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PROJECT-BASED LEARNING

ENGAGING STUDENTS THROUGH REAL-WORLD CHALLENGES

Dr. Jyoti Tiwari Dr. Karthikeyan P Kriti Guleria



Project-Based Learning:

Engaging Students Through Real-World Challenges

Editors

Dr. Jyoti Tiwari
Assistant Professor (Grade-II)
at AIBAS, Amity University
Noida, Uttar Pradesh

Dr. Karthikeyan P
Assistant Professor (Grade-II)
Amity Institute of Education, Amity University
Noida, Uttar Pradesh

Kriti Guleria
Assistant Professor
Army Institute of Education
Greater Noida, Uttar Pradesh

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Project-Based Learning: Engaging Students Through Real-World Challenges © Editor
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Preface

Education today demands innovative approaches that engage students, foster critical thinking, and equip them with skills relevant to the real world. Project-Based Learning (PBL) has emerged as a transformative pedagogy that not only enhances knowledge acquisition but also nurtures problem-solving, collaboration, and inquiry-driven learning. The book Project-Based Learning: Engaging Students Through Real-World Challenges is a comprehensive compilation of research, insights, and practical strategies that aim to guide educators in implementing PBL effectively across diverse academic disciplines.

This book has been meticulously curated to provide a deep understanding of PBL, its theoretical foundations, key components, and best practices. It is structured into multiple chapters contributed by esteemed educators and researchers, covering a wide spectrum of topics essential for effective PBL implementation. The initial chapters, Introduction to Project-Based Learning by Priyadharsini.V and Introduction to Project-Based Learning by Dr. Pooja Sharma, lay the groundwork by defining PBL and highlighting its significance in contemporary education. Dr. Jyoti Tiwari further delves into Theoretical Underpinnings of Project-Based Learning, offering a research-based perspective on its principles.

As educators navigate the complexities of designing real-world challenges, Key Elements of Effective Project-Based Learning (PBL) by Dr. Jugnu Khatter Bhatia and Project-Based Learning in Designing Real-World Challenges by Dr. Anjana Agarwal provide essential guidance. Curriculum alignment, a crucial aspect of PBL, is addressed in Aligning Project-Based Learning with Curriculum Standards by Dr. Kiran Bala, ensuring that educators can integrate PBL seamlessly into their teaching frameworks.

Inquiry and question formulation play a pivotal role in PBL, as elaborated in The Role of Inquiry in Project-Based Learning by Dr. Roma Singh and Crafting Driving Questions by Pranati Priyadarshini. Additionally, backward design, a key instructional strategy, is discussed by Prof. (Dr.) Tania Gupta and Ruchira Verma in Backward Design for Project-Based Learning.

Collaboration and inclusivity are central to successful PBL implementation. Collaborative Learning and Teamwork in Project-Based Learning by Dr. Carlus Toppo, Addressing Diverse Learners in Project-Based Learning by Dr. Alka Gaur, and Scaffolding Student Learning by Dr. Savita Gupta explore strategies to create inclusive and supportive learning environments. Given the growing role of technology in education, Integrating Technology in Project-Based Learning by Dr. Parthiban G highlights how digital tools can enhance PBL experiences.

Assessment is another critical component, covered in Summative Assessment of Project-Based Learning by Km. Garima and Bharti Sharma and Peer and Self-Assessment in Project-Based Learning by Sangeetha Muruganandham. Additionally, Documenting and Showcasing Student Learning by Kriti Guleria provides valuable insights into capturing and celebrating student achievements.

The book also explores PBL's application across various disciplines, including STEM, humanities, and interdisciplinary studies. PBL in STEM Education by Dr. P. Karthikeyan and Project-Based Learning in Humanities and Social Sciences by Mansi Sharma and Dr. Sangeeta Solanki illustrate subject-specific implementations, while Interdisciplinary Projects: Connecting Subjects through PBL by Masooda Haseeb emphasizes cross-curricular connections.

Furthermore, An Analytical Study of Community Partnerships in Project-Based Learning by Dr. Suman Tripathi examines the role of external collaborations in enriching student experiences. Addressing Diverse Learners in PBL by Girish Chandra Behera further explores strategies for inclusion and equity in PBL environments. The book also addresses practical challenges and solutions in Challenges and Solutions in Project-Based Learning Implementation by SaubiaNeyazi and explores PBL in modern learning environments in Project-Based Learning in the Online and Hybrid Classroom by Mohd Aquib Shah.

As editors, we extend our gratitude to all contributors for their scholarly work and dedication to advancing student-centred learning. We hope this book serves as a valuable resource for educators, researchers, and policymakers striving to make learning more engaging, meaningful, and impactful.

Editors

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CHAPTER- 8

Backward Design for Project-Based Learning

[1]Prof. (Dr.) Tania Gupta and [2]Ruchira Verma

Abstract

Backward design, a strategic educational framework, aligns instructional goals, assessments, and learning activities to foster meaningful and deep learning. When integrated with project-based learning (PBL), it transforms traditional instruction into dynamic and student-centered experiences. This chapter explores the application of backward design to PBL, emphasizing the alignment of desired outcomes, assessment methods, and instructional strategies. Detailed guidelines, diagrams, and examples elucidate how educators can implement this approach to craft impactful learning experiences. The chapter also discusses challenges and solutions, providing practical tools and insights for educators to enhance PBL through backward design.

Keywords: *Backward Design, Project-Based Learning, Instructional Strategies, Assessment Alignment, Student-Centered Learning.*

Introduction

Education has evolved significantly over the years, and one of the notable shifts is from traditional learning methods to more innovative approaches like project-based learning (PBL). Both methods aim to facilitate learning, but they differ fundamentally in their approach, focus, and outcomes.

Traditional Learning

Traditional learning is rooted in a structured, teacher-centric model where the instructor plays a pivotal role in imparting knowledge. This approach typically relies on lectures, textbooks, and standardized assessments to measure student understanding.

[1]Dean, School of Education and Dean, School of Humanities, Director IQAC, K.R Mangalam University, Gurugram, Haryana.
[2]Principal, Lotus Petal Senior Secondary School, (Lotus Petal Foundation), Gurugram, Haryana.

In traditional learning:

- **Teacher-Centric:** The teacher is the primary source of knowledge, and students passively receive information.
- **Focus on Content:** The emphasis is on covering a predefined syllabus, often segmented into subjects with limited integration across disciplines.
- **Assessment Methods:** Standardized tests, quizzes, and exams are the main tools for evaluating student performance, prioritizing rote memorization and theoretical understanding.
- **Learning Environment:** The classroom setup is often rigid, with limited interaction or collaboration among students.
- **Real-World Relevance:** The connection to real-world applications is minimal, and learning is often abstract, with little opportunity for practical application during the learning process.

Project-Based Learning

Project-based learning (PBL), in contrast, is a learner-centric approach where students actively engage in exploring and solving real-world problems. It is experiential and inquiry-driven, emphasizing collaboration, critical thinking, and creativity.

PBL originated in the 1960s in Canada. Distinguishing characteristics of PBL include a driving question rooted in real-world problems and an emphasis on acquiring new knowledge through projects, rather than applying previously learned concepts **(Gay, 2022).**

In PBL:

- **Student-Centric:** Students take the lead in their learning journey, guided by teachers who act as facilitators rather than sole providers of knowledge.
- **Focus on Process and Application:** Learning revolves around projects that integrate multiple disciplines and require students to apply theoretical knowledge to practical scenarios.
- **Assessment Methods:** Evaluation in PBL is multifaceted, including presentations, portfolios, peer reviews, and reflective journals, which assess understanding, skills, and the ability to apply knowledge creatively.
- **Collaborative Environment:** Students work in teams, fostering communication and teamwork skills while solving complex, open-ended problems.
- **Real-World Relevance:** PBL connects classroom learning to real-life situations, preparing students to address contemporary challenges and think critically about societal issues.

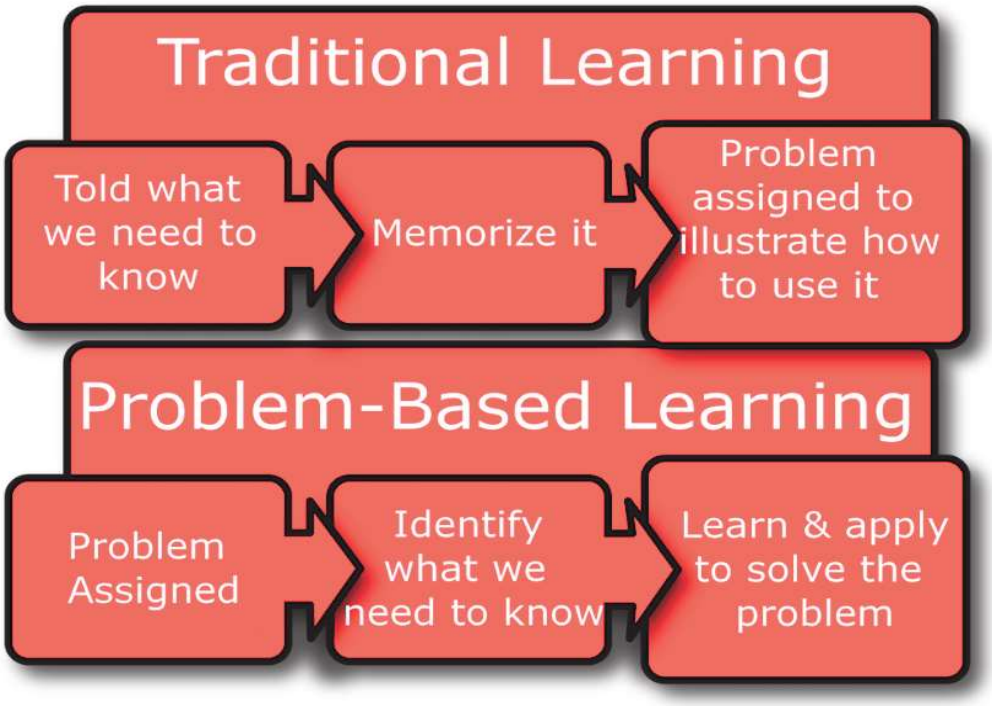


Figure- 1 Traditional Learning versus Problem-Based Learning

Benefits of PBL

Enhanced Engagement and Attitudes:

- Students enjoy working on real-life applications and group activities.
- PBL can shift students' perceptions of mathematics, fostering a growth mindset and increased interest in STEM fields.

Improved Achievement:

- Research indicates that students perform better in PBL settings compared to traditional classrooms.
- PBL benefits both high-achieving and struggling learners by allowing personalized pacing.

Skill Development:

- Students develop critical 21st-century skills, such as data literacy, public speaking, and collaboration.

Challenges in Implementing PBL

Time Constraints:

- PBL requires extensive planning and classroom time compared to traditional methods.

Misapplication of PBL:

- PBL is often confused with Problem-Based Learning (ProbBL), which lacks components like driving questions and real-world applications.

Professional Development:

- Teachers need proper training and support to facilitate PBL effectively (Gay, 2022).

Backward Design

Backward design is an instructional framework Wiggins and McTighe (2005) developed that begins with the end in mind. Rather than starting with activities or textbooks, educators identify desired learning outcomes, determine acceptable evidence of achievement, and then plan instructional activities. This method emphasizes starting with clear learning or research outcomes and working backward to design activities and assessments. When combined with project-based learning (PBL), which focuses on real-world, student-driven projects, backward design ensures that every component of the project aligns with educational objectives.



Figure- 2 Working Philosophy of Backward Design

The Principles of Backward Design

The backward design consists of three stages:

1. **Identify Desired Results**
    - Define what students should understand and be able to do.
    - Prioritize learning goals using Bloom's taxonomy.
    - Frame learning outcomes as essential questions and enduring understandings.

2. **Determine Acceptable Evidence**
    - Specify how student learning will be assessed.
    - Use performance tasks, rubrics, and formative assessments to gauge progress.
3. **Plan Learning Experiences and Instruction**
    - Design activities that develop the skills and knowledge needed to achieve the desired outcomes.
    - Ensure alignment between goals, assessments, and instruction.

According to Whitehouse (2014), this process is iterative rather than linear. As assessment questions and activities are developed, they may highlight ambiguities or gaps in learning outcomes that need refinement.

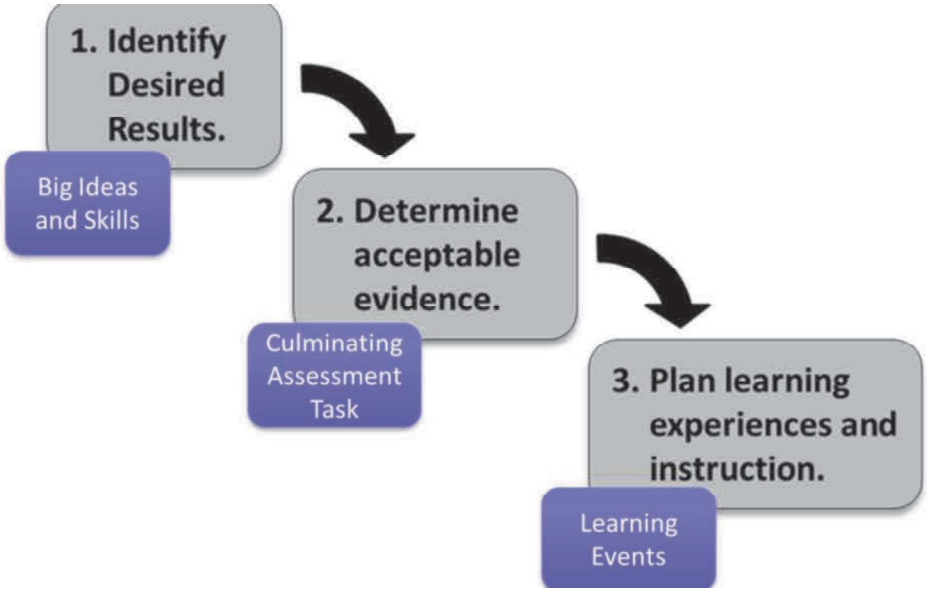


Figure- 3 Backward Design Framework for PBL

Integrating Backward Design with PBL

In PBL, students engage in extended projects that address complex questions, problems, or challenges. Incorporating backward design ensures these projects:

- **Align with Learning Goals:** Each project component directly supports learning objectives.
- **Include Rigorous Assessment:** Assessments capture student understanding and skills.

- **Promote Deep Engagement:** Activities encourage inquiry, collaboration, and critical thinking.

Step-By-Step Guide to Backward Design in PBL

Step 1: Identify Desired Results/Learning Outcomes

- **Define Core Standards:** Identify curriculum standards or competencies relevant to the project.
- **Craft Essential Questions:** Pose open-ended questions that drive inquiry.
    - Example: How can renewable energy solutions address global environmental challenges?
- **Determine Enduring Understandings:** Specify the big ideas students should retain.

Question: What should students be able to do or understand after completing a course or unit?

Example of Learning Goals
Students will understand the principles of renewable energy.
Students will develop skills in collaborative problem-solving.

Step 2: Determine Acceptable Evidence

- **Design Performance Tasks**
    - Example: Students design and present a prototype of a renewable energy solution.
- **Develop Rubrics**
    - Example: A rubric assessing technical accuracy, creativity, and presentation skills.
- **Include Formative Assessments**
    - Quizzes, journals, peer reviews, and checkpoints throughout the project.

Table -1 Sample Assessment Framework

Assessment Type	Purpose	Example
Formative	Monitor ongoing progress	Peer feedback on drafts
Summative	Evaluate final achievement	Prototype presentation
Reflective	Encourage self-assessment	Learning journal

Step 3: Plan Learning Experiences and Instruction

- **Structure the Project**
    - Define stages: introduction, research, creation, and presentation.
- **Incorporate Scaffolding**
    - Provide resources, mini-lessons, and coaching to support student learning.
- **Facilitate Collaboration**
    - Use group roles and collaborative tools.

Practical Implementation of Backward Design In PBL: Literature Review

Dolan and Collins (2015) identified four critical strategies for improving teaching practices, with Backward Design being one of the most effective. By addressing how people learn, this study highlights how intentional design, based on evidence, can enhance both teaching effectiveness and student engagement. The authors advocate backward design to bring clarity and coherence to curriculum development. The study reinforces the importance of focusing on outcomes and provides evidence for Backward Design as a universal strategy to enhance teaching practices across various fields.

Research shows that students engaged in PBL outperform their peers on traditional measures of academic achievement. The focus on problem-solving and application of knowledge helps students retain information and apply it effectively in new situations. **Baines et al. (2021a)** in their study highlight how PBL activities that integrate interdisciplinary content allow students to connect abstract concepts to practical applications. They suggest that PBL's inquiry-based structure aligns well with deeper learning goals, which include mastery of content and the ability to apply knowledge in different contexts.

Duke et al. (2021) demonstrate how PBL can improve literacy and content knowledge by embedding academic objectives in meaningful civic engagement projects. They emphasize that PBL tasks often simulate professional or civic roles, such as solving local environmental issues or developing proposals for community improvement. **Krajcik et al. (2021)** report that PBL encourages students to develop empathy and interpersonal skills by engaging in projects rooted in community issues or environmental concerns. They describe how PBL enables students to revisit core disciplinary ideas in multiple contexts, leading to a better understanding of interconnected concepts. **Saavedra et al. (2021)** discuss how students in PBL settings demonstrate greater resilience, teamwork, and emotional intelligence due to the real-world relevance of their projects. They found that the authenticity of PBL tasks motivates students to engage deeply with the material and see the value of their learning in everyday life (cited in **Tierney, Urban and Olabuenaga, 2021**).

Chaisa and Chinokul (2021) in their study utilized the Backward Design (BD) framework in conjunction with a citizenship theme to enhance reading comprehension and social responsibility among 10th-grade Thai students. The BD approach emphasizes identifying desired outcomes first, followed by designing assessments and instructional plans to achieve those goals effectively.The study incorporated themes like rights and responsibilities, social justice, and environmental well-being to create meaningful content aligned with students' real-world contexts, fostering both linguistic and civic skills. Results showed significant improvements in all aspects of reading comprehension, including literal understanding, inference, evaluation, and personal response. The students demonstrated a deeper engagement with texts due to the meaningful and relatable content. Using the citizenship theme, the instruction enhanced students' awareness and actions regarding democratic rights, community participation, and respect for diversity, with the highest improvement observed in exercising democratic responsibilities. Students reported high levels of engagement, finding the citizenship themes meaningful and tasks enjoyable. The study highlighted the role of thematic and well-structured content in motivating learners. Most students expressed positive opinions about the instructional approach, appreciating its relevance, group activities, and opportunities for critical thinking and creativity.

Studies by **Hodaeian and Biria (2015)** and **Yurtseven and Altun (2016)** confirmed the positive impact of BD on language learning. Specifically, BD improved Iranian EFL learners' reading comprehension and increased student motivation in learning English. **UNESCO (2015)** emphasized global citizenship education (GCED), focusing on cognitive, socio-emotional, and behavioural domains to cultivate socially responsible individuals. **Robles De Melendez et al. (2000)** highlighted that good citizenship includes awareness of civic rights and responsibilities, as well as demonstrating social responsibility through actions. Research on Thai civic curricula, such as **Pitiyanuwat and Sujiva (2001),** suggested integrating global and local citizenship themes in education to develop learners' understanding of their roles in society. **Grabe (2008, 2014)** defined reading comprehension as a complex process involving linguistic knowledge, strategic processing, and the ability to relate textual meaning to background knowledge. He highlighted the increasing need for strong reading skills in a globalized and information-centric era. **Nuttall (2005)** provided a taxonomy for levels of reading comprehension, including literal understanding, inference, evaluation, and personal response, which served as a framework for assessing comprehension in the study. **Stoller and Grabe (2017)** advocated for thematic instruction, arguing that relevant themes improve student engagement and language acquisition by linking lessons to real-life contexts. Themes like citizenship education provide opportunities for language teachers to simultaneously enhance language skills and civic awareness. **Afflerbach and Harrison (2017)** described the relationship between engagement and motivation, explaining how meaningful content and well-structured activities can transform reluctant learners into motivated readers.

Lee (2012) found that BD classes fostered higher levels of engagement and eagerness to participate in tasks, supporting the study's observations about student involvement. **Chuanpongpanich (2012) and Chobklang (2013)** demonstrated BD's effectiveness in improving English reading and writing skills, as well as listening and speaking abilities in Thai secondary students. **Jozwik et al. (2017)** successfully employed BD to design service-learning projects, emphasizing civic engagement and social responsibility, similar to the study's objectives.

Project-Based Learning (PBL) is an innovative pedagogical approach that helps students develop mathematical knowledge and skills by engaging them in meaningful, real-world problem-solving activities. PBL encourages students to explore mathematical concepts in context, which deepens their understanding. Instead of memorizing formulas, students learn to apply mathematics to solve real-world problems, making learning more relevant and lasting **(Gay, 2022). Boaler (2016)** found that students in inquiry-based mathematics classrooms achieved better problem-solving skills and higher test scores. **Capraro et al. (2016)** reported that PBL increased engagement and improved learning outcomes, particularly for students who struggle with traditional teaching methods.

Graff (2011) and **Reynolds and Kearns (2017)** found that applying backward design in education enhances course coherence, rigour, and relevance. This framework is particularly suited for service-learning, as it ensures that projects meet both community needs and academic goals. When applied to service-learning, backward design can enhance the integration of academic content with practical applications. For instance, **Baldwin, Buchanan, and Rudisill (2007)** demonstrated how backward-designed service-learning projects could foster critical reflection among preservice teachers. Similarly, **Santos, Ruppar, and Jeans (2012)** observed that service-learning enhanced students' awareness of cultural diversity and their ability to address complex social issues. Reflective practices are a key component of service-learning, enabling students to connect their experiences with theoretical concepts. **Dray and Wisneski (2011)** emphasized the role of mindful reflection in developing culturally responsive teaching practices, while **Cone (2012)** highlighted how reflection helps preservice teachers understand the characteristics of effective teaching in diverse classrooms. Reflective practices also facilitate critical self-awareness, enabling students to identify and address their biases (**Lin & Bates, 2015)**.

The application of backward design in service-learning has also been linked to the development of agency among preservice teachers. **Minbiole (2016)** and **Michael and Libarkin (2016)** noted that backward design fosters student empowerment by emphasizing clear objectives and actionable outcomes. Preservice teachers who engage in backward-designed service-learning projects report increased confidence in teaching diverse learners, enhanced problem-solving skills, and a stronger sense of civic engagement **(Lake & Jones, 2008).**However, challenges remain in implementing service-learning projects. For instance, logistical issues, such as resource availability and variability in student engagement, can hinder project effectiveness **(Tinker, Hannah, & Tinkler, 2016).** Additionally, the

variability in students' reflective practices suggests the need for structured guidance and feedback during the reflection process **(Tomlinson & McTighe, 2006).**

The study by **Gombu et al. (2022)** investigated the effectiveness of using backward design lesson planning in teaching and learning physics in Bhutanese schools. Backward design, also known as Understanding by Design (UbD), emphasizes starting with the desired learning outcomes, determining acceptable evidence for those outcomes, and planning instructional activities to achieve them. However, they noted limited evidence of learning transfer in practical applications, suggesting that curricular content and textbook design may limit the ability to connect classroom learning to real-life contexts. Similarly, studies by **Kulla-Abbott (2007)** and **Kelting-Gibson (2003)** demonstrated significant increases in students' achievement scores when lessons were planned using this approach. Backward design boosts teacher confidence by providing clarity on learning goals and structured lesson plans **(Davidovitch, 2013; Wiggins & McTighe, 2005).** Teachers with well-prepared plans are more effective and organized in delivering lessons **(Broughton et al., 2002).**However, challenges include the time-intensive nature of planning, limited teacher competencies in designing essential questions and assessments, and difficulties in addressing abstract topics **(Song, 2008; Herro, 2018).**

Assessment plays a crucial role in backward design by providing evidence of students' understanding and progress. While formative assessments like quizzes, discussions, and problem-solving tasks are widely used, the study highlights the need for a variety of assessment tools to address different learning needs **(Black et al., 2003; Whitehouse, 2014).**

Millery, Hall, Eisman and Murrman(2014) explored the use of Backward Design principles in public health education, particularly for online and hybrid learning environments. They asserted that starting with clear goals and competencies leads to better alignment of teaching strategies, assessments, and learning outcomes. Innovative instructional technologies, combined with Backward Design, were shown to improve learner engagement and program effectiveness, making this approach especially relevant for meeting diverse training needs in public health. This study demonstrates how Backward Design is adaptable to online and hybrid contexts, highlighting its potential to address specific competencies in professional fields like public health.

Example Project on Backward Design: Renewable Energy Challenge

Project Overview: Students explore renewable energy solutions and design a prototype to address a specific environmental issue.

1. **Stage 1: Identify Desired Results**
    - **Essential Question:** How can technology solve environmental problems?
    - **Learning Outcomes:**
        - Understand energy principles.

- Develop research and presentation skills.

2. **Stage 2: Determine Acceptable Evidence**
    - **Performance Task:** Prototype presentation and technical report.
    - **Rubric Criteria:** Innovation, feasibility, teamwork, and communication.
3. **Stage 3: Plan Learning Experiences**
    - Activities:
        - Research energy sources.
        - Conduct experiments on energy efficiency.
        - Collaborate to design and test prototypes.

Reflection and Adaptation

- Collect student feedback on the project experience.
- Adjust future projects based on reflections and outcomes.

Challenges and Solutions

- **Challenge:** Balancing structure with student autonomy.
    - **Solution:** Provide clear guidelines while allowing flexibility.
- **Challenge:** Aligning PBL with standards.
    - **Solution:** Map project goals to curriculum standards.

Benefits of Backward Design In PBL

Backward Design, as a planning framework, enhances the effectiveness of Project-Based Learning (PBL) by ensuring clarity, depth, and engagement in educational experiences.

- **Enhanced Clarity:** Backward Design begins with the end in mind, focusing first on the desired learning outcomes, followed by designing assessments to measure those outcomes, and finally planning activities that align with both. This approach ensures that every component of the PBL experience supports the overall learning objectives. Teachers gain clarity in structuring lessons, ensuring that students stay on track to meet learning objectives. Students benefit from a clear understanding of expectations, as they know how their work will be assessed and how it connects to the overall goals.

- **Deeper Learning**: Backward Design emphasizes "enduring understandings" — the big ideas or concepts that have long-term value beyond the classroom. By prioritizing these overarching principles, students engage in learning that is meaningful and transferable to real-world contexts. Teachers can guide students toward exploring deeper connections rather than focusing on superficial tasks. Students develop critical thinking skills and learn to apply their knowledge across various contexts, making their learning more durable and meaningful.
- **Increased Engagement**: Backward Design encourages teachers to create student-driven projects that align with their interests and real-world problems. This autonomy fosters intrinsic motivation and engagement, as students feel a sense of ownership over their learning. Teachers can leverage student interests to design authentic and meaningful projects. Students are more motivated to participate and persist in tasks because the projects are relevant to their lives and futures. Additionally, the sense of accomplishment from completing a meaningful project builds confidence and enthusiasm for learning.

Conclusion

Backward Design is a transformative planning framework that greatly enhances the effectiveness of Project-Based Learning (PBL) by aligning goals, assessments, and activities in a coherent and purposeful way. In conclusion, the integration of Backward Design in PBL is a game-changer for both students and educators. It bridges the gap between academic standards and real-world relevance, ensuring that projects are meaningful, engaging, and outcome-driven. By fostering clarity, deeper learning, and increased student engagement, Backward Design transforms PBL into an educational experience that not only achieves curriculum objectives but also prepares students for lifelong learning and success in an ever-changing world. As educational practices continue to evolve, the combination of Backward Design and PBL stands out as a powerful strategy to meet the challenges of modern education and cultivate learners who are prepared to thrive in the 21st century.

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Dr. Jyoti Tiwari

Dr. Jyoti Tiwari is an Assistant Professor (Grade II) at Amity Institute of Behavioural and Allied Sciences, Amity University, NOIDA. She holds an MA in Political Science and an MEd from the University of Rajasthan, where she also earned her PhD in Education in 2017. She has qualified UGC NET and SET (Rajasthan) in Education Subject. With over 11 years of experience in teacher education, she has edited four books, five National Seminar Proceedings, one Multidisciplinary Journal, one magazine and contributed over 30 chapters to various publications. Dr. Tiwari has presented several research papers at national and international conferences. She has received prestigious awards, including the **Utkrastha Shikshak Samman** and **Shiksha Bhushan Award** from Tribhuvan University, Nepal, in 2024 and 2023, respectively. She was also honoured with the **Shakti Vandan Samman** (2024) and **Shiksha Ratan Award** (2023) for her contributions to education. Her research focuses on curriculum analysis and inclusive education, making significant contributions to the academic community.



Dr. Karthikeyan P

Dr. Karthikeyan P is an Assistant Professor (Grade II) at the Amity Institute of Education, Amity University, Noida, with a Ph.D. in Education and master's degrees in Mathematics, Education, Education Management, and Psychology. A UGC-NET qualified educator, he has 14 years of teaching experience in teacher education. His core areas include mathematics pedagogy, educational psychology, assessment, and educational technology. He has published in UGC CARE-listed and peer-reviewed journals, co-authored a book on child rights, and contributed chapters on AI in education, professional development, and HRD. Dr. Karthikeyan has presented papers at national and international conferences, served as a guest lecturer, and earned certifications in AI and educational tech. He co-convened an ICSSR-sponsored international conference, led national webinars, and organized workshops. Actively involved in academic leadership, he contributes to faculty development, indigenous knowledge promotion, and employability skill enhancement programs, making significant strides in both teaching and research.



Ms. Kriti Guleria

Ms. Kriti Guleria is an Assistant Professor at the Army Institute of Education, Greater Noida, affiliated with GGSIP University since February 2016. With 2.5 yrs of school teaching experience and 12 yrs of teacher education she began her career as a PRT and taught in various Army Public Schools. She holds an M.Com. from AMU, M.Ed., UGC-NET in Education, a Diploma in French, and a PG Diploma in School Leadership and Management from IGNOU. Currently pursuing a Ph.D. in Education from Amity University, she has presented papers in national seminars, published articles, and edited the institute's newsletter 'Sankalan' since 2016. She has also convened and co-convened various seminars and conferences. Ms. Guleria completed a minor research study in 2017 and has held key administrative roles such as Registrar (Officiating), Examination Incharge, and NAAC Committee Member. She contributed to the CBSE handbook and delivered live sessions for NIOS, and serves as an external examiner and evaluator for GGSIP University.

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