Fig. 1 Pedagogy framework software user interface

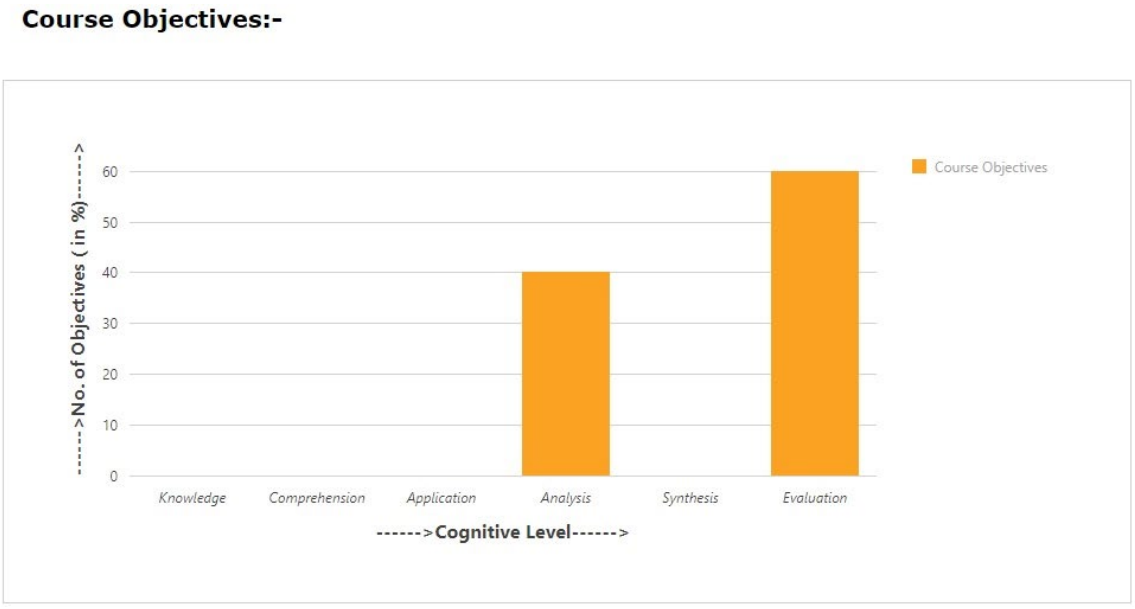

Fig. 2 Course objectives analysis

Module Objectives:-

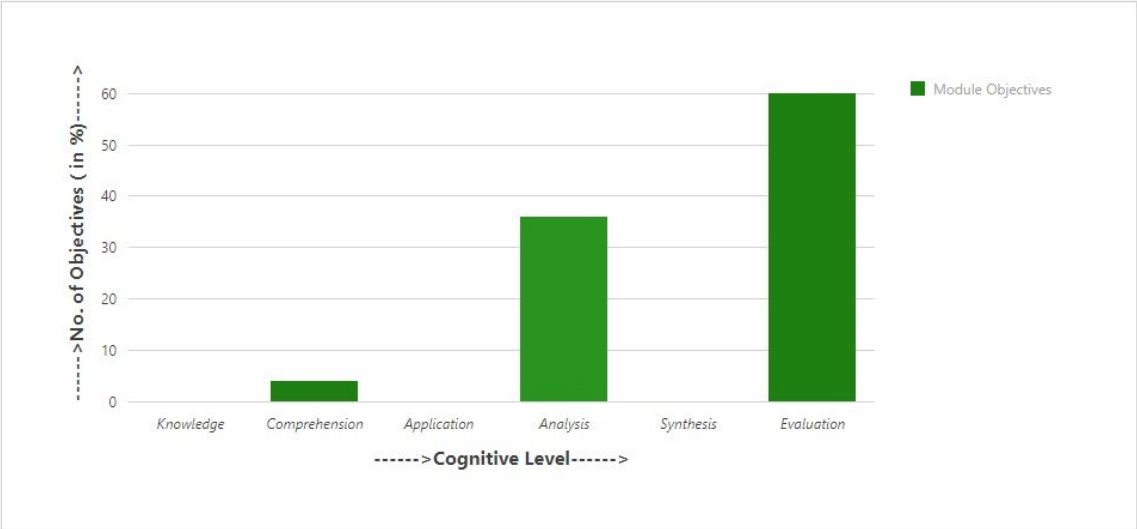

Fig. 3 Module objectives analysis

The histograms exhibit that the instructional objectives mainly focus on higher order cognitive level of learning. The *course level objectives* (Fig. 2) start from analysis level and focus on evaluation level to a greater extent. The *module level objectives* (Fig. 3) comprise a small fraction of units on comprehension along with substantial presence of units reflecting analysis and evaluation levels of learning, while the *unit level objectives* (Fig. 4) cater to all levels of cognitive learning to various extents. Ideally objectives at course, module and unit level should have the same level distribution; however, as one moves down from course level to unit level, the level of cognitive learning goes on spreading where the learner needs some knowledge, comprehension and synthesis too. It can be observed from these histograms that the claim in course objective is well supported by module and unit objectives. On the other hand, the course encourages the development of higher cognitive level skill set leading to an inference that it is a fairly well structured and designed course which exhibits strong compliance with the *Washington Accord*.

Unit Objectives:-

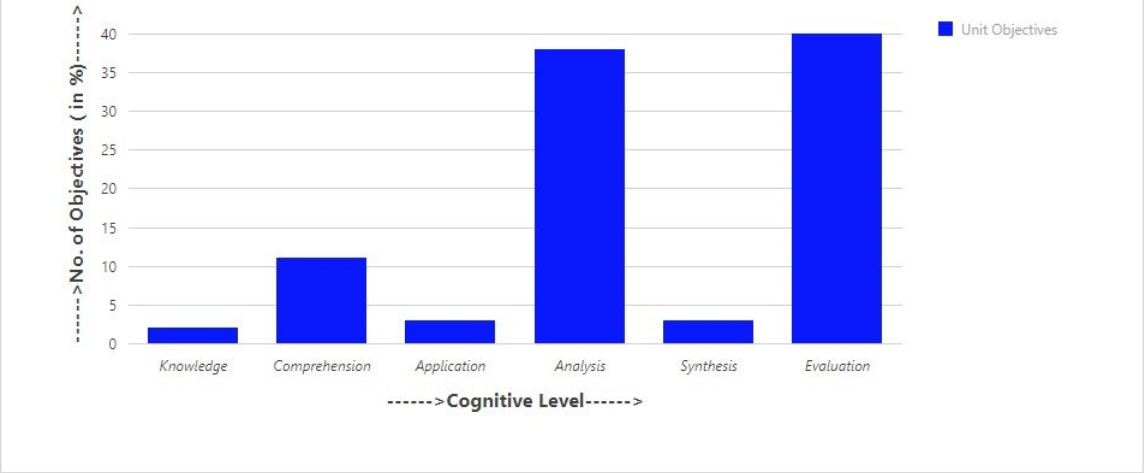

Fig. 4 Unit objectives analysis

6. Conclusion

As per the *Washington Accord*, the graduate engineers need to have competencies in terms of grasping the essential knowledge, conceptualizing it, and applying the concepts learnt in analyzing complex engineering problems to synthesizing appropriate solutions and evaluating various alternative approaches and processes. In order to achieve this objective, the engineering courses should be developed as per pedagogic framework, where the course is designed in modular fashion and which is further discretized in small units. The outcome based instructional objectives are set in terms of the pedagogic structure, at course, module and unit level with a strong correlation between these at all level.

In the present work, a course *Energy Technology* has been developed as per the pedagogic framework and has been tested using a *Shikshan* software tool. It has been observed that from a pedagogic perspective and cognitive level context, there is a near to perfect correlation between course, and module level. At the same time, there is a very good correlation between module and unit level as well.

The present and future educational needs command that courses for an engineering degree programme must encourage higher levels of cognitive learning. Thus it is essential to select instructional objectives with major emphasis on the higher level of cognitive skills such as the ability to analyze, synthesize and evaluate problems and present solutions. Higher cognitive levels were attained at the course and module level in this example course presented. However, at unit level, certain portion at lower cognitive level ushers deeper understanding of the course.

In the present era of information technology, the self and quick learning is the mantra. When ocean of information is available at the fingertip, such student centric course content developed using pedagogic framework under Washington accord gives opportunity to the learner to achieve one's objectives quickly without entering into conventional monotonous and time consuming traditional modes of learning.

Acknowledgment

The authors would like to thank MHRD, IIT Kharagpur and BITS Pilani for the support.

References

Bloom, B.S. (Ed.). Engelhart, M.D., Furst, E.J., Hill, W.H., Krathwohl, D.R. (1956). Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain. New York: David McKay Co Inc

Energy technology, http://www.ide.iitkgp.ernet.in/Pedagogy1/pedagogy_main.jsp (2017)

International Engineering Alliance (IEA), *1989–2014 Celebrating international engineering education standards and recognition, Washington Accord*, 2014 http://www.ieagreements.org/assets/Uploads/Documents/History/25YearsWashingtonAccord-A5booklet-FINAL.pdf

Lovat., T.J "The Role of the 'Teacher' coming of Age?" Australian Council Deans of Education, Discussion Paper, 2003. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.124.9919&rep=rep1&type=pdf

Ray A. K., *Developers guide for Developing suitable pedagogical methods for various classes, intellectual calibres and research in e-learning* Retrieved June 21, 2017 from http://www.ide.iitkgp.ernet.in/Pedagogy1/pdf/Guidline.pdf

Shikshan - a software tool, http://www.ide.iitkgp.ernet.in/Pedagogy1/pedagogy_main.jsp (2016)

Sonwalkar N, The First Adaptive MOOC: A Case Study on Pedagogy Framework and Scalable Cloud Architecture—Part I, MOOCs FORUM. September 2013, 1(P): 22-29. http://online.liebertpub.com/doi/10.1089/mooc.2013.0007

Biography

Manoj Kumar Soni is an Associate Professor in Mechanical Engineering department at BITS, Pilani. He has total teaching and research experience of 22+ yrs. Prior to joing BITS, he was a faculty at VNIT Nagpur. He has total 29 publications in high impact factor international journals and international conferences in his name. His coveted lecture on Spiritual thermodynamics is very well appreciated by the students, academicians and industries. He has delivered this lecture at University of South Florida, many Indian universities and industries.

Tamali Bhattacharyya completed her Masters in Economics (1989) from Calcutta University and PhD (2012) from the School of Education Technology, Jadavpur University on Impact of educational software on learning outcome in secondary school children. Currently she is engaged with the Teaching Learning Center, BITS Pilani as a consultant. She has been offering an online course on Outcome based pedagogic principles for effective teaching under SWAYAM/MOOC from IIT Kharagpur and has conducted several Faculty Development Programmes organized by

IIT Kharagpur over the last 5 years. In the recent past, she has been a Research Project Manager in several education technology based projects at IIT Kharagpur. During her free time, she runs an NGO "ASMA" in West Bengal which among other activities, runs a school employing technology for tribal under privileged children in a village near IIT Kharagpur campus.

Bani Bhattacharya is an Associate Professor in CET, IIT Kharagpur. Her broad areas of expertise are Education Technology, Instructional Design, Pedagogy, Technology Enhanced Education (TEL) and Distance Education. She is the project Principal Investigator of "Developing suitable pedagogical methods for various classes, intellectual calibers and research in e-learning" under MHRD. She is the Coordinator of "National Programme on Technology Enhanced Learning (NPTEL)" Programme – Govt. of India