties posed by the current global environment must be taken into consideration by higher education institutions, according to Haider (2008). Additionally, these institutions must to meet the increased expectations of college students. Information and communication technologies (ICT) are the driving force

behind the current economic system, which is a significant departure from the economy of the 20th century.

Leading nations' economies in the twenty-first century are centered on innovation, manufacturing, and the creation of commodities and services rather than just physical items (Friedman, 2007). Thus, accomplishing the goals of the new millennium depends in part on higher education. In this regard, Velez (2012) suggested that the world is still transitioning from an industrial economy to a knowledge-based economy and that developing 21st-century skills, which are essential for the economic success of this global world, is a key component. The future of higher education relies on how people respond to the significant social, moral, political, and economic issues it faces today (Rao, 2003). Zhao (2009) asserts that 21st-century knowledge and abilities that were deemed essential in the 20th century are no longer relevant. Instead, "conceptual and critical thinking" are the key 21st-century competencies. According to Wagner (2008) 20, those (educators and institutions) who fail to prepare students for the needs of the 21st century will be held liable for endangering or endangering the country. The World Conference on Higher Education (1998) recognized that, "On the eve of the new millennium of the 21st century, there is an unprecedented demand for vast diversification in higher education in the global world." This statement sums up the significance of 21st century skills in higher education in imparting and developing crucial skills and competencies in the 21st century generation. The future of the 21st century generations, who must be given the new skills and competences known as 21st century

skills, depends critically on higher education for economic and sociocultural progress.

Methods and Procedures

The study's research objectives were investigated using a quantitative research design and a survey-style methodology. The researcher selected ten percent of the population. So, one hundred and eighty-Three teachers selected from the sample through purposive sampling technique. The researcher selected two Likert scale questionnaires for investigation and distributed. The researcher visited herself for collection of data through questionnaire. The current study information was collected, arranged, organized and analyzed through the help of SPSS. Once the data collecting procedure was complete, Microsoft Excel was used to encrypt and record the information on a sheet. The statistical package for social sciences, or SPSS, was then used to import the data. As a result, the use of SPSS in the process of carrying out the data analysis met the requirements of the study. The researcher employed frequency analysis, mean score analysis, and standard deviation statistical approaches based on the requirements of the investigation.

Data Analysis and Interpretation

Table 1

Encourage pupils to pose thoughtful, critical questions during class.

Table #	Statement	SA	A	UD	SDA	DA	M	SD
1	Encourage pupils to pose thoughtful, critical questions during class.	80	100	3	0	0	4.41	0.52

Table 1 describes the statistical analysis of the statement," Encourage pupils to pose thoughtful, critical questions during class. ", statistical techniques of frequency score, mean score, standard deviation used to elaborate the idea. The respondents (80+100) show agreement to the statement whereas the respondents (0 +0) show disagreement to the statement. While the respondents (3) having undecided decision about the above-mentioned statement. The mean score and standard deviation of responses are (4.41) and (0.52) respectively. So, it can be concluded that majority of the respondents' responses that they encourage pupils to pose thoughtful, critical questions during class.

Table 2

Teachers that incorporate the students 'senses into their lessons have the best result

Table #	Statement	SA	A	UD	SDA	DA	M	SD
2	Teachers that incorporate the students 'senses into their lessons have the best result.	90	85	5	0	3	4.41	0.70

Table 2 describes the statistical analysis of the statement," Teachers that incorporate the students 'senses into their lessons have the best result. ", statistical techniques of frequency score, mean score, standard deviation used to elaborate the idea. The respondents (90+85) show agreement to the statement whereas the respondents (0 +3) show disagreement to the statement. While the respondents (5) having undecided decision about the above-mentioned statement. The mean score and standard deviation of responses are (4.41) and (0.70) respectively. So, it can be concluded that majority of the respondents' responses that Teachers that incorporate the students 'senses into their lessons have the best result.

Table 3

In classroom, Encourage novelty.

Table #	Statement	SA	A	UD	SDA	DA	M	SD
3	In classroom, Encourage novelty.	50	110	10	3	10	4.01	0.94

Table 3 describes the statistical analysis of the statement," In classroom, Encourage novelty. ", statistical techniques of frequency score, mean score, standard deviation used to elaborate the idea. The respondents (50+110) show agreement to the statement whereas the respondents (3 +10) show disagreement to the statement. While the respondents (10) having undecided decision about the above-mentioned statement. The mean score and standard deviation of responses are (4.01) and (0.94) respectively. So, it can be concluded that majority of the respondents' responses that in the classroom, they encourage novelty.

Table 4

In class, Involve the students in active learning.

Table #	Statement	SA	A	UD	SDA	DA	M	SD
4	In class, Involve the students in active learning.	50	120	3	0	10	2.89	1.51

Table 4 describes the statistical analysis of the statement," In class, Involve the students in active learning. ", statistical techniques of frequency score, mean score, standard deviation used to elaborate the idea. The respondents (50+120) show agreement to the statement whereas the respondents (0 +10) show disagreement to the statement. While the respondents (3) having undecided decision about the above-mentioned statement. The mean score and standard deviation of responses are (2.89) and (1.51) respectively. So, it can be concluded that majority of the respondents' responses that they involve the students in active learning in class.

Table 5

Motivate students to express their thoughts in class.

Table #	Statement	SA	A	UD	SDA	DA	M	SD

5	Motivate students to express their thoughts in class.	110	50	10	10	3	4.05	0.83

Table 5 describes the statistical analysis of the statement," Motivate students to express their thoughts in class. ", statistical techniques of frequency score, mean score, standard deviation used to elaborate the idea. The respondents (110+50) show agreement to the statement whereas the respondents (10 +3) show disagreement to the statement. While the respondents (10) having undecided decision about the above-mentioned statement. The mean score and standard deviation of responses are (4.05) and (0.83) respectively. So, it can be concluded that majority of the respondents' responses that they motivate students to express their thoughts in class.

Table 6

Involve the class in active listening exercises.

Table #	Statement	SA	A	UD	SDA	DA	M	SD
6	Involve the class in active listening exercises.	40	140	2	0	1	4.19	0.49

Table 7 describes the statistical analysis of the statement," Involve the class in active listening exercises. ", statistical techniques of frequency score, mean score, standard deviation used to elaborate the idea. The respondents (40+140) show agreement to the statement whereas the respondents (0 +1) show disagreement to the statement. While the respondents (2) having undecided decision about the above-mentioned statement. The mean score and standard deviation of responses are (4.19) and (0.49) respectively. So, it can be concluded that majority of the respondents' responses that they involve the class in active listening exercises.

Table 7

Encourage students to establish peer learning networks, or integrated learning through technologies.

Table #	Statement	SA	A	UD	SDA	DA	M	SD
7	Encourage students to establish peer learning networks, or integrated learning through technologies.	54	80	0	9	40	3.54	1.50

Table 8 describes the statistical analysis of the statement," Encourage students to establish peer learning networks, or integrated learning through technologies. ", statistical techniques of frequency score, mean score, standard deviation used to elaborate the idea. The respondents (54+80) show agreement to the statement whereas the respondents (9 +40) show disagreement to the statement. While the respondents (0) having undecided decision about the above-mentioned statement. The mean score and standard deviation of responses are (3.54) and (1.504) respectively. So, it can be concluded that majority of the respondents' responses that

they encourage students to establish peer learning networks, or integrated learning through technologies.

Table 8

Motivate students to collaborate on projects in class.

Table #	Statement	SA	A	UD	SDA	DA	M	SD
8	Motivate students to collaborate on projects in class.	30	53	30	20	50	2.96	1.46

Table 9 describes the statistical analysis of the statement," Motivate students to collaborate on projects in class. ", statistical techniques of frequency score, mean score, standard deviation used to elaborate the idea. The respondents (30+53) show agreement to the statement whereas the respondents (20 +50) show disagreement to the statement. While the respondents (30) having undecided decision about the above-mentioned statement. The mean score and standard deviation of responses are (2.96) and (1.46) respectively. So, it can be concluded that majority of the respondents' responses that they motivate students to collaborate on projects in class.

Findings

The findings of the current study have been drawn from the analysis of the collected data. The findings are as under;

- The study found that the statistical analysis of the statement" Encourage pupils to pose thoughtful, critical questions during class". The mean score and standard deviation of responses are (4.41) and (0.52) respectively. So, it can be concluded that majority of the respondents' responses that they encourage pupils to pose thoughtful, critical questions during class.

- The study explored that the statistical analysis of the statement," Teachers that incorporate the students 'senses into their lessons have the best result". The mean score and standard deviation of responses are (4.41) and (0.70) respectively. So, it can be concluded that majority of the respondents' responses that Teachers that incorporate the students 'senses into their lessons have the best result.

- Table 3 describes the statistical analysis of statement," In classroom, Encourage novelty". The mean score and standard deviation of responses are (4.01) and (0.94) respectively. So, it can be concluded that majority of the respondents' responses that in the classroom, they encourage novelty.

- Table 4 describes the statistical analysis of the statement, "In class, Involve the students in active learning. "The mean score and standard deviation of responses are (2.89) and (1.51) respectively. So, it can be concluded that majority of the respondents' responses that they involve the students in active learning in class.

- Table 5 describes the statistical analysis of the statement," Motivate students to express their thoughts in class. ", The mean score and standard deviation of responses are (4.05) and

(0.83) respectively. So, it can be concluded that majority of the respondents' responses that they motivate students to express their thoughts in class.

- Table 6 describes the statistical analysis of the statement," Involve the class in active listening exercises. "The mean score and standard deviation of responses are (4.19) and (0.49) respectively. So, it can be concluded that majority of the respondents' responses that they involve the class in active listening exercises.

- Table 7 describes the statistical analysis of the statement," Encourage students to establish peer learning networks, or integrated learning through technologies. ". The mean score and standard deviation of responses are (3.54) and (1.504) respectively. So, it can be concluded that majority of the respondents' responses that they encourage students to establish peer learning networks, or integrated learning through technologies.

- The study revealed that the table 9 describes the statistical analysis of the statement, "Motivate students to collaborate on projects in class". The mean score and standard deviation of responses are (2.96) and (1.46) respectively. So, it can be concluded that majority of the respondents' responses that they motivate students to collaborate on projects in class.

Discussion

This study aimed to explore the impact of brain-based learning strategies on the development of 21st century skills among secondary school students. By employing a descriptive analysis, we investigated the effectiveness of various brain-based learning methods in enhancing critical thinking, creativity, collaboration, communication, and problem-solving abilities. Through our exploration, several significant insights emerged.

Our findings reveal that the integration of brain-based learning techniques substantially influences students' 21st century skills. By fostering an interactive and participatory learning environment, brain-based methods encouraged students to engage actively with the subject matter. Techniques such as problem-based learning and collaborative group activities not only enhanced critical thinking but also promoted creative thinking and innovative solutions. The emphasis on real-world scenarios facilitated the development of practical problem-solving skills, aligning with the demands of the contemporary workforce.

One of the most noteworthy outcomes of our study was the emphasis on collaboration and communication. Brain-based learning activities, especially those involving group projects and peer discussions, significantly improved students' abilities to work effectively in teams. These collaborative experiences not only honed their communication skills but also instilled a sense of collective responsibility and mutual respect. The synergy between brain-based learning methods and the development of these interpersonal skills is a testament to the holistic nature of this educational approach.

While the positive impact of brain-based learning on 21st century skills is evident, our study also identified challenges. The adaptability of these methods within diverse classroom settings and teacher readiness to implement them emerged as key concerns. Some educators faced challenges aligning

these techniques with standardized curricula, highlighting the need for comprehensive teacher training programs that incorporate brain-based learning methodologies.

Furthermore, our findings emphasize the potential of brain-based learning to bridge educational disparities. By providing interactive, student-centered learning experiences, this approach can cater to diverse learning styles and backgrounds. This inclusivity is essential for fostering equitable educational opportunities, ensuring that all students have access to the skills necessary for success in the 21st century.

In conclusion, this study provides valuable insights into the transformative potential of brain-based learning on 21st century skills. By addressing both its benefits and challenges, our research underscores the need for a paradigm shift in educational practices. As we move forward, it is essential to prioritize teacher training, curriculum adaptation, and inclusive pedagogical approaches. Through these concerted efforts, we can pave the way for an educational landscape that nurtures not only knowledgeable individuals but also adept thinkers, communicators, and problem solvers, well-equipped for the demands of the 21st century.

Conclusion

In this study, we delved into the intricate relationship between brain-based learning strategies and the development of essential 21st century skills among secondary school students. Through a comprehensive analysis of classroom implementations and teachers' responses, our research shed light on the significant impact of brain-based learning methods on fostering critical thinking, creativity, collaboration, communication, and problem-solving abilities. Our findings

demonstrate that brain-based learning techniques provide a powerful framework for nurturing 21st century skills. The interactive, student-centered approaches facilitated a deeper engagement with the learning material, encouraging active participation and collaborative knowledge construction. Notably, the emphasis on real-world problem-solving scenarios and creative tasks enhanced students' ability to think critically and innovatively. Moreover, the emphasis on communication and collaboration within these methods contributed to the development of strong interpersonal and teamwork skills. The implications of this study for the field of education are profound. Educators, armed with the knowledge from this research, have a substantial foundation upon which to reshape their teaching methodologies. Brain-based learning, when integrated effectively, not only equips students with vital 21st century skills but also fosters a love for learning, transforming classrooms into dynamic hubs of knowledge and creativity.

It is essential to recognize that our exploration into the effects of brain-based learning on 21st century skills is just the beginning. The integration of these findings into educational policies and practices can pave the way for a transformative shift in our education systems. By embracing brain-based learning, educators can prepare students not only for the challenges of the modern world but also empower them to become adaptable, lifelong learners capable of tackling the unforeseen challenges of the future.

To sum up, this study highlights how brain-based learning approaches may significantly impact how the future generation of thinkers, innovators, and problem solvers is developed. The pursuit of improving 21st-century skills via brain-based learning is a continuous

process that might lead to a more promising and intellectually stimulating future for students throughout the globe.

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