Inquiry-Based Learning: Fostering Critical Competencies and Innovation

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Abstract-The rapid evolution of the modern world necessitates a dynamic approach to education. Traditional methods often fall short in preparing students for the complexities of the 21st century. Inquiry-Based Learning (IBL) emerges as a powerful pedagogical strategy aimed at developing critical competencies and fostering innovation. This research paper explores the historical background, core components, implementation strategies, benefits, and challenges of IBL, demonstrating its potential to revolutionize education and prepare students for future challenges.

Keywords: Inquiry-based Learning, Innovative approach, Problem solving, Foster Critical Competencies.

INTRODUCTION

"The meaning of 'knowing' has shifted from being able to remember and repeat information to being able to find and use it." (National Research Council, 2007) With the rapid pace of change in today's world and the need to constantly adapt to new and changing conditions in order to meet challenges that have never been encountered before, child enter adulthood with expectations and goals that are difficult to achieve without the critical competencies developed during the educational process. And these are now recognized as an integral set of behaviors, skills, and expertise in eight crucial domains. Focus should be placed on developing practical research skills, based education on experiments and particular allusions to everyday life in order to motivate and teach them, as these are areas that are closely related to experience and practical work. According to (Rocard, 2007), inquiry-based learning is the most effective teaching style in this field. When we discuss inquiry-based learning, we consider the following: the development of research abilities based on learners' interest and inquisitiveness; creativity; and the improvement of critical thinking and reasoning. Inquiry-based learning is student-centered, in contrast to traditional teaching methods, which helps students become increasingly independent learners. All three areas of human development cognitive, psychomotor, and affective are stimulated and reinforced by IBL because it requires careful and deep reflection, activity, and meaningful student participation.

Lay it another way; IBL encourages the development of competences, which are defined as a blend of content knowledge, abilities, and attitudes. To ensure that the next generation possesses the essential life skills needed to thrive in the modern world, education must evolve to meet 21st-century demands. These essential skills include critical thinking, effective and efficient communication, technological proficiency, and the ability to work in a flexible, productive, innovative, and responsible manner (Silva, 2008). The life skills students acquire during their education are reflected in their learning outcomes (Suto, 2013).

1.1 Inquiry-based Learning

Inquiry is the dynamic process of being open to wonder and puzzlements and coming to know and understand the world" (Galileo Educational Network, 2004).

Inquiry-based learning (IBL) is an educational approach where students take an active role in their learning by asking questions, investigating solutions, and constructing new knowledge. This method promotes deep understanding, critical thinking, creativity, and problem-solving skills. It moves away from rote memorization towards understanding concepts and applying knowledge in real-world contexts.

John Dewey (1938), a foundational figure in education theory, argued that inquiry-based learning is essential for true education. Dewey believed that education should be rooted in the experiences and interests of students, and that learning through inquiry helps students develop a deeper understanding and connect

knowledge to real-life situations. Bruner (1961) supported the idea that students learn best when they discover information for themselves. Bruner's theory of discovery learning posits that inquiry-based learning facilitates the construction of knowledge through active engagement and manipulation of the environment.

Pedaste et al. (2015) outlined the benefits of inquiry-based learning, including improved student engagement, enhanced critical thinking skills, and better retention of knowledge. They emphasized that the process of inquiry encourages students to take ownership of their learning and to develop skills necessary for lifelong learning.

"Inquiry-based learning is a process where students are involved in their learning, formulate questions, investigate widely and build new understandings, meanings, and knowledge. That knowledge is new to the students and may be used to answer a question, develop a solution, or support a position or point of view" (Justice et al., 2002).

"Inquiry-Based Learning (IBL) is a broad term encompassing various teaching methods, such as fieldwork, problem-solving activities, research projects, and hands-on experiences. These approaches encourage students to explore, investigate, and discover knowledge independently" (Hutchings, 2007).

"Unlike traditional methods with definitive answers, IBL emphasizes open-ended learning where students take the lead in shaping their educational journey" (Levy & Petrulis, 2012).

The fundamental concept in inquiry - based learning regards to a process of personal discovery by the learners. The learners or the student inquirers are guided to inquire or generate relevant questions and to come up with the appropriate answers through critical thinking. In inquiry learning learners are also shown how knowledge is generated, how it is transmitted, and how all parties including experts, teachers, parents and society contribute to a learner's knowledge. Inquiry learning teaches the learners to respect one's own interest and the interest of others (Donham, 2001).

The role of the teacher in an inquiry-based classroom is markedly different from that in a traditional classroom. Instead of delivering direct instruction, teachers assist students in generating their own questions related to the content and guide the subsequent investigation. This unconventional approach can sometimes be misunderstood. Administrators, parents, and even students may not recognize the significant effort required to plan and implement inquiry-based learning, mistakenly thinking that teachers "aren't doing anything" as students grapple with formulating questions and seeking answers. In reality, teachers who adopt an inquiry-based approach are dedicated to providing rich experiences that stimulate students' thinking and curiosity. They meticulously plan questioning sequences, manage multiple student investigations simultaneously, continuously assess each student's progress towards their solution or final product, and respond promptly to students' emerging questions and discoveries.

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1.2 Historical Perspective of Inquiry-Based Learning

Inquiry-based learning (IBL) has its roots in educational philosophies and practices that date back to ancient times. The approach has evolved through the contributions of various educational theorists and practitioners over the centuries.

1. Socratic Method

The origins of inquiry-based learning can be traced back to Socrates (470-399 BCE), who used questioning to stimulate critical thinking and illuminate ideas. This method, known as the Socratic Method, encourages students to think deeply and engage in dialogue, laying the foundation for modern IBL.

2. John Dewey's Experiential Learning

John Dewey (1938) was a pivotal figure in the development of IBL. He argued that education should be grounded in real-life experiences and that students learn best through active participation and problem-solving. Dewey's emphasis on experiential learning and reflective thinking significantly influenced the practice of IBL.

3. Jerome Bruner's Discovery Learning

Jerome Bruner (1961) further advanced the concept of IBL with his theory of discovery learning. Bruner posited that students learn more effectively when they discover information for themselves rather than simply receiving it from teachers. This approach encourages exploration and active engagement in the learning process.

4. Lev Vygotsky's Social Constructivism

Lev Vygotsky (1978) introduced the idea that social interaction plays a crucial role in cognitive development. His theory of social constructivism highlights the importance of collaborative learning and scaffolding, which are essential elements of IBL. Vygotsky's work emphasizes the role of the teacher in guiding students through the inquiry process within their Zone of Proximal Development (ZPD).

5. Joseph Schwab's Practical Inquiry

Joseph Schwab (1962) was an advocate for practical inquiry in science education. He argued that science should be taught as a dynamic and exploratory process, rather than a static body of knowledge. Schwab's ideas contributed to the development of IBL by emphasizing the importance of inquiry and investigation in the learning process.

6. The Constructivist Movement (Piaget & Papert)

The constructivist movement, led by theorists such as Jean Piaget and Seymour Papert, has also been instrumental in shaping IBL. Piaget's theory of cognitive development and Papert's work on constructionism both support the idea that learners construct knowledge through active engagement and inquiry.

8. Cognitive Apprenticeship

The cognitive apprenticeship model, proposed by Collins, Brown, and Newman (1989), aligns with IBL by emphasizing learning through guided experiences. This model involves experts demonstrating tasks and providing support as learners progressively take on more responsibility. Cognitive apprenticeship highlights the importance of context and social interaction in learning.

7. Situated Learning

Situated learning theory, proposed by Lave and Wenger (1991), posits that learning occurs through participation in authentic activities within a community of practice. This theory supports IBL by emphasizing the importance of context and real-world application in the learning process.

8. Contemporary Developments

In recent decades, research on IBL has continued to expand. Hmelo-Silver, Duncan, and Chinn (2007) discuss the effectiveness of IBL and highlight the importance of scaffolding to support student learning. Their work contributes to understanding how IBL can be effectively implemented in modern classrooms.

These theories collectively provide a strong foundation for understanding the principles and practices of inquiry-based learning, stress the importance of active, student-centered, and socially mediated learning processes.

1.3 Characteristics of inquiry-based learning approach

Inquiry-based learning (IBL) is characterized by several elements that differentiate it from traditional educational approaches. These characteristics emphasize active participation, critical thinking, and student-centered learning. IBL have the following characteristics

1. Student-Centered Learning: IBL places students at the center of the learning process. Students take an active role in their education, pursuing their interests and questions. The teacher acts as a facilitator rather than a transmitter of knowledge, guiding students through the inquiry process.
2. Question-Driven: The learning process in IBL is initiated by questions posed by students or the teacher. These questions drive the inquiry, with students exploring and investigating to find answers. This approach encourages curiosity and a deeper understanding of the subject matter.
3. Active Engagement: Students engage actively with the material through hands-on activities, experiments, and real-world problem-solving. This active engagement helps students to internalize and apply what they learn, leading to a deeper comprehension of the content.
4. Collaborative Learning: IBL often involves collaboration among students. Working in groups, students share ideas, debate, and build on each other's knowledge. This collaborative environment fosters communication skills and allows students to learn from diverse perspectives.
5. Emphasis on Critical Thinking: IBL encourages critical thinking and analytical skills. Students are challenged to evaluate information, make connections, and develop reasoned arguments.

This approach helps students to become independent thinkers and problem solvers.

6. Process-Oriented: The focus in IBL is on the learning process rather than just the final product. Students learn to appreciate the value of exploration, investigation, and reflection. The process of inquiry is iterative, with students revisiting and refining their questions and approaches as they gain new insights.
7. Integration of Multiple Disciplines: IBL often involves integrating knowledge and skills from various disciplines. This interdisciplinary approach helps students to see connections between different areas of study and apply their learning in a broader context.
8. Use of Real-World Problems: IBL frequently incorporates real-world problems and scenarios that are relevant to students' lives. This relevance makes learning more meaningful and engaging, and helps students to see the practical applications of their knowledge.
9. Assessment for Learning: Assessment in IBL is ongoing and formative, focusing on students' progress throughout the inquiry process. Teachers provide feedback that helps students to improve and develop their understanding, rather than just evaluating their final performance.
10. Reflective Practice: Reflection is a crucial component of IBL. Students are encouraged to think about their learning experiences, what they have learned, and how they have learned it. This reflective practice helps to deepen their understanding and promotes lifelong learning skills.

These characteristics collectively foster an environment where students are motivated to learn, think critically, and engage deeply with the subject matter, making IBL a powerful educational approach.

1.4 Types of Inquiry-Based Learning

Inquiry-based learning (IBL) encompasses various approaches, each differing in the level of guidance provided by the teacher and the degree of student autonomy. Here are the main types of inquiry-based learning:

Type	Description	Example	Key Points
1. Structured Inquiry	In structured inquiry, the teacher provides the students with a specific question and a detailed procedure to follow. The students then gather and analyze data to reach a conclusion.	In a science class, the teacher might ask students to determine the effect of different types of soil on plant growth and provide the steps for conducting the experiment.	Role of teacher: Provides question and procedure Student's Role :Follows given procedure Level of Autonomy :Low Focus: Develops procedural and technical skills.
2. Guided Inquiry	In guided inquiry, the teacher presents the research question, but students are responsible for designing the procedure to investigate the question. The teacher provides support and guidance as needed.	Students might be asked to explore how different types of music affect concentration. They would develop their own methods to test this hypothesis, with the teacher offering guidance on experimental design and data analysis.	Role of teacher: Provides question and guidance Student's Role : Designs procedure Level of Autonomy : Moderate Focus: Encourages experimentation and data analysis
3. Open Inquiry:	Open inquiry is the most student-driven form of inquiry-based learning. Students formulate their own research questions, design and carry out their experiments or	In a history class, students might choose to investigate a particular event or era of their interest, determine the questions they want to answer, gather sources, and present their findings.	Role of teacher: Acts as facilitator Student's Role : Formulates questions and methods Level of Autonomy : High

	investigations, and draw conclusions. The teacher acts as a facilitator, providing minimal guidance.		Focus: Fosters creativity, independence, and self-directed learning.
4. Confirmatory Inquiry:	In confirmatory inquiry, students are given a question and a known outcome. The goal is to confirm the established outcome through their own investigation. This type of inquiry helps students develop their understanding of scientific principles and processes.	Students might be given the task of confirming the relationship between temperature and the rate of chemical reactions by conducting experiments that demonstrate this principle.	Role of teacher: Provides question and expected outcome Student's Role : Confirms expected outcome Level of Autonomy : Low to Moderate Focus: Develops problem-solving, collaboration, and communication skills.

1.5 Process of Inquiry-based learning (IBL)

Inquiry-based learning (IBL) involves a dynamic and iterative process that engages students in questioning, investigating, reflecting, and constructing new knowledge. Implementing IBL in the classroom requires careful planning and a shift from traditional teaching methods to a more student-centered approach. Below are the steps involved in applying IBL in the classroom.

1. Formulating Questions and Identifying Problems

The first step in IBL is to encourage students to ask questions and identify problems that are relevant and interesting to them. Jerome Bruner (1961) emphasized the importance of curiosity and the role of discovery in learning, which begins with students formulating their own questions.

Foster a classroom environment that values curiosity, questioning, and critical thinking. (Piaget, 1970) and encourage students to ask questions and explore their interests.

2. Planning and Designing Investigations

Once questions are identified, students plan and design investigations to explore their questions. Edelson, Gordin, and Pea (1999) argue that this step involves selecting appropriate methods, gathering resources, and planning how to collect and analyze data.

3. Conducting Investigations

Students then conduct their investigations, which involves data collection, experimentation, and observation. Hmelo-Silver (2004) highlights that this phase requires active engagement and hands-on activities, allowing students to interact directly with the material and phenomena they are studying.

4. Analyzing and Interpreting Data

After collecting data, students analyze and interpret their findings. Krajcik, McNeill, and Reiser (2008) discussed that this step involves critical thinking and reasoning, as students make sense of their data and draw conclusions based on evidence.

5. Reflecting and Communicating Findings

Reflection and communication are crucial components of IBL. Donald Schon (1983) emphasized the importance of reflective practice in learning. Students reflect on their inquiry process, evaluate their findings, and communicate their results to others, which reinforces their understanding and allows for feedback and further inquiry.

6. Applying New Knowledge

Finally, students apply their new knowledge to different contexts or further inquiries. Barron and Darling-Hammond (2008) explained that this step helps solidify learning and promotes the transfer of skills and knowledge to real-world situations, encouraging continuous learning and adaptation.

In their 2002 study, Justice et al. describe the process of Inquiry-Based Learning (IBL) as a student-centered, active learning approach that emphasizes critical thinking and problem-solving. Their model outlines several key stages in the inquiry process:

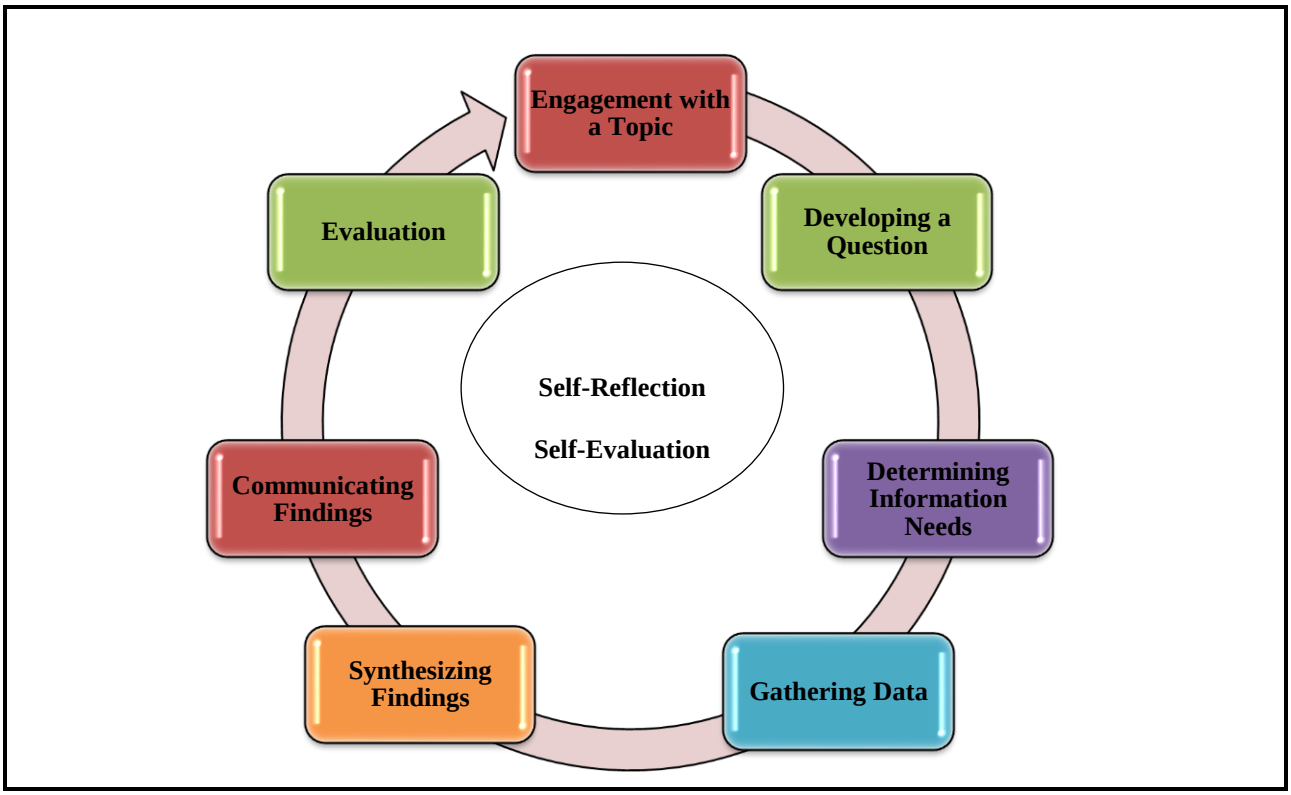

Figure: 1-Inquiry-based learning process (Justice et al., 2002)

Justice et al., (2002) outline a cyclical model of inquiry-based learning (IBL) that involves several key stages:

1. Engagement with a Topic: Students begin by becoming interested in a particular subject or area. This initial spark of curiosity is crucial for motivating further exploration.
2. Developing a Question: Based on their engagement, students formulate a specific question or problem they want to investigate. This question should be focused and open-ended to encourage exploration.
3. Determining Information Needs: Once a question is established, students identify the information required to answer it. This stage involves critical thinking and research skills as students determine relevant sources and data.
4. Gathering Data: Students actively collect data through various methods such as experiments, observations, interviews, or literature reviews. This stage emphasizes hands-on learning and data collection skills.
5. Synthesizing Findings: Students analyze the collected data to identify patterns, trends, or relationships. This stage involves critical thinking and interpretation of information.
6. Communicating Findings: Students share their findings with others through presentations, reports, or other forms of communication. This stage develops communication and presentation skills.
7. Evaluation: Students reflect on the inquiry process, assessing their learning and the effectiveness of their methods. This stage promotes metacognition and continuous improvement.

Importantly, Justice et al. emphasize that this process is cyclical. The findings from one inquiry can lead to new questions and further exploration, creating a continuous learning cycle. This model provides a clear framework for implementing IBL in the classroom, emphasizing student autonomy, critical thinking, and active learning.

Justice et al.'s Emphasis on Key Aspects

Student Autonomy: A trait of Justice et al.'s model is the emphasis on student autonomy. Students take charge of their learning, making decisions about what and how to investigate.

Teacher as Facilitator: Teachers guide and support students without directing their inquiry. This role helps

students develop independence and confidence in their abilities.

Collaborative Learning: Collaboration among students is encouraged, promoting the exchange of ideas and collective problem-solving.

Iterative Process: The inquiry process is iterative, with students revisiting and refining their questions and methods as they progress.

By following this process, Justice et al. focus that students develop essential skills for the 21st century, including critical thinking, problem-solving, collaboration, and lifelong learning habits. This model underscores the transformative potential of IBL in creating engaged, reflective, and capable learners.

1.6 Benefits of Inquiry-Based Learning

Inquiry-based learning (IBL) offers numerous benefits. Below are the benefits of inquiry-based Learning supported by various authors' findings:

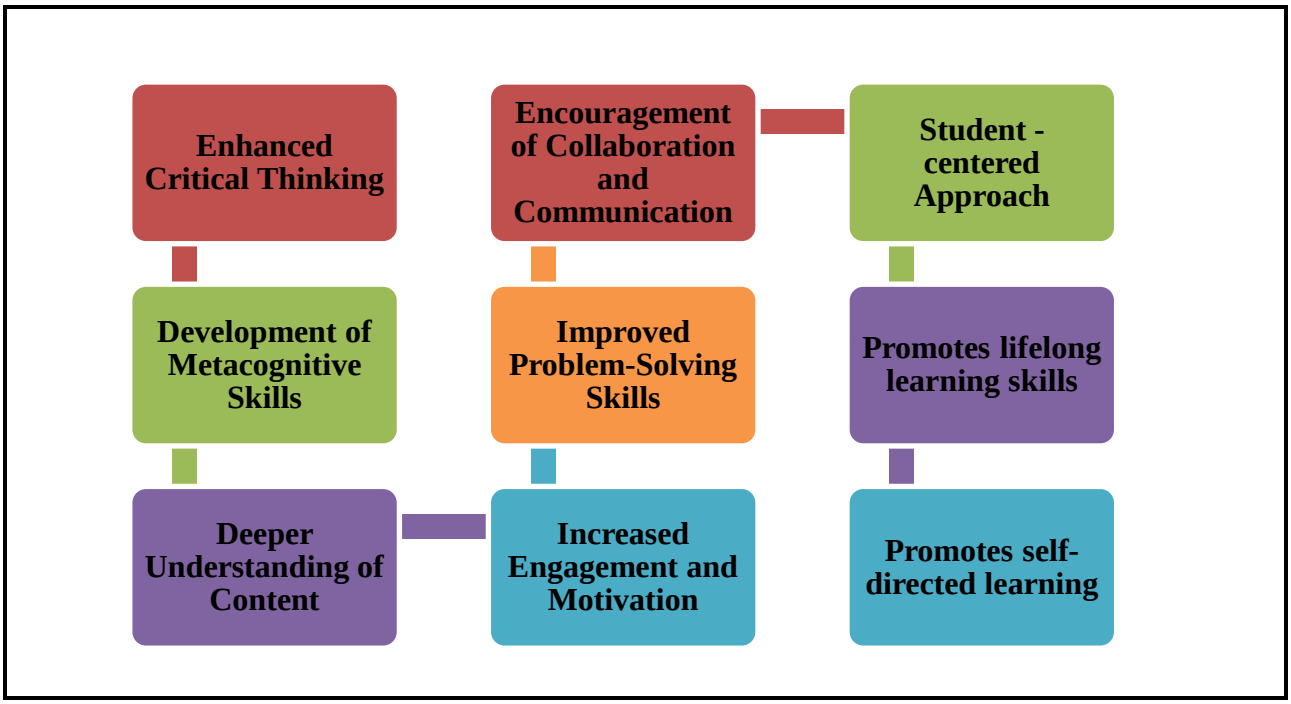

Figure-1: Benefits of Inquiry-Based Learning

IBl enhances student engagement by making learning more interactive and student-centered. When students are involved in formulating questions and exploring answers, they become more motivated and invested in their learning and developing scientific inquiry skills (Hmelo-Silver et al., 2007). Inquiry-based learning helps develop critical thinking skills and students engage in higher-order thinking processes as they analyze, synthesize, and evaluate information to answer their questions and solve problems (Goldston et al. 2010; Liu et al., 2014). It leads to a deeper understanding of content. When students actively participate in the learning process, they construct knowledge more effectively and understand the material at a more profound level (Edelson et al., 1999). Bell et al., 2010 emphasize that IBL improves collaboration and communication skills. As students work together to explore questions and share findings, they develop essential social and communication skills. IBL promotes lifelong learning skills. IBL encourages independent learning. Students learn to ask questions, seek out information, and explore answers independently, which fosters self-directed learning and intellectual autonomy (Kuhn et al., 2000). Barron & Darling-Hammond, 2008) IBL prepares students for real-world problem-solving by engaging them in authentic tasks that mirror real-life challenges. This practical approach helps students develop the skills needed to tackle problems they will encounter in their personal and professional lives. Lazonder & Harmsen, 2016) exposed that IBL enhances metacognitive skills. As students engage in inquiry, they develop the ability to plan, monitor, and evaluate their own learning processes, leading to improved self-regulation and

cognitive control. Han et al. (2020) found significantly higher critical thinking abilities among students exposed to IBL compared to traditional methods. IBL cultivates innovative thinking and problem-solving by presenting students with real-world challenges. Gu et al. (2015) report increased academic self-efficacy, conflict resolution, and risk-taking among IBL students. Marks (2013) underscores IBL's role in developing both content mastery and "habits of mind," essential for problem-solving. Lee et al. (2012) found that IBL enhanced students' research skills and information literacy. IBL promotes self-directed learning, encouraging students to monitor and regulate their cognitive processes. Zimmerman (2002) highlights the role of self-regulation in academic achievement, which is fostered through IBL. Hmelo-Silver, 2004; Exline, 2004 emphasizes that IBL's focus on critical thinking, problem-solving, and communication. IBL's role in developing problem-solving methods and disciplinary knowledge simultaneously.

CONCLUSION

Inquiry-Based Learning (IBL) emerges as a transformative pedagogical approach that aligns seamlessly with the demands of the 21st century. By prioritizing student autonomy, critical thinking, and real-world problem-solving, IBL cultivates a generation equipped with the essential life skills to thrive in an increasingly complex world. Its historical roots, coupled with contemporary research, underscore its efficacy in fostering deep learning, engagement, and intellectual independence. As educators seek to empower students to become lifelong learners and active contributors to society, IBL stands as a beacon, illuminating a path toward a more meaningful and effective education.

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