

RELATIONSHIP BETWEEN
EMPLOYABILITY AND GRADUATE'S
COMPETENCIES BASED ON PROGRAMME
LEARNING OUTCOMES ANALYSIS

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ANALYSIS

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ABSTRAK

Isu kebolehpasaran siswazah yang berkaitan dengan sifat atau kualiti seseorang yang diambil bekerja seperti pengetahuan dan kemahiran yang mereka miliki ke pasaran buruh adalah isu yang sangat penting dalam institusi pengajian tinggi (IPT). Oleh itu, selaras dengan aspirasi dan misi daripada Pelan Pembangunan Kebolehpasaran Siswazah 2012-2017, mereka menjangkakan untuk melahirkan graduan yang cekap dengan 75% graduan bekerja di dalam bidang berkaitan dalam tempoh enam bulan selepas bergraduasi. Kajian literatur menunjukkan kajian pengesanan biasanya digunakan dan telah diterima pakai oleh Kementerian Pengajian Tinggi untuk mengesan maklumat kebolehpasaran siswazah dan penilaian terhadap program pengajian telah membantu dalam meningkatkan peralihan graduan dari pendidikan ke pasaran buruh. Walaubagaimanapun, terdapat dua masalah yang timbul;- (1) kekurangan dalam membuat peramalan, dan (2) kekurangan data siswazah yang inklusif dimana data dan analisis daripada kajian pengesanan tidak dapat disampaikan dengan baik kepada pihak berkepentingan yang lain. Tambahan pula, didapati hanya sedikit perbincangan mengenai ramalan tempoh masa yang diambil oleh graduan dalam mendapat pekerjaan setelah bergraduasi. Oleh itu, kajian ini bertujuan untuk mengkaji hubungan antara tempoh masa kebolehpasaran dan kecekapan graduan berdasarkan hasil pembelajaran program (*programme learning outcomes, PLO*) dalam domain Sains Komputer atau kejuruteraan IT. Pembelajaran berasaskan hasil (*outcome-based education, OBE*) menyumbang kepada pencapaian hasil pembelajaran iaitu PLO yang membantu para pelajar untuk berjaya terutama dalam kehidupan professional dan pendidikan. Oleh itu, kajian ini menggunakan proses analisis ramalan bagi versi yang diubah suai bermula dengan definisi permasalahan dan mendapatkan dataset bersih sebelum formulasi model dan penilaian dibuat. Terdapat dua sumber yang telah digunakan dalam kajian ini, pangkalan data dari institusi akademik (PTMK UMP) dan maklum balas dalam talian daripada graduan. Kajian ini menerima 47 maklumbalas daripada 164 graduan dari Fakulti Komputeran (FK) kumpulan 2014/2015, dengan 29% kadar tindak balas. 'Simple linear regression' telah digunakan untuk mengukur hubungan diantara kategori PLO dan tempoh masa yang diambil oleh graduan untuk mendapat pekerjaan serta merumuskan model ramalan. Penemuan daripada kajian ini mendapati PLO6 (kemahiran penyelesaian masalah dan saintifik) adalah PLO yang paling sensitif kepada tempoh masa graduan untuk mendapat pekerjaan ($r = -0.2515$, $p = 0.0882$, $p < 0.25$, $N = 47$). Oleh itu, model ini dirumuskan berdasarkan persamaan linear PLO6 iaitu $Tempoh\ masa = -9.549x + 73.497$. Model ramalan ini disahkan melalui analisis kadar ralat dengan hasil yang dapat diterima dan dinilai dengan analisis kekerapan kadar ralat. Penilaian melalui kaedah pemeringkatan berdasarkan analisis kekerapan kadar ralat turut mendapati bahawa PLO6 berada di kedudukan pertama diikuti oleh PLO3, PLO1, PLO4, PLO5, PLO2, PLO8, PLO7. Kajian ini melaporkan data daripada pembelajaran berasaskan hasil berpotensi untuk meramal prestasi kebolehpasaran graduan dalam tempoh masa (enam bulan) seperti yang ditentukan oleh Kementerian Pengajian Tinggi. Dengan kemampuan ramalan daripada model yang dibangunkan, lebih banyak penambahbaikan program dapat dirancang secara strategik untuk memastikan graduan memperoleh pekerjaan dalam masa sebenar dan didalam bidang masing-masing.

ABSTRACT

Graduate employability pertains to issues that are related to the person's character or quality of being employable such as the knowledge and skills they possess to the labour market is a crucial issue in higher education institutions (HEIs). Accordingly, in line with the aspirations and mission of the National Graduate Employability Blueprint Malaysia 2012-2017, they expect to produce competent graduates with 75% of the graduates working in their related fields within six months after graduation. Throughout the literature, tracer study is commonly used and has been adopted by the Ministry of Higher Education to trace graduate employability (GE) information and evaluation on study programmes have helped in improving the transition of graduates from education to the labour market. However, two issues arise;- (1) a lack in predictive capability, and (2) the lack of inclusive graduate data where data and analysis from a tracer study have not been well communicate to other stakeholders. Furthermore, there have been little discussion on predicting the duration of a graduate's employment after graduation. Therefore, this study intends to investigate the relationship between employability duration and the graduate's competencies based on programme learning outcomes (PLO) among Computer Science or IT engineering domain. The outcome-based education (OBE) contributes to the learning outcomes attainment which is the PLO that helps the learners to succeed especially in professional life and education. Thus, this study used a modified version of the predictive analytic process that started with problem definition and obtained a clean dataset before the model formulation and evaluation took place. There are two data sources that have been used in this study, institutional academic database (PTMK UMP) and an online feedback from the graduates. This study received 47 responses out of 164 graduates from 2014/2015 Faculty of Computing (FK) batch, with a response rate of 29%. A simple linear regression was used to measure the correlation between the category of PLO and the duration of graduate to get employed as well as to formulate the prediction model. The findings from this study found that PLO6 (*problem solving and scientific skills*) was the most sensitive PLO on the duration for a graduate to get employed ($r = -0.2515$, $p = 0.0882$, $p < 0.25$, $N = 47$). Thus, the model was formulated based on the linear equation of PLO6 which is $Duration = -9.549x + 73.497$. This prediction model was validated through error rate analysis with acceptable result and evaluated by error rate frequency analysis. The evaluation through ranking method based on the frequency analysis of error rate also found that PLO6 was at the first rank followed by PLO3, PLO1, PLO4, PLO5, PLO2, PLO8, PLO7. This study reported the potential of outcome-based education data to predict graduate employability performance within the time frame (six months) as determined by the Ministry of Higher Education. With prediction capacity from the formulated model, more intervention programme can be strategically planned to assure that graduates can be employed in time and in-field.

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LIST OF SYMBOLS

r	Correlation coefficient
R^2	Coefficient of determination
p	Significant value
N	Number of pairs
Σ	Summation
α	Alpha
df	Degree of freedom
H_0	Null hypothesis
H_a	Alternative hypothesis

LIST OF ABBREVIATIONS

iCGPA	integrated Cumulative Grade Point Average
CGPA	Cumulative Grade Point Average
GPA	Grade Point Average
MoHE	Ministry of Higher Education
MQF	Malaysian Qualifications Framework
OBE	Outcome-Based Education
PLO	Program Learning Outcomes
CLO	Course Learning Outcomes
PEO	Program Educational Objectives
PO	Program Outcomes
CO	Course Outcomes
ILO	International Labour Organization
VET	Vocational Education and Training
HEI	Higher Education Institution
SAffAD	Student Affairs & Alumni Department
UMP	Universiti Malaysia Pahang
FK	Faculty of Computing
PTMK	Pusat Teknologi Maklumat & Komunikasi
SLR	Simple Linear Regression

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REFERENCES

- Abbott, D. (2014). Applied predictive analytics: Principles and techniques for the professional data analyst. In *Journal of World Trade*. <https://doi.org/10.1002/ejoc.201200111>
- Abdul Lateh, M., Muda, A. K., Izzah Mohd Yusof, Z., Azilah Muda, N., & Sanusi Azmi, M. (2017). Handling a small dataset problem in prediction model by employ artificial data generation approach: a review. *Journal of Physics: Conference Series*, 892(1). <https://doi.org/10.1088/1742-6596/892/1/012016>
- Aboueisha, H., Amin, T., Chikalov, I., Hussain, S., & Moshkov, M. (2019). Extensions of dynamic programming for combinatorial optimization and data mining. *Intelligent Systems Reference Library*, 146. <https://doi.org/10.1007/978-3-319-91839-6>
- Adam, S. (2004). A consideration of the nature, role, application and implications for European education of employing ‘learning outcomes’ at the local, national and international levels. In *United Kingdom Bologna Seminar, Heriot-Watt University (Edinburgh Conference Centre) Edinburgh*. <https://doi.org/Heriot-Watt University>
- Adedeji, A., Ojelabi, R., Tunji-Olayeni, P., Omuh, I., & Oyeyipo, O. (2019). Critical factors influencing building graduates’ employability in a developing economy. *10th International Structural Engineering and Construction Conference, ISEC 2019*, 1–7.
- Afiq, A. (2018). Embrace 21st-century learning approach. *The Malaysia Reserve*, 1–6. <https://themalaysianreserve.com>
- Aina, L. O., & Moahi, K. (1999). Tracer study of the Botswana library school graduates. *Education for Information*, 17(3), 215–244. <https://doi.org/10.3233/EFI-1999-17304>
- Al-Radaideh, Q. A., Al-Shawakfa, E. M., & Al-Najjar, M. I. (2006). Mining student data using decision trees. *International Arab Conference on Information Technology (ACIT'2006), Yarmouk University, Jordan*.
- Amrhein, V., Greenland, S., & Mcshane, B. (2019). Retire statistical significance. *Nature*, 567(7748), 305–307. <https://doi.org/10.1038/d41586-019-00857-9>
- Andrews, J., & Higson, H. (2008). Graduate employability, “soft skills” versus “hard” business knowledge: A european study. *Higher Education in Europe*, 33(4), 411–422. <https://doi.org/10.1080/03797720802522627>
- Association, A. M. (2019). *Executives say 21st century needs more skilled workers*. <https://www.amanet.org/articles/executives-say-21st-century-needs-more-skilled-workers/>
- Bai, L. (2015). Graduate unemployment : dilemmas and challenges in China’s move to mass higher education. *The China Quarterly*, 185, 128–144. <https://doi.org/10.1017/S0305741006000087>

- Baradwaj, B. K., & Pal, S. (2012). Mining educational data to analyze students' performance. *ArXiv Preprint ArXiv:1201.3417*.
- Bell, R. (2016). Unpacking the link between entrepreneurialism and employability: An assessment of the relationship between entrepreneurial attitudes and likelihood of graduate employment in a professional field. *Education and Training, 58*(1), 2–17. <https://doi.org/10.1108/ET-09-2014-0115>
- Bhardwaj, B. K., & Pal, S. (2011). Data Mining: A prediction for performance improvement using classification. *International Journal of Computer Science and Information Security (IJCSIS), 9*(4). <http://arxiv.org/abs/1201.3418>
- Bharian. (2019). *Graduan UMP pilihan utama pasaran kerja*. <https://www.bharian.com.my/berita/nasional/2019/07/590370/graduan-ump-pilihan-utama-pasaran-kerja>
- Bhuriya, D., Kaushal, G., Sharma, A., & Singh, U. (2017). Stock market predication using a linear regression. *Proceedings of the International Conference on Electronics, Communication and Aerospace Technology, ICECA 2017, 2017-Janua*, 510–513. <https://doi.org/10.1109/ICECA.2017.8212716>
- Bindra, S. K., Girdhar, A., & Bamrah, I. S. (2017). Outcome based predictive analysis of automatic question paper using data mining. *2017 2nd International Conference on Communication and Electronics Systems (ICCES), 2018-Janua*(Icces), 629–634. <https://doi.org/10.1109/CESYS.2017.8321154>
- Bonilla, J. (J. C. (2017). Modeling data analytics capabilities from text: an explanatory analysis on data mining initiatives. *ProQuest Dissertations and Theses*, 160. <https://search.proquest.com/docview/1911955602?accountid=17242>
- Boonsiritomachai, W., McGrath, G. M., & Burgess, S. (2016). Exploring business intelligence and its depth of maturity in Thai SMEs. *Cogent Business and Management, 3*(1). <https://doi.org/10.1080/23311975.2016.1220663>
- Bowen, M. M., & Johnson, K. R. (2019). Entrepreneurial skills for the 21st century workplace. In *In Handbook of Research on Promoting Higher-Order Skills and Global Competencies in Life and Work* (pp. 56–69). IGI Global. <https://doi.org/10.4018/978-1-5225-6331-0.ch004>
- Breslow, L. A., & Aha, D. W. (1997). Simplifying decision trees: A survey. *Knowledge Engineering Review, 12*(1), 1–40. <https://doi.org/10.1017/S0269888997000015>
- Bridgstock, R., & Jackson, D. (2019). Strategic institutional approaches to graduate employability: navigating meanings, measurements and what really matters. *Journal of Higher Education Policy and Management, 41*(5), 468–484. <https://doi.org/10.1080/1360080X.2019.1646378>
- Brooks, C., & Thompson, C. (2017). Chapter 5: predictive modelling in teaching and learning. In *Handbook of Learning Analytics* (pp. 61–68). <https://doi.org/10.18608/hla17>

- Brown, S., McHardy, J., McNabb, R., & Taylor, K. (2011). Workplace performance, worker commitment, and loyalty. *Journal of Economics and Management Strategy*, 20(3), 925–955. <https://doi.org/10.1111/j.1530-9134.2011.00306.x>
- Bui, B., & Porter, B. (2010). The expectation-performance gap in accounting education: An exploratory study. *Accounting Education*, 19(1–2), 23–50. <https://doi.org/10.1080/09639280902875556>
- Bui, H. T. M., Nguyen, H. T. M., & Cole, D. (2019). Innovate higher education to enhance graduate employability. In H. T. M. Bui, H. T. M. Nguyen, & D. Cole (Eds.), *Innovate Higher Education to Enhance Graduate Employability*. Routledge. <https://doi.org/10.4324/9780429058899>
- Burns, R. P., & Burns, R. (2008). *Business research methods and statistics using SPSS*. Sage.
- Cai, Y. (2012). Graduate employability: A conceptual framework for understanding employers' perceptions. *Higher Education*, 1–13. <https://doi.org/10.1007/s10734-012-9556-x>
- Casner-Lotto, J., & Benner, M. (2006). Are they really ready to work? Employers' perspectives on the basic knowledge and applied skills of new entrants to the 21st Century U.S. workforce. In *Human Resource Management*.
- Chai, X., Shan, S., Chen, X., & Gao, W. (2007). Locally linear regression for pose-invariant face recognition. *IEEE Transactions on Image Processing*, 16(7), 1716–1725. <https://doi.org/10.1109/TIP.2007.899195>
- Chao, G. Y., Tsai, T. I., Lu, T. J., Hsu, H. C., Bao, B. Y., Wu, W. Y., Lin, M. T., & Lu, T. L. (2011). A new approach to prediction of radiotherapy of bladder cancer cells in small dataset analysis. *Expert Systems with Applications*, 38(7), 7963–7969. <https://doi.org/10.1016/j.eswa.2010.12.035>
- Chaudhry, N. G., & Rasool, G. (2012). A case study on improving problem solving skills of undergraduate computer science students. *World Applied Sciences Journal*, 20(1), 34–39. <https://doi.org/10.5829/idosi.wasj.2012.20.01.1778>
- Choi, J., Lee, H.-S., & Kim, J.-J. (2017). Analysis of pediatric foot disorders using decision tree and neural networks. *2017 European Conference on Electrical Engineering and Computer Science (EECS)*, 41–46. <https://doi.org/10.1109/EECS.2017.17>
- Clarke, M. (2008). Understanding and managing employability in changing career contexts. *Journal of European Industrial Training*, 32(4), 258–284. <https://doi.org/10.1108/03090590810871379>
- Clarke, M. (2018). Rethinking graduate employability: the role of capital, individual attributes and context. *Studies in Higher Education*, 43(11), 1923–1937. <https://doi.org/10.1080/03075079.2017.1294152>

- Colbert, A., Yee, N., & George, G. (2016). The digital workforce and the workplace of the future. *Academy of Management Journal*, 59(3), 731–739. <https://doi.org/10.5465/amj.2016.4003>
- Commission, P. (2013). *On efficiency and effectiveness : some definitions* (Issue May).
- Connell, J., & Burgess, J. (2006). The influence of precarious employment on career development: The current situation in Australia. *Education + Training*, 48(7), 493–507. <https://doi.org/10.1108/00400910610705881>
- Cornock, M. (2011). Legal definitions of responsibility, accountability and liability. *Nursing Children and Young People*, 23(3), 25–26. <https://doi.org/10.7748/ncyp2011.04.23.3.25.c8417>
- Council, T. G. and B. (2011). *The global skills gap: preparing young people for the new global economy*. https://think-global.org.uk/wp-content/uploads/dea/documents/BusinessPoll_online_TG.pdf
- Dahlstrom, E. (2016). Digital capabilities in higher education, 2015: Analytics. In *Louisville, CO: ECAR*. <https://library.educause.edu/~media/files/library/2016/11/ers1611.pdf>
- Damotharan, L. V. (2012). *Tracer study on AIMST University students using data mining*.
- Davenport, T. H., & Harris, J. G. (2007). *Competing on analytics: the new science of winning*. Harvard Business School Press Boston, MA, USA ©2007. <https://doi.org/10.1080/14783360902925454>
- Davenport, T. H., Harris, J. G., & Morison, R. (2010). *Analytics at work: smarter decisions , better results*.
- Delgado Calvo-Flores, M., Gibaja Galindo, E., Pegalajar Jiménez, M. C., & Pérez Piñeiro, O. (2006). Predicting students' marks from Moodle logs using neural network models. *Current Developments in Technology-Assisted Education*, 586–590. <https://doi.org/10.1017/S0922156509990057>
- Deng, Y., Lei, H., Li, X., & Lin, Y. (2018). An improved deep neural network model for job matching. *2018 International Conference on Artificial Intelligence and Big Data (ICAIBD)*, 106–112. <https://doi.org/10.1109/ICAIBD.2018.8396176>
- Dr.A.Kavitha, James, K. I. A., K.A.Harish, & V.Rajamani, D. (2018). A empirical study on Co-Po assessment & attainment for NBA Tier-II engineering accreditation towards empowering the students through outcome based education. *International Journal of Pure and Applied Mathematics*, 118(20), 2615–2624.
- Duncan, I. G. (2011). *Healthcare risk adjustment and predictive modeling*.
- Dunham, M., & Ming, D. (2003). Introductory and advanced topics. *Engineering*. <https://doi.org/10.5539/gjhs.v8n3p183>

- E. Glickman, M., & A. van Dyk, D. (2007). Basic bayesian methods. In *Methods in molecular biology* (Vol. 404, pp. 319–338). https://doi.org/10.1007/978-1-59745-530-5_16
- Educause. (2010). *7 things you should know about analytics*. Educause Learning Initiative. <http://www.educause.edu/Resources/7ThingsYouShouldKnowAboutAnaly/202736>
- Ekowo, M., & Palmer, I. (2017). Predictive analytics in higher education: five guiding practices for ethical use. *New America, March*(March). <https://na-production.s3.amazonaws.com/documents/Predictive-Analytics-GuidingPractices.pdf>
- European Training Foundation. (2017). *Tracer studies evaluating the impact of training programmes*.
- Fahimirad, M., Kumar Nair, P., Shakib Kotamjani, S., Mahdinezhad, M., & Bao Feng, J. (2019). Integration and development of employability skills into malaysian higher education context: Review of the literature. *International Journal of Higher Education*, 8(6), 26–35. <https://doi.org/10.5430/ijhe.v8n6p26>
- Fan, D., Li, S., Shuyu, M., Zhibin, X., & Li, X. (2018). Predicting submarine topography by linear regression analysis. *Zhongguo Guanxing Jishu Xuebao/Journal of Chinese Inertial Technology*, 26, 2018.
- Fang, T., & Lahdelma, R. (2016). Evaluation of a multiple linear regression model and SARIMA model in forecasting heat demand for district heating system. *Applied Energy*, 179, 544–552. <https://doi.org/10.1016/j.apenergy.2016.06.133>
- Fawcett, T. (2004). ROC graphs: notes and practical considerations for data mining researchers. *Machine Learning*, 31(1), 1–38.
- Fellows, R. (2009). Advanced research methods in the built environment. *Construction Management and Economics*. <https://doi.org/10.1080/01446190902896637>
- Fenta, H. M., Asnakew, Z. S., Debele, P. K., Nigatu, S. T., & Muhaba, A. M. (2019). Analysis of supply side factors influencing employability of new graduates: A tracer study of Bahir Dar University graduates. *Journal of Teaching and Learning for Graduate Employability*, 10(2), 67. <https://doi.org/10.21153/jtlge2019vol10no2art801>
- Field, R. (2019). Teaching resilience and self-management skills. In *Education for Employability (Volume 2)* (pp. 237–246). Brill | Sense. https://doi.org/10.1163/9789004418707_020
- Figueiredo Filho, D. B., Paranhos, R., Rocha, E. C. da, Batista, M., Silva Jr., J. A. da, Santos, M. L. W. D., & Marino, J. G. (2013). When is statistical significance not significant? *Brazilian Political Science Review*, 7(1), 31–55. <https://doi.org/10.1590/s1981-38212013000100002>

- Fitzpatrick, J. J., Byrne, E. P., & Kennedy, D. (2009). Making programme learning outcomes explicit for students of process and chemical engineering. *Education for Chemical Engineers*, 4(2), 21–28. <https://doi.org/10.1016/j.ece.2009.07.001>
- Futch, K. W. (2014). *Factors that predict time to in-field employment of associate degree graduates: a study of one college in the technical college system of georgia* (Issue April). <https://search-proquest-com.ezproxy.ump.edu.my/docview/1527477363?accountid=29391>
- Gaglio, C. M. (2004). The role of mental simulations and counterfactual thinking in the opportunity identification process. *Entrepreneurship: Theory and Practice*. <https://doi.org/10.1111/j.1540-6520.2004.00063.x>
- Galagan, P. (2010). Bridging the skills gap: new factors compound the growing skills shortage. *T + D*, 64(2), 44.
- Galton, F., & Pearson, K. (2001). A brief history of linear regression for statistics instructors. *Journal of Statistics Education*, 9(3), 1–13. <https://doi.org/10.1080/10691898.2001.11910537>
- Gandomi, A., & Haider, M. (2015). Beyond the hype: Big data concepts, methods, and analytics. *International Journal of Information Management*, 35(2), 137–144. <https://doi.org/10.1016/j.ijinfomgt.2014.10.007>
- Gao, X., An, H., Fang, W., Huang, X., Li, H., Zhong, W., & Ding, Y. (2014). Transmission of linear regression patterns between time series: From relationship in time series to complex networks. *Physical Review E - Statistical, Nonlinear, and Soft Matter Physics*, 90(1), 1–7. <https://doi.org/10.1103/PhysRevE.90.012818>
- George, G. H., Moore, E., & Patey, M. C. (1994). A simple model for predicting success in an engineering programme. *International Journal of Engineering Education*, 10(3), 268–273.
- Gharehchopogh, F. S., Bonab, T. H., & Khaze, S. R. (2013). A linear regression approach to prediction of stock market trading volume: a case study. *International Journal of Managing Value and Supply Chains*, 4(3), 25–31. <https://doi.org/10.5121/ijmvsc.2013.4303>
- Ghulman, H. A., & Mas'odi, M. S. (2009). Modern measurement paradigm in engineering education: Easier to read and better analysis using rasch-based approach. *2009 International Conference on Engineering Education, ICEED2009 - Embracing New Challenges in Engineering Education, ICEED*, 1–6. <https://doi.org/10.1109/ICEED.2009.5490624>
- Gill, R. (2018). Building employability skills for higher education students: An Australian example. *Journal of Teaching and Learning for Graduate Employability*, 9(1), 84–92. <https://doi.org/10.21153/jtlge2018vol9no1art739>
- Guerard, J. B. (2013). Regression analysis and forecasting models. In *Introduction to Financial Forecasting in Investment Analysis* (Issue 2007). Springer New York. <https://doi.org/10.1007/978-1-4614-5239-3>

- Gupta, B., Rawat, A., Jain, A., Arora, A., & Dhama, N. (2017). Analysis of various decision tree algorithms for classification in data mining. *International Journal of Computer Applications*, 163(8), 5–9. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=%22Analysis+of+Various+Decision+Tree+Algorithms+for+Classification+in+Data+Mining%22&btnG=
- H. Taib, S M Salleh, B A Md Zain, M.A. Azlan, S. Mahzan, Hafeez Z A, Ong, P., S. Ahmad, M. N.A Rahman, N.F. Nasir, M. Azham Azmi. H.A Rahman, Z. N. (2017). Programme learning outcomes assessment and continuous quality improvement in Faculty of Mechanical and Manufacturing, UTHM. *IOP Conference Series: Materials Science and Engineering*, 165. <https://doi.org/10.1088/1742-6596/755/1/011001>
- Hamid, M. S. A., Islam, R., & Hazilah, A. M. N. (2014). Malaysian graduates' employability skills enhancement: An application of the importance performance analysis. *Journal for Global Business Advancement*, 7(3), 181–197. <https://doi.org/10.1504/JGBA.2014.064078>
- Hamilton, M., Carbone, A., Gonsalvez, C., & Jollands, M. (2015). Breakfast with ICT employers: What do they want to see in our graduates? *Conferences in Research and Practice in Information Technology Series*, 160(January), 29–36.
- Harden, R. M. (2007). Learning outcomes as a tool to assess progression. *Medical Teacher*, 29(7), 678–682. <https://doi.org/10.1080/01421590701729955>
- Harvey, L. (2001). Quality in higher education: defining and measuring employability. *Quality in Higher Education*, 7(2), 96–109. <https://doi.org/10.1080/1353832012005999>
- Harvey, L., Geall, V., & Moon, S. (1997). Graduates' work: implications of organizational change for the development of student attributes. *Industry and Higher Education*, 11(5), 287–296. <https://doi.org/10.1177/095042229701100504>
- Hauser, W. J. (2007). Marketing analytics: the evolution of marketing research in the twenty-first century. *Direct Marketing: An International Journal*, 1(1), 38–54. <https://doi.org/10.1108/17505930710734125>
- Haykin, S. (1998). *Neural networks: a comprehensive foundation* (2nd ed.). Prentice Hall PTR.
- Hazelkorn, E., & Gibson, A. (2019). Public goods and public policy: what is public good, and who and what decides? *Higher Education*. <https://doi.org/10.1007/s10734-018-0341-3>
- Held, L., & Ott, M. (2018). On p - values and bayes factors. *Annual Review of Statistics and Its Application*, 5(1), 393–419. <https://doi.org/10.1146/annurev-statistics-031017-100307>
- Hluchy, L., Habala, O., Ciglan, M., & Tran, V. D. (2008). *Mining and integration of environmental data*. 247–252.

- Ieraci, S. (2007). Responsibility versus accountability in a risk-averse culture. *EMA - Emergency Medicine Australasia*, 19(1), 63–64. <https://doi.org/10.1111/j.1742-6723.2006.00935.x>
- Imanishi, Y., Fukuma, S., Karaboyas, A., Robinson, B. M., Pisoni, R. L., Nomura, T., Akiba, T., Akizawa, T., Kurokawa, K., Saito, A., Fukuhara, S., & Inaba, M. (2017). Associations of employment status and educational levels with mortality and hospitalization in the dialysis outcomes and practice patterns study in Japan. *PLoS ONE*. <https://doi.org/10.1371/journal.pone.0170731>
- Irza Hanie, A. S., Razleena, R., & Haslina, H. B. (2015). *Lifelong learning and youth employability: graduates in Malaysia*. 2(5).
- Iwu, P. C. (2019). Employability skills needed to prepare final year degree students of business education for global work competition in Imo State, Nigeria. *Nigerian Journal of Business Education (NIGJBED)*, 6(2), 358–367.
- Jantawan, B., & Tsai, C. (2013). The application of data mining to build classification model for predicting graduate employment. *International Journal of Computer Science and Information Security*, 11(1), 1–8. <https://doi.org/10.1016/j.bdr.2015.01.001>
- Johnson, L. H. (1953). Limitations of the descriptive method. *The Phi Delta Kappan*, 34(6), 241–245. <http://www.jstor.org/stable/20332351>
- K, R. B., & Simha, J. B. (2010). Evaluation of logistic regression model with feature selection methods on medical dataset. *ACS-International Journal on Computational Intelligence*, 1(2), 35–42. <https://pdfs.semanticscholar.org/25fd/2069a2ebb9d634321cd0c048e1471ee6fc2a.pdf>
- Katajavuori, N., Lindblom-Ylänne, S., & Hirvonen, J. (2006). The significance of practical training in linking theoretical studies with practice. *Higher Education*, 51(3), 439–464. <https://doi.org/10.1007/s10734-004-6391-8>
- Khalilzadeh, J., & Tasci, A. D. A. (2017). Large sample size, significance level, and the effect size: Solutions to perils of using big data for academic research. *Tourism Management*, 62, 89–96. <https://doi.org/10.1016/j.tourman.2017.03.026>
- King, G., & Zeng, L. (2001). Explaining rare events in international relations. *International Organization*. <https://doi.org/10.1162/00208180152507597>
- Kirzner, I. M. (1999). Creativity and/or alertness: A reconsideration of the schumpeterian entrepreneur. *Review of Austrian Economics*, 11(1–2), 5–17. <https://doi.org/10.1023/A:1007719905868>
- Kishore Babu, S., & Vasavi, S. (2019). Predictive analytic as a service on tax evasion using feature engineering strategies. In D. Mandal, R. Kar, S. Das, & B. K. Panigrahi (Eds.), *Smart Intelligent Computing and Applications* (Vol. 343, pp. 393–402). Springer India. https://doi.org/10.1007/978-981-13-1921-1_39

- Kiss, E., Barker, M., & Singh, P. (2019). International undergraduate business students' perceptions of employability. *5th International Conference on Higher Education Advances (HEAd'19)*, 1105–1112. <https://doi.org/10.4995/HEAD19.2019.9354>
- Klein, B. D., & Rossin, D. F. (1999). Data quality in linear regression models: effect of errors in test data and errors in training data on predictive accuracy. *Informing Science*, 2.
- Kokol, P., Zorman, M., Stiglic, M. M., & Malèiae, I. (1998). The limitations of decision trees and automatic learning in real world medical decision making. *Studies in Health Technology and Informatics*, 52 Pt 1(6), 529–533. <https://doi.org/10.1023/A:1022876330390>
- König, R. (2009). *Predictive techniques and methods for decision support in situations with poor data quality*.
- Kucel, A., Róbert, P., Buil, M., & Masferrer, N. (2016). Entrepreneurial skills and education-job matching of higher education graduates. *European Journal of Education*, 51(1), 73–89. <https://doi.org/10.1111/ejed.12161>
- Laalo, H., Kinnari, H., & Silvennoinen, H. (2019). Setting new standards for Homo academicus: entrepreneurial university graduates on the EU agenda. *European Education*, 51(2), 93–110. <https://doi.org/10.1080/10564934.2018.1489729>
- Lani, J. (2010). *What is logistic regression?* Statistics Solutions.
- Larsen, R. W. (2011). *Developing program learning outcomes*.
- Latif, L. A., & Bahroom, R. (2010). OUM's tracer study: a testimony to a quality open and distance education. *ASEAN Journal of Open and Distance Learning*, 2(1), 35–47.
- Lau, J. (2006). Guidelines on information literacy for lifelong learning. Retrieved October, 60. <http://www.jesuslau.com/docs/publicaciones/doc2/Iflaguidelines.pdf>
- Lehmann, E. L. (1958). Significance level and power. *The Annals of Mathematical Statistics*, 29(4), 1167–1176. <http://www.jstor.org/stable/2236953>
- Lim, H. E. (2010). Predicting low employability graduates: The case of universiti utara Malaysia. *Singapore Economic Review*, 55(3), 523–535. <https://doi.org/10.1142/S0217590810003870>
- Low, M., Botes, V., Rue, D. Dela, & Allen, J. (2016). Accounting employers' expectations - the ideal accounting graduates. *Journal of Business Education & Scholarship of Teaching*, 101010(11), 36–57. <http://www.ejbest.org>
- Lundberg, G. M., Krogstie, B. R., & Krogstie, J. (2020). Becoming fully operational: Employability and the need for training of computer science graduates. *IEEE Global Engineering Education Conference, EDUCON, 2020-April*, 644–651. <https://doi.org/10.1109/EDUCON45650.2020.9125188>

- Malaysian Qualification Agency. (2017). *Malaysian qualifications framework (MQF) 2nd edition*.
- Malaysian Qualifications Agency, M. (2018). *Code of Practice for Programme Accreditation* (Issue 2017).
- Manda, M., & Matidza, I. (2016). A tracer study of 2011-2015 graduates from the land management programme at Mzuzu University. *Journal of Education and Society in Southern Africa*, 3(3), 45–67.
- Manea, A. D. (2014). Lifelong learning programs—an effective means of supporting continuing education. *Procedia - Social and Behavioral Sciences*. <https://doi.org/10.1016/j.sbspro.2014.07.648>
- Mason, G., Williams, G., & Cranmer, S. (2009). Employability skills initiatives in higher education: What effects do they have on graduate labour market outcomes? *Education Economics*, 17(1), 1–30. <https://doi.org/10.1080/09645290802028315>
- Mcculloch, W. S., & Pitts, W. (1990). A logical calculus of the ideas immanent in nervous activity. *Bulletin of Mathematical Biology*, 52(1/2), 99–115. <https://doi.org/10.1007/BF02478259>
- McGrath, S. K., & Whitty, S. J. (2018). Accountability and responsibility defined. *International Journal of Managing Projects in Business*, 11(3), 687–707. <https://doi.org/10.1108/IJMPB-06-2017-0058>
- McQuaid, R. W., & Lindsay, C. (2005). The concept of employability. *Urban Studies*, 42(2), 197–219. <https://doi.org/10.1080/0042098042000316100>
- Ministry of Higher Education. (2015). Integrated Cummulative Grade Point Average (iCGPA). In *Ministry of Higher Educaation*. <https://doi.org/10.5923/j.ijis.20120206.05>
- Ministry of Higher Education Malaysia. (2012). The national graduate employability blueprint 2012-2017. In *Perpustakaan Negara Malaysia*.
- Misra, R. K., & Khurana, K. (2017). Employability Skills among Information Technology Professionals: A Literature Review. *Procedia Computer Science*, 122, 63–70. <https://doi.org/10.1016/j.procs.2017.11.342>
- Mn, K., Khalid, F., & Husnin, H. (2020). Preparing graduates with digital literacy skills toward fulfilling employability need in 4IR Era: A review. *International Journal of Advanced Computer Science and Applications*, 11(6), 307–316. <https://doi.org/10.14569/IJACSA.2020.0110641>
- MOE. (2018). Laporan Kajian Pengesanan Graduan 2018. *Kementerian Pendidikan Malaysia Putrajaya*, 101.
- MOE. (2019). Laporan Kajian Pengesanan Graduan 2018. In *Kementerian Pendidikan Malaysia*.

- Mohd Adnan, Y., Daud, M. N., Alias, A., & Razali, M. N. (2012). Importance of soft skills for graduates in the real estate programmes in Malaysia. *Journal of Surveying, Construction & Property*, 3(2), 1–13. <https://doi.org/10.22452/jscp.vol3no2.4>
- MoHE. (2019). *Graduate Tracer Studies*. 152–163.
- Morris, D. (2016). *Bayes theorem: a visual introduction for beginners*.
- Morton, S. M. B., Bandara, D. K., Robinson, E. M., & Atatoa Carr, P. E. (2012). In the 21st Century, what is an acceptable response rate? *Australian and New Zealand Journal of Public Health*, 36(2), 106–108. <https://doi.org/10.1111/j.1753-6405.2012.00854.x>
- Moshkov, M. J. (2005). Time complexity of decision trees. *Transactions on Rough Sets III*, 244–459. http://link.springer.com/chapter/10.1007/11427834_12
- Moucary, C. El, Khair, M., & Zakhem, W. (2011). Improving student's performance using data clustering and neural networks in foreign-language based higher education. *The Research Bulletin of Jordan ACM*, 2(3), 34. <http://ijj.acm.org/volumes/volume2/no3/ijjvol2no3p1.pdf>
- Mumme, B. (2017). Graduate education and impact: stakeholder responsibilities for employability in the fourth industrial revolution. *20th Annual Irish Academy of Management Conference 2017*.
- Nabilah, Z. (2018). *personal communication*.
- Nafi, M. N. A., & Ghani, I. A. (2011). Modelling employability of graduates using logistic regression. *Journal of Statistical Modelling and Analytics*, 2(1), 45–52.
- Ngoo, Y. T., Tiong, K. M., & Pok, W. F. (2015). Bridging the gap of perceived skills between employers and accounting graduates in Malaysia. *American Journal of Economics*, 5(2), 98–104. <https://doi.org/10.5923/c.economics.201501.09>
- Nguyen Thai Nghe, Janecek, P., & Haddawy, P. (2007). A comparative analysis of techniques for predicting academic performance. *2007 37th Annual Frontiers in Education Conference - Global Engineering: Knowledge without Borders, Opportunities without Passports*, 20(44), T2G-7-T2G-12. <https://doi.org/10.1109/FIE.2007.4417993>
- O'Neil, H. F. (2014). *Workforce readiness: competencies and assessment*. <https://books.google.com/books?hl=en&lr=&id=9mgAAwAAQBAJ&pgis=1>
- Okubo, F., Yamashita, T., Shimada, A., & Ogata, H. (2017). A neural network approach for students' performance prediction. *Proceedings of the Seventh International Learning Analytics & Knowledge Conference on - LAK '17, March*, 598–599. <https://doi.org/10.1145/3027385.3029479>
- Oladokun, V. O., Adebajo, A. T., & Charles-Owaba, O. E. (2008). Predicting students' academic performance using artificial neural network: a case study of an engineering course. *The Pacific Journal of Science and Technology*, 9(1), 72–79. <https://doi.org/10.1007/978-90-481-9572-5>

- Oommen, T., Baise, L. G., & Vogel, R. M. (2011). Sampling bias and class imbalance in maximum-likelihood logistic regression. *Mathematical Geosciences*, 43(1), 99–120. <https://doi.org/10.1007/s11004-010-9311-8>
- Ornellas, A., Falkner, K., & Edman Stålbrandt, E. (2019). Enhancing graduates' employability skills through authentic learning approaches. *Higher Education, Skills and Work-Based Learning*, 9(1), 107–120. <https://doi.org/10.1108/HESWBL-04-2018-0049>
- Othman, Z., Shan, S. W., Yusoff, I., & Kee, C. P. (2018). Classification techniques for predicting graduate employability. *International Journal on Advanced Science, Engineering and Information Technology*, 8(4–2), 1712. <https://doi.org/10.18517/ijaseit.8.4-2.6832>
- Panth, B. (2014). Skills development for employability and inclusive growth: Policy dilemmas and priorities in South Asia. *Prospects*, 44(2), 167–182. <https://doi.org/10.1007/s11125-014-9309-y>
- Pearson K. (1900). On the criterion that a given system of deviations from the probable in the case of a correlated system of variables is such that it can be reasonably supposed to have arisen from random sampling. *Philosophical Magazine*, 50(5), 157–175.
- Pereira, O., & Raposo, M. J. (2019). Soft skills in knowledge-based economics. *Marketing and Management of Innovations*, 6718(1), 182–195. <https://doi.org/10.21272/mmi.2019.1-15>
- Pfeffer, J., & Robert, I. S. (2006). Evidence-based management. *Harvard Business Review*, 84(1), 63–74.
- Phuong, N. (2019). *Enhancing the employability of graduate students with transversal skills*. https://www.theseus.fi/bitstream/handle/10024/166982/Phuong_Nguyen.pdf?sequence=2
- Piad, K. C., Dumlao, M., Ballera, M. A., & Ambat, S. C. (2016). Predicting IT employability using data mining techniques. *2016 Third International Conference on Digital Information Processing, Data Mining, and Wireless Communications (DIPDMWC)*, January 2014, 26–30. <https://doi.org/10.1109/DIPDMWC.2016.7529358>
- Pianta, M. (2018). Technology and employment: twelve stylised facts for the digital age. In *Indian Journal of Labour Economics* (Vol. 61, Issue 2). Springer India. <https://doi.org/10.1007/s41027-018-0124-5>
- Poon, J. (2017). Relationships between demographic factors and employment prospects of architecture, construction and urban planning graduates. *International Journal of Construction Education and Research*, 13(2), 83–101. <https://doi.org/10.1080/15578771.2016.1153008>
- Poornima, S., & Pushpalatha, M. (2018). A survey of predictive analytics using big data with data mining. *International Journal of Bioinformatics Research and Applications*, 14(3), 269. <https://doi.org/10.1504/IJBRA.2018.092697>

- Quinlan, J. . (1985). Induction of decision trees. In *Kluwer Academic Publishers*.
<https://doi.org/10.1023/A:1022643204877>
- Rahmat, M., Ahmad, K., Idris, S., & Zainal, N. F. A. (2012). Relationship between Employability and Graduates' Skill. *Procedia - Social and Behavioral Sciences*, 59(2011), 591–597. <https://doi.org/10.1016/j.sbspro.2012.09.318>
- Ranjit, S. M., & Wahab, A. B. (2008). *Your dream job : how to get it and excel*. Kuala Lumpur : TQM Consultants Sdn. Bhd.
- Rasul, M. S., Rauf, R. A. A., Mansor, A. N., Yasin, R. M., & Mahamod, Z. (2013). Graduate employability for manufacturing industry. *Procedia - Social and Behavioral Sciences*, 102(Ifee 2012), 242–250. <https://doi.org/10.1016/j.sbspro.2013.10.739>
- Reed, P., & Wu, Y. (2013). Logistic regression for risk factor modelling in stuttering research. *Journal of Fluency Disorders*, 38(2), 88–101. <https://doi.org/10.1016/j.jfludis.2012.09.003>
- Rogan, M., & (NALSU), N. A. L. S. U. (2016). Tracing graduates into the labour market. In *Human Sciences Research Council HSRC*. <http://www.hsrc.ac.za/en/review/hsrc-review-july-to-sept-2016/tracing-graduates>
- Rogulkin, D. (2011). Predicting 6-year graduation and high-achieving and at-risk students. *Online Submission*.
- Rokach, L., & Maimon, O. (2009). Classification trees. In *Data mining and knowledge discovery handbook* (pp. 149–174). Springer.
- S.Timbo, N., Labidi, S., Nascimento, T. P. d., L. Lima, M., Nunes Neto, G., & C.Matos, R. (2016). Approach based on linear regression for stock exchange prediction – case study of Petr4 Petrobrás, Brazil. *International Journal of Artificial Intelligence & Applications*, 7(1), 21–31. <https://doi.org/10.5121/ijaia.2016.7103>
- Saibon, R. A., & Kamis, A. (2019). Employability skills in business management graduate and role of Malaysian vocational college. *International Journal of Academic Research in Business and Social Sciences*, 9(2). <https://doi.org/10.6007/ijarbss/v9-i2/5674>
- Saleh, H. (2019). Employer satisfaction with engineering graduates employability: A study among manufacturing employers in Malaysia. *International Journal of Scientific & Technology Research*, 8(09), 819–817.
- Sanchez, M. P. R., & Diamante, V. A. M. (2017). Graduate tracer study of the college of nursing. *Malaysian Journal of Nursing*, 8(January), 41–47.
- Sapaat, M. A., Mustapha, A., Ahmad, J., Chamili, K., & Muhamad, R. (2011). A classification-based graduates employability model for tracer study by MOHE. In *Communications in Computer and Information Science* (pp. 277–287). https://doi.org/10.1007/978-3-642-22389-1_25

- Sarycheva, T. V., & Shvetsov, M. N. (2015). Statistical approaches to the evaluation of the demand and supply at the labour market based on panel data. *Review of European Studies*, 7(8), 356–367. <https://doi.org/10.5539/res.v7n8p356>
- Schomburg, H. (2016). *Carrying out tracer studies guide to anticipating and matching skills and jobs* (Vol. 6). <https://doi.org/10.2816/938667>
- Seng, L. C. (2018). Malaysia public universities ' graduate employability policies : an analysis of first degree graduates unemployment and underemployment issues. *International Journal of Social Science and Humanities Research*, 6(4), 480–489. <https://doi.org/10.5281/zenodo.2589702>
- Serhan, C., Tsangari, H., Bengoa, D. S., & Mekdessi, S. (2016). Fresh graduates' retention: a review of literature. *Journal of Business and Management*, 18(2), 51–64. <https://doi.org/10.9790/487X-18225164>
- Shanks, G., & Bekmamedova, N. (2012). The impact of strategy on business analytics success. *Proceedings of the 23rd Australasian Conference on Information Systems 2012*, 1–11.
- Shao, H. R. (2011). *A study of the employability-based curriculum development in american universities : focus on business schools*. <https://search-proquest-com.ezproxy.ump.edu.my/docview/1874889827?accountid=29391>
- Sharma, S. (2019). *Descriptive statistics*. <https://doi.org/10.21475/ajcs.19.13.05>
- Shawyun, T. (2019). Re-profiling a university graduate's generic skill set of workforce of the future. *18th Annual SEAAIR Conference, At Jakarta, Indonesia, June*.
- Singh, M., Sharma, S., & Kaur, A. (2013). Performance analysis of decision trees. *International Journal of Computer ...*, 71(19), 10–14. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.402.5290&rep=rep1&type=pdf>
- Singh, P., Thambusamy, R., Ramly, A., Abdullah, I. H., & Mahmud, Z. (2013). Perception differential between employers and instructors on the importance of employability skills. *Procedia - Social and Behavioral Sciences*, 90(October 2015), 616–625. <https://doi.org/10.1016/j.sbspro.2013.07.133>
- Sperandei, S. (2014). Understanding logistic regression analysis. *Biochemia Medica*, 24(1), 12–18. <https://doi.org/10.11613/BM.2014.003>
- Stewart, J., & Knowles, V. (1999). The changing nature of graduate careers. *Career Development International*, 4(7), 370–383. <https://doi.org/10.1108/13620439910295754>
- Stone, C., Horn, C. Van, & Zukin, C. (2012). Chasing the American dream: recent college graduates and the great recession. *John J. Heldrich Center for Workforce Development*.

- Suarta, I. M., Suwintana, I. K., Sudhana, I. F. P., & Hariyanti, N. K. D. (2017). *Employability skills required by the 21st century workplace: a literature review of labor market demand*. *102(Ictvt)*, 337–342. <https://doi.org/10.2991/ictvt-17.2017.58>
- Suleman, F. (2018). The employability skills of higher education graduates: insights into conceptual frameworks and methodological options. *Higher Education*, *76*(2), 263–278. <https://doi.org/10.1007/s10734-017-0207-0>
- Sullivan, G. M., & Feinn, R. (2012). Using effect size—or why the P value is not enough. *Journal of Graduate Medical Education*, *4*(3), 279–282. <https://doi.org/10.4300/jgme-d-12-00156.1>
- Syed Tahir Hijazi, & Naqvi, S. M. M. R. (2006). Factors affecting students' performance: a case of private colleges. *Bangladesh E-Journal of Sociology*, *3*. <http://doi.wiley.com/10.1002/tea.3660200906>
- T. Jaynes, E. (2003). Probability theory: the logic of science. In *Cambridge University Press*. [https://books.google.com.my/books?id=UjsgAwAAQBAJ&lpg=PR17&ots=OUPq8PYI8u&dq=probability theory the logic of science&lr&pg=PA3#v=onepage&q=probability theory the logic of science&f=false](https://books.google.com.my/books?id=UjsgAwAAQBAJ&lpg=PR17&ots=OUPq8PYI8u&dq=probability+theory+the+logic+of+science&lr&pg=PA3#v=onepage&q=probability+theory+the+logic+of+science&f=false)
- Tang, J., Kacmar, K. M. M., & Busenitz, L. (2012). Entrepreneurial alertness in the pursuit of new opportunities. *Journal of Business Venturing*. <https://doi.org/10.1016/j.jbusvent.2010.07.001>
- Tapado, B. M., Acedo, G. G., & Palaoag, T. D. (2018). Evaluating information technology graduates employability using decision tree algorithm. *Proceedings of the 9th International Conference on E-Education, E-Business, E-Management and E-Learning*, 88–93. <https://doi.org/https://doi.org/10.1145/3183586.3183603>
- Tomlinson, M. (2012). Graduate employability: A review of conceptual and empirical themes. *Higher Education Policy*, *25*(4), 407–431. <https://doi.org/10.1057/hep.2011.26>
- Torres-niño, J., Rodríguez-gonzález, A., Colomo-palacios, R., & Jiménez-domingo, E. (2013). Improving accuracy of decision trees using clustering techniques. *Journal of U*, *19*(4), 484–501.
- Tran, L. H. N. (2018). Game of blames: Higher education stakeholders' perceptions of causes of Vietnamese graduates' skills gap. *International Journal of Educational Development*, *62*(July), 302–312. <https://doi.org/10.1016/j.ijedudev.2018.07.005>
- Tran, T. T. (2015). Is graduate employability the 'whole-of-higher-education-issue'? *Journal of Education and Work*, *28*(3), 207–227. <https://doi.org/10.1080/13639080.2014.900167>
- Tremblay, K., Lalancette, D., & Roseveare, D. (2012). Assessment of higher education learning outcomes. In *OECD Directorate for Education* (Vol. 1). www.oecd.org/edu/ahelo

- Tu, J. V. (1996). Advantages and disadvantages of using artificial neural networks versus logistic regression for predicting medical outcomes. *Journal of Clinical Epidemiology*, 49(11), 1225–1231. [https://doi.org/10.1016/S0895-4356\(96\)00002-9](https://doi.org/10.1016/S0895-4356(96)00002-9)
- Valli, K. S., & Priya, N. S. V. (2019). Sustainable employability skills for civil and other engineering professionals in the global market. *International Journal of Civil Engineering and Technology (IJCIET)*, 10(01), 1074–1080.
- Walters, C., & Ludwig, D. (1994). Calculation of bayes posterior probability distributions for key population parameters. *Canadian Journal of Fisheries and Aquatic Sciences*, 51(3), 713–722. <https://doi.org/10.1139/f94-071>
- Weligamage, S. S. (2009). Graduates' employability skills: evidence from literature review. *Asaihl*, May, 115–125. <http://www.kln.ac.lk/uokr/ASAIHL/SubThemeA8.pdf>
- World Economic Forum. (2016). The future of jobs employment, skills and workforce strategy for the fourth industrial revolution. *Growth Strategies*, january, 2–3. <https://doi.org/10.1177/1946756712473437>
- Yusof, N., & Jamaluddin, Z. (2015). Graduate employability and preparedness : a case study of University of Malaysia Perlis (UNIMAP), Malaysia. *Geografia-Malaysian Journal of Society and Space* 11, 11, 129–143.
- Zakaria, N., & Nair, R. (2019). Enhancing the employability of graduates through an industry-led initiative. *PERTANIKAJOURNAL OF SOCIAL SCIENCE AND HUMANITIES*, 27(T1), 11–26.
- Zhang, D. (2017). A coefficient of determination for generalized linear models. *The American Statistician*, 71(4), 310–316. <https://doi.org/10.1080/00031305.2016.1256839>
- Zwick, R., & Sklar, J. G. (2005). Predicting college grades and degree completion using high school grades and SAT scores: the role of student ethnicity and first language. *American Educational Research Journal*, 42(3), 439–464. <http://www.jstor.org/stable/3700459>