Implementation of Sustainable PBL towards Affordable and Clean Energy: Industry, Innovation

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***Abstract*— Sustainable development is way of life need to adopt to preserve resources for future generation. Adopting this idea will help to keep the ecosystem in balance. Sustainable development is defined as development that fully recognizes, supports human needs while explicitly endorsing ecological limitations within the framework of economic activity. The Sustainable Development Goals (SDGs) are examined in this study as a critical international framework for addressing environmental, socioeconomic issues. It breaks down intricacies of SDG implementation by carefully examining advancements, obstacles, strategic paths. This research work focuses on different Sustainable Project based learning methods of Industry, Innovation, Infrastructure; Sustainable Cities. To obtain clean energy, industry innovation education plays key role in energy transition by raising awareness, training, sector players to promote renewable energies. In order to give high-quality education on renewable energy, it is imperative that educators stay up to date on current industry trends, emerging technology, and successful pedagogical approaches. This can be achieved through ongoing professional development programmers. For energy transition a continuous monitoring and SDG indicators, baseline assessment, promotion of energy policies, examining investment trends, regulatory frameworks, public-private partnerships supporting industrial development, innovation ecosystems are required. For this a new project-based learning (PBL) must be involved to obtain specified goals. PBL teachers should support acquisition of interdisciplinary learning goals via a variety of learning activities that include direct instruction organized under an inquiry, typically with significant student voice.**

***Keywords*—Sustainable Development Goals (SDG), Sustainability, Renewable Energy, PBL, SDG indicators.**

I. INTRODUCTION

Sustainable forms of energy are required to accelerate green transition. Renewables are only form of low carbon, energy future [1]. Solar, wind energy technologies compete with traditional sources of electricity Energy is used in different forms, which creates its own complexities [2]. To understand these sustainable goals educational institutions has to implement the project-based learning (PBL) which is a powerful instructional methodology [3]-[5]. PBL promoted more experiential, student-centered learning methods that facilitate deeper learning by actively examining issues, challenges encountered in real world [6]-[7]. Recent shifts in education reform movement contributing to popularity of PBL [8]. In this research PBL is developed for sustainability, Clean Energy: Industry, Innovation, Infrastructure; Sustainable Cities, Communities. With PBL students can solve complex problems by integrating, constructing their knowledge as they work together [9].

PBL refers to student-centered learning that is organized around project. When designing, implementing, and/or assessing a course, the PBL concept calls for cooperation of two or more teachers [10]. This collaboration primarily entails sharing of training expertise [11]. PBL is incorporated into classroom practice [12]. PBL relies on four significant ideas (1) construct understanding activity (2) work collaboratively (3) authentic learning environments (4) cognitive tools [13]-[14] Compared to traditional teaching with PBL the advantages are improvement of student critical thinking, progression of intra-inter personnel skills, one of the famous methods in PBL is K-12 science education [15]-[16]. This method resulted deeper understanding of possibilities, challenges related to implementation of PBL [17]-[19]. The PBL can be practiced more effectively by including more student workshops and industry interaction [20]. PBL stands for is problem-based, student-centered. This indicates that project that students work on in groups facilitates planned acquisition of new knowledge, skills [21].

There are mainly six factors which will affect the PBL are effective efficacy of teacher, employability skill, students transferring a skill, infuse john Hattie's visible learnings strategies, top-down PBL implementation mandate, Venn diagram for sustainability [22]-[23].

This paper is organized as

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follows: Section II includes literary survey of proposed work, Section III is SPBL, Section IV includes methodology of SPBL, Section V is results & discussions, section VI is conclusion.

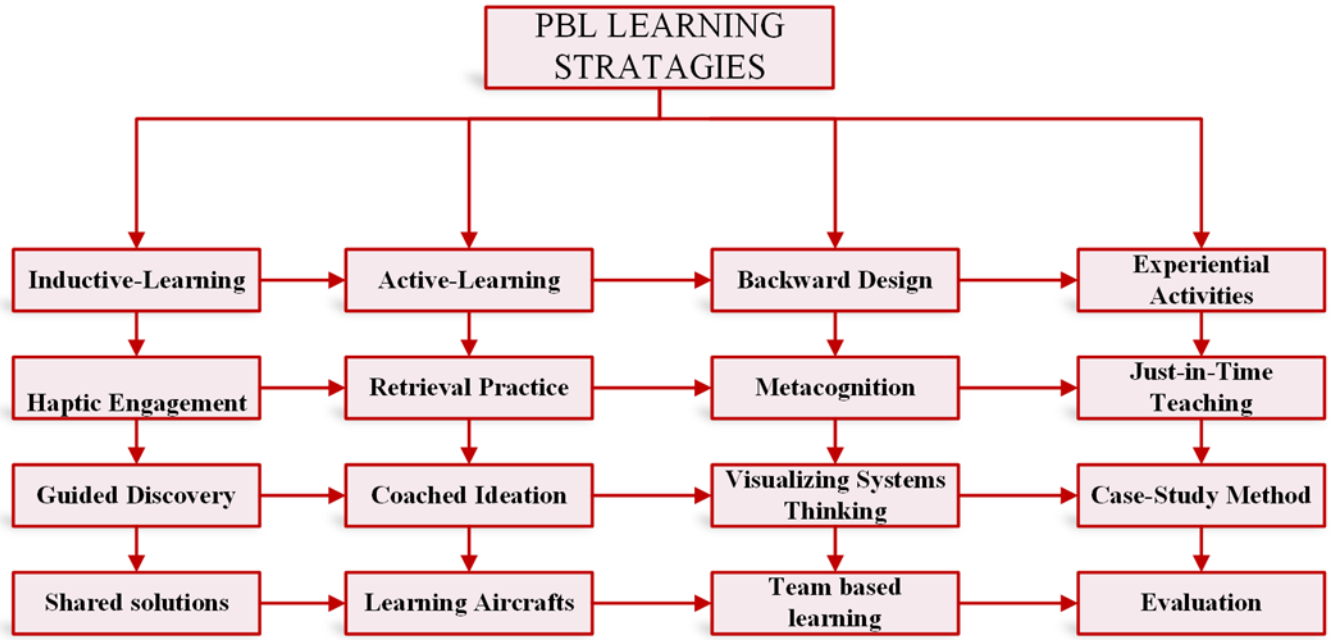

Fig. 1. PBL Learning strategies

II. LITERATURE SURVEY

Sustainable Development Goals (SDGs). Extensive research has been prompted by growing global attention on urban transformation as a critical component in achieving SDG's. Smart cities are also praised for encouraging the production of sustainable energy, which benefits urban people' health and well-being.

Maria E. Mondejar.et.al expressed interest on sustainable development will capitalize greatly on digitalization. The creation of intelligent systems with internet connectivity can present special chances to approach problems strategically. The advantages of digitization's led to advancement of sensors that are seamlessly linked into internet of things (IoT) environment.

Niloufar Fallah Shayan.et.al worked on corporate social responsibility (CSR) which can intensify strategy to support socio-economic, management, stakeholders. The SDGs were created using knowledge of international experts, views of governments, institutions.

M Carrió Llach.et.al explored higher education institutions have a great responsibility to put education for sustainable development at their work. If institutions can provide education for sustainable development (ESD) which can transform their reality. ESD includes critical thinking, scientific knowledge, integrated problem-solving competencies.

M. Mukunda Vani.et.al. approached on Sustainable Project Based Learning (SPBL), sustains on root depth learning of concepts, to improve ability of students, develop cognitive skills. SPBL has positive impact on student skills. Prior to implementing SPBL, groups should be formed to promote collaborative learning at start of course.

Long Thang Van Nguye et.al. explored how (PBL) programs can address SDG via higher education (HE) curriculum, relevant assessments, supporting learning at HE institutions. It presents a mapping tool that allows HE to determine how sustainable their curricula, instructional materials, pertinent exams are. The modern concept of wide sustainability incorporates economy, culture, society, and politics in addition to environmentalism.

Ana Bilbao-Goyoaga et.al aimed guide for integrating sustainability into university degrees with use of Challenge-Based Learning (CBL).CBL fosters teamwork to find significant ideas, pose meaningful questions, research, and resolve obstacles.

III. SUSTAINABLE PBL(SPBL)

Educators, researchers suggesting, practicing experimental learning by reconnecting to real-life situations; holistic thinking, knowledge associated with complex, interconnected systems to improve critical thinking. In contemporary world for an effective teaching transmitting knowledge, create knowledge form research is highly appreciable. To implement the above understanding sustainable PBL is required which is defined as root depth learning of concepts, to improve ability of students, to develop cognitive, socio-emotional skills. For an effective SPBL educators must include basic PBL strategies which should show great impact on affordable clean energy in terms of industry, innovation.

There are seventeen sustainable development goals are there in world for the betterment of human life. In those goals affordable, clean energy, industry, innovation are major research topics in proposed work. To achieve specified SDG's PBL, SPBL must be implemented.

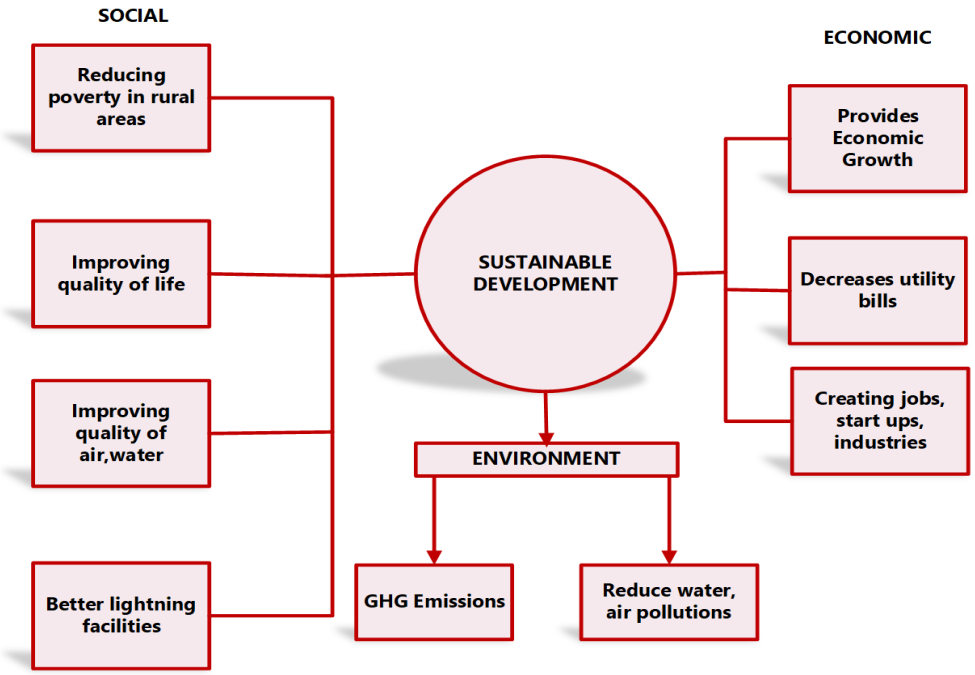

Fig. 2. Sustainable development

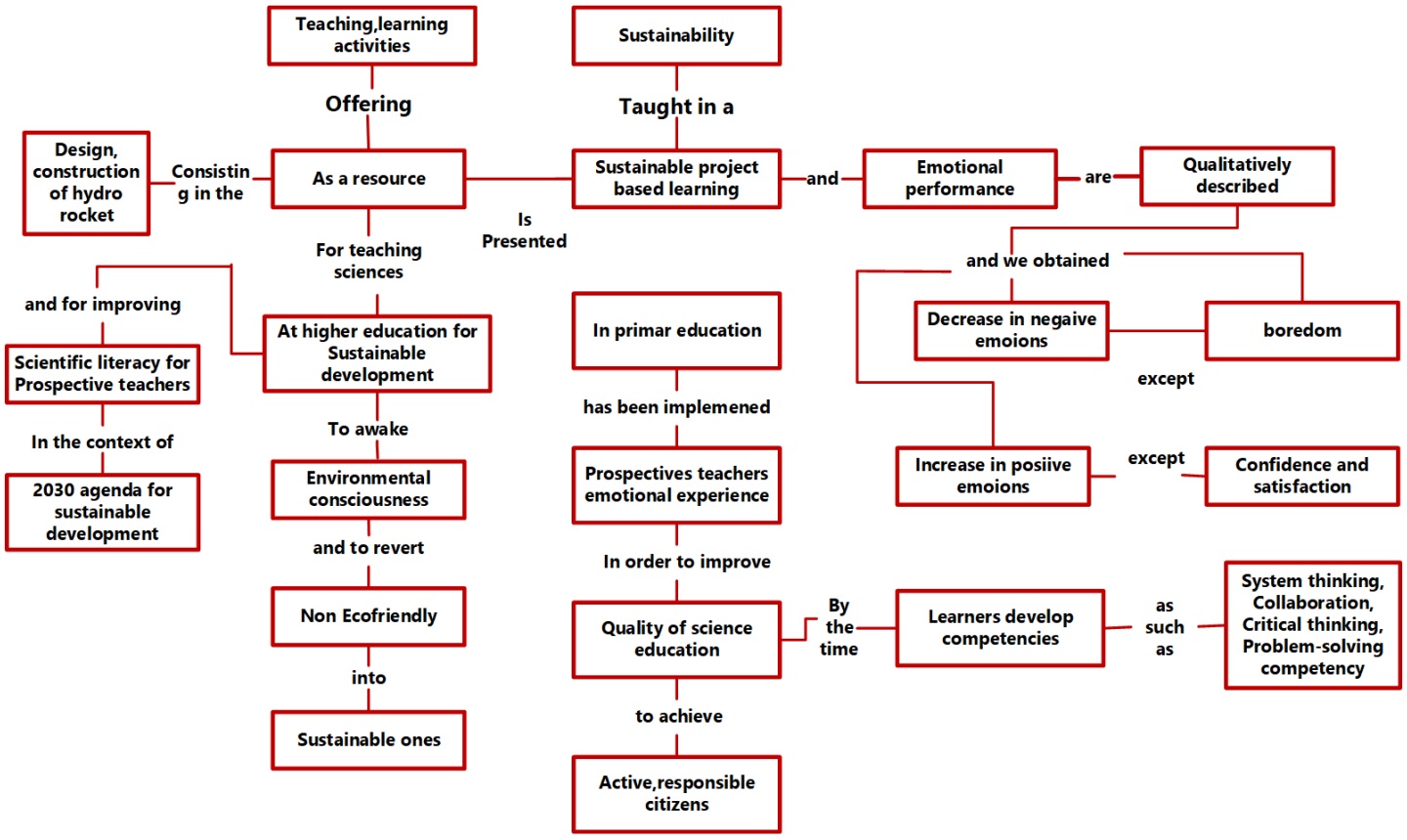

Fig.3. Flow chart for Sustainable PBL

IV. METHODOLOGY TO IMPROVE SPBL

A. Need for SPBL in electrical engineering towards industry innovation

Electrical Engineers are the conductors of a greener melody. Fundamentally, it combines sustainable energy with electrical energy management, generation, transfer, transformation, distribution, storage. The following problems are solved by electrical engineers: to bridge gap between development, sustainability; creating eco-friendly environment; transforming electrical distribution to cut down on energy waste. The advancing technologies in this field are RES, IoT, nanotechnology, AI and wireless technologies.

B. Designing SPBL

1. Mapping course outcomes (CO's), program specific outcomes (PSO's)

The teaching, learning methodology known as "student-centered approach" centers educational process around the needs, interests of pupils. For adopting this method CO's and PSO's of various subjects related to sustainable affords should be understand by students. Learning outcomes will help both faculty, students to understand the goals of course where as PSO's are responsible for standardization of project management processes, The PSO's of electrical engineering are given by (a) Ability to apply fundamental knowledge to identify, design, analyze, investigate various problems of electrical systems (b) Ability to apply emerging technologies in design, simulation of electrical engineering The CO's, PSO's of GUEE, power converters, RES are given in TABLE I, TABLE II, TABLE III.

TABLE I
CO'S, PSO'S OF GENERATION, UTILIZATION OF ELECTRICAL ENERGY

Course Contents	Course outcomes	PSO'S	
		PSO1	PSO2
Basic concepts of power generation: Turbines: Hydel Power Plant:	Distinguish and analyse different types of power generation and turbines	√	
Thermal Power Stations: Nuclear Power Stations	Compare hydel, thermal, nuclear power stations		√
Economic Aspects of Power Generation and Tariff:	Calculate cost of generation, tariffs.	√	√
Illumination: Electric Heating & Welding:	Estimate levels of illumination heating & welding techniques		√
Electric Traction:	Determine speed/time characteristics of different types of traction systems	√	√

TABLE II
CO'S, PSO'S OF POWER ELECRONIC CONVERTEERS

Course Contents	Course outcomes	PSO1	PSO2
Introduction to Power Conversion	Identify need for power conversion	√	√
Phase Controlled Rectifiers	Analyse different converter configurations for AC to DC power conversion		√
DC Choppers :	Need for DC-to-DC power conversion	√	
AC- AC Converters	Analyse AC voltage, frequency conversion circuit configurations	√	√
Inverters	Apply different DC to AC conversion techniques	√	

TABLE III
CO'S, PSO'S OF POWER ELECRONIC CONVERTEERS

Course Contents	Course outcomes	PSO'S	
		PSO1	PSO2
Principles of solar radiation	Knowledge on various types of renewable energy sources.	√	
Solar Energy Collection: Storage & Applications:	Develop storage systems of solar energy	√	
Wind Energy: Bio-mass	Knowledge on hybrid energy systems.	√	
Geothermal Energy: Ocean Energy: Tidal and wave energy:	Knowledge on principles of direct energy conversion	√	
Direct Energy Conversion	Real world electrical, electronic problems	√	√

2. Industry innovation training

In view of moving towards industry innovation student needs training. For this electrical engineering department planned industrial visits, workshops on solar PV plant design, electrical CAD by HIEE, Hyderabad for both second, third year students respectively. The industrial visits for second year students is Nuclear Fuel corporation, Hyderabad and for third year students is BHEL, Hyderabad. With this kind of visits the affective, psychomotor skills will be improved. By applying knowledge which is gained in workshops will leads to designing of plants. Apart from all these things students can do major, mini projects where it leads to critical thinking. To improve communication, competitive skills end of academic year project competitions will be held under professional bodies like IEEE.By adopting all PBL strategies following projects were carried and mentioned in TABLE IV.

TABLE IV
MAJOR PROJECTS MAPPED WITH PO'S

Project Name	Implemented course	Mapped PO's
Automatic Solar Panel Cleaning System	RES	PO1, PO2, PO3, PO7, PO9, PO12
Solid State Room Heater Generator Electric Energy	RES, GUEE	PO1, PO3, PO4, PO5, PO6, PO7
Hybrid power Generation on Highways	RES, GUEE, PE	PO1, PO7, PO9, PO11, PO12

Automatic Sunflower Solar Tracking and Panel Positioning System	RES, GUEE, PE	PO1, PO7, PO8, PO9, PO11, PO12
Solar Vehicle Equipped with Super Boost Converter designed for HVEV	RES, PE	PO1, PO2, PO3, PO7, PO8, PO9, PO11
Power Continuity and Quality and Load Monitoring over IoT	RES, PE, POWER SYSTEMS	PO1, PO7, PO8, PO9, PO12

IV. RESULTS AND DISCUSSIONS

The SPBL paradigm improves students' technological proficiency, offers an examination of significant research demonstrating beneficial effects of SPBL on academic performance. For maximizing the student engagement and learning may be new tools can be introduced. SPBL leads to real world learning.

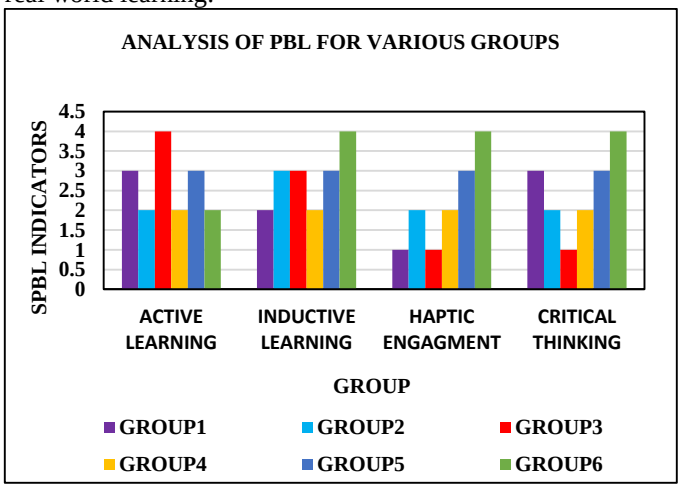

Fig.4. Analysis of PBL for proposed work

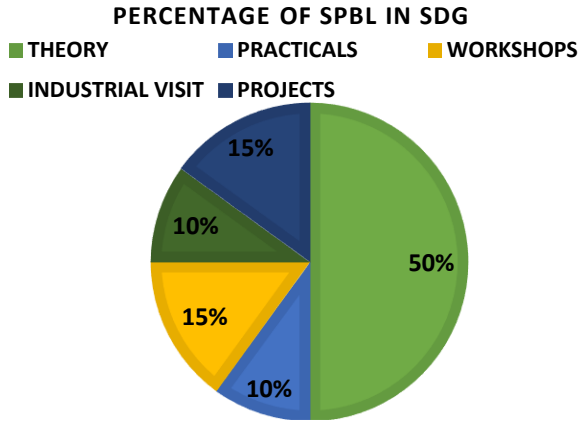

Fig.5. Fractions of course content

V. CONCLUSION

There are several advantages of implementing PBL, SPBL for students' improvement. In contemporary world SDG goals are playing vital role. In order to ensure prosperity for both the present, future generations, sustainable development must strike a balance between our economic, environmental, and social needs. The current research was able to show that importance of SDGs, regardless of pillar of sustainability. The greater advantages of proposed work are adopting, applying PBL strategies like inductive, active learning, haptic engagement by industrial visits. This research is giving idea of pertaining subjects like power systems, converters and renewables. The fulfilled PO's by SPBL are Engineering knowledge: Design/development of solutions: Environment and sustainability: Life-long learning. The future scope for SPBL is choice-based learning where student-friendly learning that provides the learners with opportunity to differentiate their learning methods.

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