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Performance evaluation of mechanical engineering degrees using partial minimum squares and data envelopment analysis

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Abstract
This study analysed the causal relationship between the learning outcomes acquired in high school and university by mechanical engineering students in Colombia. The methodology articulates partial least squares and data envelopment analysis. The data represents the standardised exams conducted by the Colombian Institute for the Quality of Education from 2012 to 2019. The results indicate that 42% of the degrees that receive students with high levels of high school knowledge cannot add value to higher education learning outcomes. In parallel, 21% of the programs that receive students with low academic performance in high school can reach high-performance learning outcomes in higher education. In conclusion, the present methodology contributes to the spectrum of knowledge of models that support decision-making in the educational field to focus on improving academic levels and educational quality. Copyright © 2022 Inderscience Enterprises Ltd.

Index Keywords
academic performance, data envelopment analysis, decision making, education, performance assessment, secondary education; Colombia

References

- Abidi, S.S.R.
  Knowledge management in healthcare: towards 'knowledge-driven' decision-support services
  (2001) *International Journal of Medical Informatics*, 63 (1–2), pp. 5-18.
  Nos

- Agasisti, T., Munda, G., Hippe, R.
  Measuring the efficiency of European education systems by combining data envelopment analysis and multiple-criteria evaluation
  (2019) *Journal of Productivity Analysis*, 51 (2), pp. 105-124.
  [online]

- Aparicio, J., Cordero, J., Ortiz, L.
  Measuring efficiency in education: the influence of imprecision and variability in data on DEA estimates

(2019) *Socio-Economic Planning Sciences*, 68, p. 100698.
[online]

- Barelli, E., Branchetti, L., Tasquier, G., Albertazzi, L., Olivia, L.
Science of complex systems and citizenship skills: a pilot study with adult citizens
(2018) *Eurasia Journal of Mathematics, Science and Technology Education*, 14, pp. 1533-1545.
[online]

- Bianchi, N., Giorcelli, M.
Scientific education and innovation: from technical diplomas to University Stem Degrees
(2020) *Journal of the European Economic Association*, 18 (5), pp. 2608-2646.
[online] (accessed 25 February 2021)

- Biggeri, M., Mauro, V.
Towards a more 'sustainable' human development index: integrating the environment and freedom
(2018) *Ecological Indicators*, 91, pp. 220-231.
[online]

- Chansarn, S.
The evaluation of the sustainable human development: a cross-country analysis employing slack-based DEA
(2014) *Procedia Environmental Sciences*, 20, pp. 3-11.
[online]

- Charnes, A., Cooper, W.W., Rhodes, E.
Measuring the efficiency of decision making units
(1978) *European Journal of Operational Research*, 2 (6), pp. 429-444.
Elsevier [online] (accessed 2 April 2020)

- Coll-Serrano, V., Benítez, R., Bolós, V.
(2018) *Data Envelopment Analysis with deaR*,
España, Universidad de Valencia [online] (accessed 15 April 2020)

- Colombo, M.G., Piva, E.
Start-ups launched by recent STEM university graduates: the impact of university education on entrepreneurial entry
(2020) *Research Policy*, 49 (6), p. 103993.
[online]

- Cook, W.D., Ramón, N., Ruiz, J.L., Sirvent, I., Zhu, J.
DEA-based benchmarking for performance evaluation in pay-for-performance incentive plans
(2019) *Omega*, 84, pp. 45-54.
[online] (accessed 2 September 2020)

- de La Hoz, E., Zuluaga, R., Mendoza, A.
  Assessing and classification of academic efficiency in engineering teaching programs
  (2021) *Journal on Efficiency and Responsibility in Education and Science*, 14 (1), pp. 41-52.
  [online]

- Delahoz-Dominguez, E., Zuluaga, R., Fontalvo-Herrera, T.
  Dataset of academic performance evolution for engineering students
  (2020) *Data in Brief*, 30, p. 105537.
  [online]

- Delahoz-Dominguez, E.J., Fontalvo, T., Zuluaga, R., Delahoz-Dominguez, E.J., Fontalvo, T., Zuluaga, R.
  Evaluation of academic productivity of citizen competencies in the teaching of engineering by using the Malmquist index
  (2020) *Formación Universitaria, Centro de Información Tecnológica*, 13 (5), pp. 27-34.
  [online]

- Duan, S.X.
  Measuring university efficiency: an application of data envelopment analysis and strategic group analysis to Australian universities
  (2019) *Benchmarking: An International Journal*, 26 (4), pp. 1161-1173.
  Emerald Publishing Limited [online] (accessed 23 October 2020)

- Esteve, M., Rodriguez-Sala, J., Lopez-Espin, J., Aparicio, J.
  Heuristic and backtracking algorithms for improving the performance of efficiency analysis trees
  (2021) *IEEE Access*,
  [online]

- Gralka, S., Wohlrabe, K., Bornmann, L.
  How to measure research efficiency in higher education? Research grants vs. publication output
  (2019) *Journal of Higher Education Policy and Management*, 41 (3), pp. 322-341.
  Routledge [online] (accessed 25 June 2020)

- Handayati, P., Wulandari, D., Soetjipto, B.E., Wibowo, A., Narmaditya, B.S.
  Does entrepreneurship education promote vocational students' entrepreneurial mindset?
  (2020) *Heliyon*, 6 (11), p. e05426.
  [online]

- Hoeg, D.G., Bencze, J.L.
  Values underpinning STEM education in the USA: an analysis of the next generation science standards

(2017) *Science Education*, 101 (2), pp. 278-301.
[online] (accessed 25 June 2020)

- Ibañez, N., Mujica, M., Castillo, R.
Componentes del desarrollo humano sustentable
(2017) *Revista Negotium*, (36), pp. 63-77.
0

- Jones, C.I.
Chapter 1 – the facts of economic growth
(2016) *Handbook of Macroeconomics*, 2, pp. 3-69.
Taylor, J.B. and Uhlig, H. (Eds): Elsevier [online]

- Latan, H., Noonan, R.
(2017) *Partial Least Squares Path Modeling*,
(Eds): Cham, Springer International Publishing [online] (accessed 4 April 2021)

- Law, L., Fong, N.
Applying partial least squares structural equation modeling (PLS-SEM) in an investigation of undergraduate students' learning transfer of academic English
(2020) *Journal of English for Academic Purposes*, 46, p. 100884.
[online]

- Long, P., Siemens, G.
Penetrating the fog: analytics in learning and education
(2014) *Italian Journal of Educational Technology, Edizioni Menabò – Menabò SRL*, *22* (3), pp. 132-137.
[online] (accessed 25 June 2020)

- Maaß, K., Doorman, M., Jonker, V., Wijers, M.
Promoting active citizenship in mathematics teaching
(2019) *ZDM*, 51.
[online]

- Madria, W.F., Miguel, A.S., Li, R.C.
Quality-oriented network DEA model for the research efficiency of Philippine universities
(2019) *2019 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)*, pp. 596-600.
[online]

- Mardani, A., Zavadskas, E.K., Streimikiene, D., Jusoh, A., Khoshnoudi, M.
A comprehensive review of data envelopment analysis (DEA) approach in energy efficiency
(2017) *Renewable and Sustainable Energy Reviews*, 70, pp. 1298-1322.
[online]

- Minuci, E., Ferreira Neto, A.B., Hall, J.
  A data envelopment analysis of West Virginia school districts
  (2019) *Heliyon*, 5 (7), p. e01990.
  [online]

- Moncayo-Martínez, L.A., Ramírez–Nafarrate, A., Hernández–Balderrama, M.G.
  Evaluation of public HEI on teaching, research, and knowledge dissemination by data envelopment analysis
  (2020) *Socio-Economic Planning Sciences*, 69, p. 100718.
  [online]

- Navas, L.P., Montes, F., Abolghasem, S., Salas, R.J., Toloo, M., Zarama, R.
  Colombian higher education institutions evaluation
  (2020) *Socio-Economic Planning Sciences*, 71, p. 100801.
  [online]

- Nitzl, C., Roldan, J.L., Cepeda, G.
  Mediation analysis in partial least squares path modeling: Helping researchers discuss more sophisticated models
  (2016) *Industrial Management & Data Systems*, 116 (9), pp. 1849-1864.
  [online]

- (2015) *Objetivo 4: educación de calidad PNUD*,
  (PNUD) [online] (accessed 20 February 2020)

- (2013) *R: a language and environment for statistical computing*,
  R Foundation for Statistical Computing, R, Vienna, Austria [online] (accessed 15 April 2020)

- Raghupathi, W., Raghupathi, V.
  Big data analytics in healthcare: promise and potential
  (2014) *Health Information Science and Systems*, 2 (1), p. 3.

- Richaud, M.C.
  Algunos aportes sobre la importancia de la empatía y la prosocialidad en el desarrollo humano
  (2017) *Revista Mexicana de Investigación en Psicología*, 6 (2), pp. 171-176.

- Rönkkö, M., McIntosh, C.N., Antonakis, J., Edwards, J.R.
  Partial least squares path modeling: time for some serious second thoughts
  (2016) *Journal of Operations Management*, 47 (1), pp. 9-27.
  48 [online]

- Sadidi, M., Khalilifar, O., Amiri, M., Moradi, R.
  Use of partial least squares – structural equation modeling for identifying the most important variables via application of data envelopment analysis
  (2018) *Journal of Archives in Military Medicine*, 6 (1).
  Kowsar [online] (accessed 15 May 2021)

- Sanchez, G.
  (2013) *PLS Path Modeling with R*,
  Trowchez Editions, R, Berkeley, [online] (accessed 4 November 2020)

- Shambaugh, J., Nunn, R., Portman, B.
  Eleven facts about innovation and patents
  (2017) *Economic Facts – The Hamilton Project*, 1 (1), pp. 1-17.

- Shamohammadi, M., Oh, D.
  Measuring the efficiency changes of private universities of Korea: a two-stage network data envelopment analysis
  (2019) *Technological Forecasting and Social Change*, 148, p. 119730.
  [online] (accessed 18 June 2020)

- Smith, K.A., Willis, R.J., Brooks, M.
  An analysis of customer retention and insurance claim patterns using data mining: a case study
  (2000) *Journal of the Operational Research Society*, 51 (5), pp. 532-541.

- Suh, S.C., Bandi, H., Kim, J., Tanik, U.J.
  Case study: STEM contribution in Indian IT clusters
  (2020) *STEM in the Technopolis: The Power of STEM Education in Regional Technology Policy*, pp. 285-296.
  Zintgraff, C., Suh, S.C., Kellison, B. and Resta, P.E. (Eds): Springer International Publishing, Cham, [online] (accessed 25 February 2021)

- Tziogkidis, P., Philippas, D., Leontitsis, A., Sickles, R.C.
  A data envelopment analysis and local partial least squares approach for identifying the optimal innovation policy direction
  (2020) *European Journal of Operational Research*, 285 (3), pp. 1011-1024.
  [online]

- Valero-Carreras, D., Aparicio, J., Guerrero, N.
  Support vector frontiers: a new approach for estimating production functions through support vector machines
  (2021) *Omega*,

- Visbal-Cadavid, D., Martínez-Gómez, M., Guijarro, F.
  Assessing the efficiency of public universities through DEA. A case study
  (2017) *Sustainability*, 9 (8), p. 1416.

- Visbal-Cadavid, D., Mendoza, A.M., Hoyos, I.Q.
  Prediction of efficiency in Colombian higher education institutions with data envelopment analysis and neural networks
  (2019) *Pesquisa Operacional*, 39 (2), pp. 261-275.
  [online]

- Wei, G., Wang, J.
  A comparative study of robust efficiency analysis and data envelopment analysis with imprecise data
  (2017) *Expert Systems with Applications*, 81, pp. 28-38.
  [online]

- Wold, H.
  Causal flows with latent variables: partings of the ways in the light of NIPALS modelling
  (1974) *European Economic Review*, 5 (1), pp. 67-86.
  [online]

- Wolszczak-Derlacz, J.
  (2017) *An evaluation and explanation of (in) efficiency in higher education institutions in Europe and the U.S. with the application of two-stage semi-parametric DEA*, 46 (9).
  [online] (accessed 24 February 2020)

- Yang, G., Fukuyama, H., Song, Y.
  Measuring the inefficiency of Chinese research universities based on a two-stage network DEA model
  (2018) *Journal of Informetrics*, 12 (1), pp. 10-30.
  [online] (accessed 16 February 2021)

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