

Problem Based Learning in Education– its Need for Sustainable Development

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Abstract: Poverty, hunger, gender inequality are some of the social problems which seems difficult to overcome in a country like India with the second largest population in the world. India is a country, with diverse culture and traditions where nature is being exploited for the benefit of humans. The greed to have more and more of the materialistic things have not only led, to the deterioration of our environment, flora and fauna, but has also increased the rate of crime alarmingly. Education is one of the most important factors which can act as a means to achieve the Goals of Sustainable Development as it can help an individual to think logically and inculcate the habit of questioning and finding answers to the unsolved social problems which has spread its roots deeply affecting the economic development of our country. Quality education should focus on the overall development of an individual and should also aid in the social and economic development of a nation. To improve the status of the education, we should not mainly focus on just adding on the enrolment of students but also on the methods of teaching. Globalization and industrialization is booming all walks of life with rapid progress in science and technology. Problem based learning can be a promising method of teaching learning process which

can give an insight to the learner to understand various social, economic and environmental problems in a better way by integrating science and technology with education. The present paper is an attempt to associate the use of problem based learning (PBL) for achieving the goals of Sustainable development.

Keywords: Problem-based learning (PBL), Sustainable Development, goals, education.

1. Introduction

India is a country with varied cultural and demographic differences with the ranking of second largest population in the world. Strategies and approaches for education for Sustainable development (ESD) are difficult to manage in country, like India with limited resources and with people with different economic status. Quality education can help in achieving all the goals of sustainable development which in turn will help in the development and progress of the country.

Education plays a pivotal role in the survival of any society as it inculcates transmission which is trans-generational for practices, knowledge, culture and traditions. Education also contributes to transformations that are insufficient and inappropriate if necessary steps to cope up with the changes are not taken at the right time. (De Amorim et al., 2011). The change the whole world is undergoing is inevitable whether we welcome or acknowledge that change or not, so the education system of a nation should be

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designed in such a manner that these changes are adequately imbibed. We cannot be the passive spectators and depend on good fortune as an inaction towards change can only magnify our problems and difficulties (Collarbone, 2009). In the last few decades, science and technology has progressed rapidly which has directly influenced our day to day life in the way we buy daily routine items, access information and communicate, but the methods of teaching being used at school, colleges and university in our country have not changed much (Thakur & Dutt, 2017a), thus posing a hindrance in achieving the goals of sustainable development. The quality of education does not depend only on the quality of the teachers but also on the instructional methods employed by the teacher in the classroom. Memorization of the content by the students is not enough, teachers are in dire need of student-centric instructional methods that can help learner to retain better and enhance creativity, problem solving and soft skills (Chauhan, 2017). Today jobs in almost all fields are primarily thinking jobs which requires intellectual of high order, creative skills and the fair amount of problem solving skills. (Thakur, Dutt and Chauhan, 2018).

Many educators are of the view that sustainable education can be achieved with the help of pedagogies which enables a learner to develop skills based on real world problems along with collaboration and one such method is Problem Based Learning (PBL) which is ideal in developing skills as well as competencies (Bessant et al, 2013). Learning should be a concrete activity which must engage learners in conceptual understanding, provide variety and challenge, and be interesting and not just limited to remembering the acquired knowledge only to forget after examinations. Educational concepts such as learning by doing, learning by experiencing and learning by discovery can be best explored through problem based learning (National Curriculum Framework, 2005). Problem based learning appropriately fits with the words of A.P.J Abdul Kalam, who once said that “one cannot succeed without involving oneself and cannot fail by once involvement,” so PBL is a method which involves the student in the learning process. If we wish to analyze the relationship of learning with community life, it is mandatory to encourage reflection about what it means to know something and how to apply the same in our day to day life. The learner should be identified as a participant who is proactive and is responsible for his or her own learning. (NCF, 2005, pp 30). The various

developments in last few decades has increased the momentum of problem based learning bridging the gap between practice and theory(Baldwin, Beltran and Chernobilsky, 2004)and helping a learner to understand when and how to apply that knowledge (Richards & Cameron, 2008).

2. Objective

In the present study, an attempt is made to critically review the studies in order to explore the use of Problem Based Learning (PBL) for sustainable development.

3. Concept of Sustainable Development

In September, 2015 at Sustainable Development Summit, 2015, India along with other countries signed the declaration “2030 Agenda for Sustainable Development containing 17 Sustainable Development Goals (SDGs) focusing mainly on 5Ps: People, Prosperity, Peace Planet and Partnership (UN: RIS for Developing Countries, 2016).



Fig.1: Seventeen Goals of Sustainable Development

Education for sustainable development means ensuring social, ecological and economical well being with the right kind of education and teaching learning process (Winter, Sterling, & Cotton, 2015). So, the goals of sustainable development can be achieved by applying innovative methods of teaching learning process in education such as Problem Based Learning which will sensitize learners to think logically about the social problems existing in the society.

4. Problem Based Learning (PBL)

Shamsanand & Syed (2009) described PBL is an effective technique by students learn, retain, integrate and apply information by being active learners. Monrad & Molholt (2017) viewed that the problem in PBL acts as a trigger and motivator for learning and

discovery. It helps students decide what they will learn rather than the teacher delivering the content. Smith & Hung (2017) considered PBL as an instructional way which lays emphasis on problem-solving and active participation of the students in the pedagogical process to learn the subject.

PBL is a method of instruction which has been in use in the field of medical science for more than forty years and has a tremendous potential in building and developing understanding of the concepts in learners of all age groups and in varied fields due to its constructive and collaborative nature (Thakur & Dutt, 2017b).

4.1 Historical Perspective of Problem Based Learning

Epistemological origins of problem-based learning can be found in a number of schools of philosophical thought helped people to acquire, develop and design educational approaches in understandings the nature of knowledge. (Savin-Baden & Major, 2004, Chapter-2, pp 11 - 15)

- A. Connections with naturalism: developing knowledge through questioning: The Questioning approach helps in developing understanding and shapes the beginning of a critical questioning approach in learning to define the ultimate nature of things. In the similar manner, problem-based learning also arises curiosity in students to question the very nature of a problem and also considers ways and means for investigation, a feature which can be connected with naturalism.
- B. Connections with metaphysics: critiquing knowledge through reason: Development of metacognitive skills is acknowledged in PBL approach which expects students to use reasoning abilities in managing and solving complex problems by using logic.
- C. Connections with rationalism: deductive reasoning: Rationalism assumes that humans grasp only their impressions and do not know things directly. PBL emphasize on deductive reasoning by ensuring strong links between intellect and emotions which help in solving the problem.
- D. Connections with empiricism: scientific observation and discovery: Empiricists put forward the idea that observable reality is the unvarnished image of the world, and that knowledge comes from the inductive reasoning of the evidence retained from experiences, observations and congregation of information.
- E. Connections with phenomenologicalism: individual perception of knowledge: PBL is designed in such a manner that it connects knowledge learned in class to that of knowledge needed for the workplace. PBL identifies a gap between knowledge; theory and practice. Education helps in negotiating that gap, a feature of problem-based learning.
- F. Connections with positivism: social justice appears: The problem-based learning class is designed in a manner so as to reach all students, including those who might otherwise be marginalized addressing the issues of social justice.
- G. Connections with existentialism: motivating to grow to be a self-governing thinker: In PBL, learning occurs by observing and experimentation which helps in developing an individual who is self-directed and an independent thinker.
- H. Connections with postmodernism: the individual and society: PBL can be an effective pedagogy for women and minority groups as it does not eliminate participants in ways that most of the conventional pedagogies do.
- I. Educational origins: in school of medicine: At the initial stage, Problem-based instruction was designed for graduate medical students when instructors found that physicians who were graduating had adequate information but to use that information wisely they lacked the skills of problem solving (Gallagher et al. 1995). In 1969, a unique educational philosophy, the "McMaster philosophy," was founded by a medical school in Ontario which had evolved as problem-based learning (PBL) educational strategy. (Bayard, 1994). Jim Anderson, a professor of anatomy and physical anthropology, is considered the creator of PBL with learning occurring in small groups. The new medical curriculum based on PBL was launched in 1969. "Basic Philosophy" on which problem based learning depended consisted of three visions (Spaulding, 1969): A vision of mankind and society, its role in society, medical profession and education.

Breakthroughs in multidisciplinary pursuits and Internet revolution are the recent developments that have made PBL an educational innovation (Tan, 2003) which has been adopted in higher education outside the medical field in various disciplines. PBL has been applied worldwide in professional schools such as architecture, business administration, chemical engineering, calculus, algebra, mathematics, engineering studies, law schools, leadership education, social work, teacher education, biology, biochemistry, chemistry, physical education, geology, psychology, science courses, history, arts, physics, educational psychology, criminal justice, diet and nutrition and other domains of post-secondary education. So, problem based learning though initially started in medical schools has a wide range of applicability in the field of education across different disciplines, both in higher as well as school education, and thus can help in achieving the goals of sustainable development.

4.2. Process of Problem Based Learning

According to Wijina (2014, pp 87), the process of PBL is summarized in Figure2.

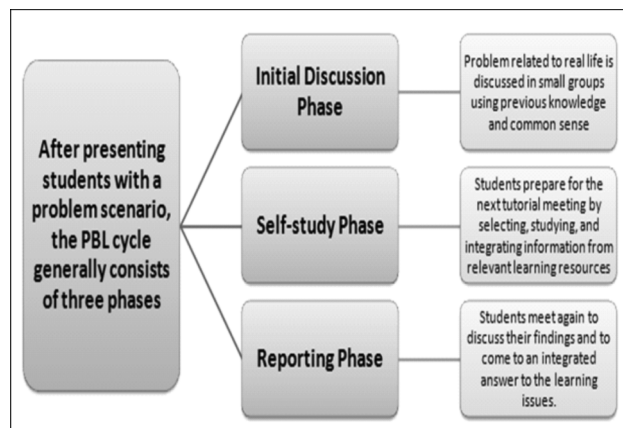


Fig. 2 : Process of Problem Based Learning

The initial phase in PBL process is presentation of the problem to students who work collaboratively to solve the ill structured problem in small teams by exploring the available resources, undergoing self-study and discussing amongst themselves. And after finding the possible solution to the problem the results are discussed. Thus, the problem based learning process being a systematic process, starts with encountering the problem and ends with summarizing, integration, review and evaluation of the information gathered related to the problem.

4.3 Characteristics of PBL (Problem Based Learning)

Problem based learning though initially started in medical schools has a wide range of applicability in the field of education across different disciplines both in higher as well as school education with some of characteristics being shared in all disciplines (Fig. 3).

- i. PBL always starts with a problem.
- ii. The Learning environment is student-centered.
- iii. Small group of students work together under the guidance of a tutor.
- iv. Multiple perspectives of the problem challenges the current knowledge, attitudes and competencies of the students.
- v. Cooperative, collaborative and communicative learning takes place amongst students
- vi. The PBL teacher only facilitates in learning.
- vii. Integration and synthesis of the problem are included in the closure for a PBL process along with the review and evaluation of the learning process and the learner's experience.

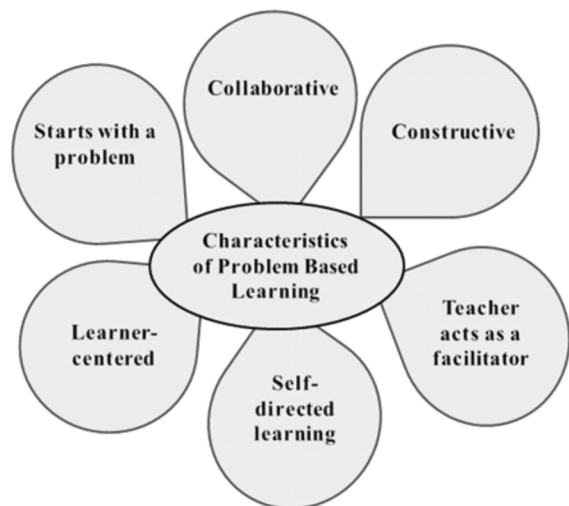


Fig.3 : Characteristics of Problem Based Learning

5. Review on Problem Based Learning And Sustainable Development

Mantri et. al. (2008a) designed and evaluated a PBL-Based Course in Analog Electronics. The investigators found significant differences between the attitudes of the PBL based treatment group and

control group. In addition, PBL has improved the presentation and teamwork skills in the PBL class.

Mantri et. al. (2008b) the surveyed HR heads of different companies who suggested major changes in the education system are required not only in terms of curriculum design, but also the way knowledge is imparted to the students. The knowledge and skill test scores of the PBL student vis-à-vis those of traditional students are already available in the literature and show encouraging results. If incorporated on a larger footing with more faculties being trained on the skills of becoming facilitators, PBL can be one of the tools to produce better “Industry Ready” engineers. In addition, the authors (2009) have studied the use of PBL to deliver course in Digital Electronics and recommended its use on wider basis. It is, however, necessary to consider issues like faculty training in PBL and the cost factor, since the PBL is useful in small class size, before switching over to PBL.

Thomas (2009) emphasized the use of problem based learning pedagogy as a teaching approach focusing on the learning process rather than knowledge accumulation to enhance skills such as team work, problem solving, interdisciplinary and holistic thinking, and operationalize the sustainable education.

Garland, Khan & Parkinson (2010) adopted problem based learning approach for first and second year Design Engineering students and concluded that if learning through PBL is introduced early in the course learning gained becomes a practice and when a graduate enters a profession sustainability in the future is contributed.

Zhou, Purushothaman & Rongbutsri (2013) elaborated the use of Problem Based Learning as an approach for pedagogical strategy and use of ICTs strategy as a technological approach for constructing knowledge, sharing, reflecting and collaboration in connection with the community, resources and network along with challenges faced by developing countries like China, Thailand and India for development of sustainable education.

Abdul-Aziz et al, (2013) used longitudinal quantitative research methodology in their investigation on students of first year engineering and concluded a positive effect of Cooperative Problem-Based Learning (CPBL) for inculcating sustainable development on students.

Roy et al. (2014) in their study in Tanzania schools used PBL method to create a local contextualized video for solving forest fires by connecting students and local experts in forestry. PBL activities were conducted by students to understand conservation and environmental issues. Pre and post test method was used for collecting data along with interviews for teachers. The study concluded that PBL is an effective approach to sustainability.

Targamadze & Kvieskaite (2014) illustrated that implementing Problem Based Learning wholly as a strategy of learning in high school or at national level can act as an agent for sustainable development naturally.

Overton & Randles (2015) studied the use of novel pedagogy, dynamic PBL, to teach first year chemistry undergraduates about sustainable development and found that the resources used by students to learn about sustainability developed skills successfully.

Corvers. et al, (2016) in their study emphasized the use of project-based learning and problem-based learning for fostering student centre learning and innovation in education to transform sustainability programmes at universities.

Guerra (2017) in his investigation on relationship between Education for sustainable development and PBL in engineering curricula in master programmes from Aalborg University, Denmark, found that ESD and PBL share common learning principles of collaborative and interdisciplinary learning.

Wyness& Dalton (2018) in their study concluded that PBL is an enabling and appropriate method to introduce sustainability in accounting.

Noordegraaf-Eelens, Kloeg & Noordzi (2019) suggested that the sustainable education criteria can be met by reconnecting Problem Based Learning to the world we share.

Vargas et. al (2019) in their study applied the principles of PBL on Automobile Mechanics Project based on the Cuban educational context and concluded that the students developed skills and attitudes along with content knowledge to meet the demands of the chosen field.

From the review of the research study in respect

of Problem Based Learning and Sustainable development, it can be concluded that Problem Based Learning (PBL) is an effective method to meet the demand of sustainable development in varied fields. But the main focus in today scenario should be on the applicability of Problem based learning at different levels of education both at school and college to achieve sustainable goals.

6. Need for implementing problem based learning for sustainable development

Development of skills like reasoning, creative thinking, problem solving, scientific decision making, communication, self- regulated learning skills, leadership and team building skills during the process of problem based learning (Thakur, Dutt & Chauhan, 2018 b) can help a learner to think critically about a social problem and can help in building harmony amongst masses benefiting the society and community. Thus, Problem based learning can help to build responsible citizens who can help in attaining all the seventeen goals of sustainable development like eradication of poverty, enhancing the quality of education, sensitization towards gender equality, protection of environment etc. which enhance the economic progress of a country.

The experiential learning a learner undergoes during the process of problem based learning which is both constructive and collaborative gives a life time experience for a learner and better retention of the solution to the problem can be aptly be applied by the learner in day to day activities. Further sustainable development is not something which can be achieved in a day or two, so it needs to be inculcated in the children right from the school so that the importance of conserving environment, nature, natural resources to achieve the goals of sustainable development are enrooted deep into the mind of an individual.

7. Strategies to implement PBL in education at all levels

Various social problems existing in society can be addressed to the learner in the form of a problem and the possible solutions can be implemented to attain the goals of sustainable development. With rapid depletion of non- renewable resources due to increasing population throughout the world, it is the high time that students be made aware of using renewable resources consciously and exploring non-renewable resources of energy for fulfilling daily needs right from school days and problem based

learning can help in giving the hands on experience to the learner to critical analyse the problem and can improve environmental literacy (Febriasari & Supriatna, 2017) and environmental attitude (Kuvac & Koc, 2019) which can aid in achieving the goals of sustainable development.

Children are regarded as an agent of social change. India is a secular and democratic country but still the minds of people are divided on the basis of religion, caste, state, cultures and community. Problem based learning is based on the principle of collaboration and thus promotes team skills in students which can help in building up love, care and bonding amongst learners. Thus, this can help in achieving the goals of peace and justice for sustainable development.

Nowadays our market is booming with junk food which attracts people of all ages and gradually individuals are shifting from healthy and nutritious diet to ready to eat processed food which instead of benefitting is making people sick and prone to diseases like obesity, osteoporosis, cancer, heart and liver diseases, etc. Problem based learning can prove to be a good strategy that can help in motivating learner towards healthy eating habits (Estrada, Rodriguez & Melendez, 2018).

Although science and technology has shown a rapid progress in all fields of life, but still gender inequality exists in our society. PBL approach can be a promising strategy to eradicate gender gap and inequality in fields where females are not considered at par with male counterparts (McCullough, 2015).

8. Conclusion

The major aim of education is to create happy and healthy citizens who are sensitized by the social, environmental and economical problem of a country. Problem Based Learning (PBL) is an effective method of teaching which can help a learner to connect with the real world and help a developing country like India to achieve the Goals of Sustainable Development. Problem Based Learning can help an individual to have a better insight of the contents that is being taught in a classroom by thinking critically about the problem and linking it to day to day life activity leading to better life and in turn helping our country to progress. As education is only the means which can help in uplifting the economic status of the poor by raising the standard of living and help everyone to understand the importance of healthy and hygienic

living, clean environment, climate leading to better living so it is a high time to revolutionize the education sector with new and innovative methods of teaching like Problem Based Learning (PBL) for a better tomorrow so that developing countries like India become self efficient and is able to eradicate the social evils like poverty and hunger from the society which are hindrance for the future development of the country and achieve all the goals of sustainable development.

References

- [1] Abdul-Aziz, A; Mohd-Yusof, K; Udin, A & Mohamad-Yatim, J (2013). A Longitudinal Study on the Impact of Cooperative Problem-Based Learning in Inculcating Sustainable Development. *PBL Across Cultures*, 222. Retrieved from www.researchgate.net/publication/251566516_A_
- [2] Baldwin, MS; Beltran, RO & Chernobilsky, E (2004). Enhancing thinking through problem-based learning approaches: International perspectives. Thomson Learning Asia.
- [3] Bayard, B (1994). Problem-based learning in dietetic education: A descriptive and evaluative case study and an analytical comparison with a lecture based method (Doctoral dissertation, University of Wisconsin, 1994/1995). *Dissertation Abstracts International*, 55, 1874.
- [4] Bessant, S; Bailey, P; Robinson, Z; Tomkinson, CB; Tomkinson, R; Ormerod, RM & Boast, R (2013). *Problem-Based Learning: a case study of sustainability Education*. Keele University: Newcastle, UK.
- [5] Chauhan, A (2017). An overview of problem based learning in engineering education. *Journal of Emerging Technologies and Innovative Research*, 4(10), 225-228.
- [6] Collarbone, P (2009). *Creating tomorrow: Planning, developing and sustaining change in education and other public services*. A&C Black.
- [7] Corvers, R; Wiek, A; de Kraker, J; Lang, DJ & Martens, P (2016). Problem-based and project-based learning for sustainable development. In *Sustainability Science* (pp. 349-358). Springer, Dordrecht. DOI : https://doi.org/10.1007/978-94-017-7242-6_29
- [8] De Amorim Soares, ML & Petarnella, L (Eds.). (2011). *Schooling for Sustainable Development in South America: Policies, Actions and Educational Experiences* (Vol. 2). Springer Science & Business Media.
- [9] Estrada, L., Rodríguez, E., & Meléndez, A. (2018). Healthy Choices with Problem-based Learning: Editor: Ferman Konukman. *Journal of Physical Education, Recreation & Dance*, 89(1), 55-57. Retrieved from <https://doi.org/10.1080/07303084.2018.1393229>
- [10] Febriasari, L. K., & Supriatna, N. (2017). Enhance Environmental Literacy through Problem Based Learning. In *Journal of Physics: Conference Series* (Vol. 895, No. 1, p. 012163). IOP Publishing. Retrieved from doi :10.1088/1742-6596/895/1/012163
- [11] Gallagher, SA; Sher, BT; Stepien, WJ & Workman, D (1995). Implementing problem-based learning. *School Science and Mathematics*, 95, 136-146.
- [12] Garland, NP; Khan, ZA, & Parkinson, B (2010). Sustainable development for design engineering students: a peer assisted problem based learning approach. The Design Society. Retrieved from www.researchgate.net/publication/236960227_Sustainable_develop...
- [13] Guerra, A (2017). Integration of sustainability in engineering education. *International Journal of Sustainability in Higher Education*, 18 (3), 436-454. Retrieved from
- [14] Kuvac, M., & Koc, I. (2019). The effect of problem-based learning on the environmental attitudes of pre service science teachers. *Educational Studies*, 45(1), 72-94. Retrieved from <https://doi.org/10.1080/03055698.2018.1443795>.
- [15] Mantri, A; Dutt, S; Gupta, JP & Chitkara, M (2008a). Design and evaluation of a PBL-Based Course in Analog Electronics. *IEEE Transactions on Education*, Vol. 51, No. 4, 432-438p.
- [16] Mantri, A; Dutt, S; Chitkara, M & Chitkara, M

- (2008b). Problem Based Learning in Engineering Education in India: An urgently needed paradigm shift. *Journal of Engineering and Technology Education*, Vol. 2, No. 1, 21-258p.
- [17]Mantri, A; Dutt, S; Gupta, JP & Chitkara, M (2009). Using PBL to deliver course in Digital Electronics. *Advances in Engineering Education*, Vol. 1, Issue 4.
- [18]McCullough, C.L. (2015). Problem Based Learning as a Tool in Addressing Gender Bias. 122nd American Society for Engineering Education Conference and Exposition, 2015. Paper ID #11551.
- [19]Monrad, M., & Molholt, A. K. (2017). Problem-Based Learning in Social Work Education: Students' Experiences in Denmark. *Journal of Teaching in Social Work*. Retrieved from vbn.aau.dk/.../problembased-learning-in-social-work-education-students-experiences.
- [20]National Curriculum Framework, (2005) issued by NCERT.- [ncert.nic.in/Chapter-1 Perspective, 5](http://ncert.nic.in/Chapter-1/Perspective_5). Retrieved from www.ncert.nic.in/rightside/links/pdf/framework/english/nf2005.pdf
- [21]Noordegraaf-Eelens, L; Kloeg, J & Noordzij, G (2019). PBL and sustainable education: addressing the problem of isolation. *Advances in health sciences education : theory and practice*, 24(5), 971–979. Retrieved from <https://doi.org/10.1007/s10459-019-09927-z>
- [22]Overton, TL & Randles, CA (2015). Beyond problem-based learning: using dynamic PBL in chemistry. *Chemistry Education Research and Practice*, 16(2), 251-259. Retrieved from <https://doi.org/10.1039/C4RP00248B>
- [23]Richards, D & Cameron, L (2008). Applying Learning Design concepts to problem-based learning. In L. Cameron & J. Dalziel, *Proceedings of the 3rd International LAMS & Learning Design Conference* (pp. 87-96). Retrieved from lams2008sydney.lamsfoundation.org/pdfs/04g.pdf
- [24]Roy, A; Kihoza, P; Suhonen, J; Vesisenaho, M & Tukiaianen, M (2014). Promoting proper education for sustainability: An exploratory study of ICT enhanced Problem Based Learning in a developing country. *International Journal of Education and Development using Information and Communication Technology (IJEDICT)*, 10 (1), pp. 70-90. Retrieved from
- [25]files.eric.ed.gov: EJ1071197Savin-Baden, M & Major, CH (2004). *Foundations of problem-based learning*. McGraw-Hill Education (UK).
- [26]Shamsan, B., & Syed, A. T. (2009). Evaluation of problem based learning course at college of medicine, qassim university, Saudi Arabia. *Int J Health Sci (Qassim)*, 3(2), 249-258.
- [27]Spaulding, WB (1969). The undergraduate medical curriculum (1969 model): McMaster university. *Canadian Medical Association Journal*, 100(14), 659-664.
- [28]Smith, C. S., & Hung, L. C. (2017). Using problem-based learning to increase computer self-efficacy in Taiwanese students. *Interactive Learning Environments*, 25(3), 329-342. Retrieved from <http://dx.doi.org/10.1080/10494820.2015.1127818>.
- [29]Tan, OS (2003). Problem-based learning innovation: Using problems to power learning in the 21st century. Thomson Learning Asia.
- [30]Targamadze, V & Kvieskaitė, E (2014). Problematical Learning is the agent of sustainable development in higher education. *Education in a Changing Society*, 1, 94-98.
- [31]Thakur, P & Dutt, S (2017 a). Problem based learning in biology: Its effect on achievement motivation of students of 9th standard. *International Journal of Multidisciplinary Education and Research*, 2(2), 99-104.
- [32]Thakur, P & Dutt, S (2017 b). Attitude of secondary class students towards biology exposed through problem based learning. *International Journal of Multidisciplinary Research and Development*, 4(6), 427-432.
- [33]Thakur, P; Dutt, S, & Chauhan, A (2018 a). Learning Biology through Problem Based Learning—Perception of Students. *i-Manager's Journal of Educational Technology*, 15(2), 44.

- [34]Thakur, P., Dutt, S., & Chauhan, A. (2018 b). Problem Based Learning Strategy for Development of Skills--A Review. *Journal of Educational Technology*, 15(1), 53-62.
- [35]Thomas, I (2009). Critical thinking, transformative learning, sustainable education, and problem-based learning in universities. *Journal of Transformative Education*, 7(3), 245-264. <https://doi.org/10.1177/1541344610385753>
- [36]United Nations: Research and Information System for Developing Countries (2016). India and Sustainable Development Goals: The Way Forward: Website: www.ris.org.in.
- [37]Vargas, NV; Ortiz, JLA; Pueyo, NP & Rodríguez, ARL (2019). Project Based Learning to Enhance Environmental Education through Automobile Mechanics. *Journal of Problem-Based Learning*, 6(2), 76-84.
- [38]Wijina, L (2014). Motivation and Achievement in Problem-Based Learning: The Role of Interest, Tutors, and Self-Directed Study. Erasmus University Rotterdam. pp 87. Retrieved from <http://hdl.handle.net/1765/77158>
- [39]Winter, J; Sterling, S & Cotton, D (2015). Steps to embedding sustainability into student learning. Educational Development, Plymouth University. Available online.
- [40]Wyness, L & Dalton, F (2018). The value of problem-based learning in learning for sustainability: Undergraduate accounting student perspectives. *Journal of Accounting Education*, 45, 1-19. Retrieved from <https://doi.org/10.1016/j.jaccedu.2018.09.001>
- [41]Zhou, C; Purushothaman, A &Rongbutsri, N (2013). Facilitating sustainability of education by problem-based learning (PBL) and information and communication technology (ICT). *International Journal of Emerging Technologies in Learning (IJET)*, 8(6), 50-54. Kassel, Germany: International Association of Online Engineering. Retrieved March 29, 2020 from <https://www.learntechlib.org/p/130243/>.