

*SELF-EVALUATION BERBASIS FUZZY EXPERT SYSTEM:
PENGAMBILAN KEPUTUSAN SUBJEKTIF TENTANG SELF-EFFICACY*

TESIS

diajukan untuk memenuhi sebagian syarat untuk memperoleh gelar
Magister Pendidikan Teknologi dan Kejuruan



oleh
Nia Amelia
NIM 1706828

PROGRAM STUDI
PENDIDIKAN TEKNOLOGI DAN KEJURUAN
SEKOLAH PASCASARJANA
UNIVERSITAS PENDIDIKAN INDONESIA
2019

SELF-EVALUATION BERBASIS FUZZY EXPERT SYSTEM: PENGAMBILAN KEPUTUSAN SUBJEKTIF TENTANG SELF- EFFICACY

Oleh

Nia Amelia

S.Pd. Universitas Pendidikan Indonesia, 2016

Sebuah Tesis yang diajukan untuk memenuhi salah satu syarat memperoleh gelar Master Pendidikan (M.Pd.) pada Program Studi Pendidikan Teknologi dan Kejuruan

© Nia Amelia 2019

Universitas Pendidikan Indonesia

Juli 2019

Hak Cipta dilindungi undang-undang.

Tesis ini tidak boleh diperbanyak seluruhnya atau sebagian,
dengan dicetak ulang, difoto kopi, atau cara lainnya tanpa ijin dari penulis.

LEMBAR PENGESAHAN

NIA AMELIA

*SELF-EVALUATION BERBASIS FUZZY EXPERT SYSTEM:
PENGAMBILAN KEPUTUSAN SUBJEKTIF TENTANG SELF-EFFICACY*

disetujui dan disahkan oleh pembimbing:

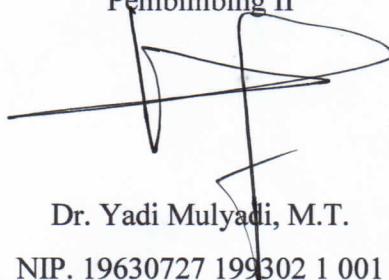
Pembimbing I

*acc
26/07/2019*


Dr. Ade Gafar Abdullah, M.Si.
NIP. 19721113 199903 1 001

Pembimbing II

*acc
26/07/2019*


Dr. Yadi Mulyadi, M.T.
NIP. 19630727 199302 1 001

Mengetahui,

Ketua Program Studi Pendidikan Teknologi dan Kejuruan



Dr. Ade Gafar Abdullah, M.Si.
NIP. 19721113 199903 1 001

PERNYATAAN

Dengan ini saya menyatakan bahwa tesis dengan judul "***Self-Evaluation Berbasis Fuzzy Expert System: Pengambilan Keputusan Subjektif Tentang Self-Efficacy***" ini beserta seluruh isinya adalah benar-benar karya saya sendiri. Saya tidak melakukan penjiplakan atau pengutipan dengan cara-cara yang tidak sesuai dengan etika ilmu yang berlaku dalam masyarakat keilmuan. Atas pernyataan ini, saya siap menanggung risiko/sanksi apabila di kemudian hari ditemukan adanya pelanggaran etika keilmuan atau ada klaim dari pihak lain terhadap keaslian karya saya ini.

Bandung, Juli 2019

Yang membuat pernyataan,



Nia Amelia
NIM. 1706828

UCAPAN TERIMA KASIH

Penyusunan tesis ini dapat terlaksana atas bantuan berbagai pihak baik secara langsung maupun tidak langsung, sehingga penyusun dapat menyelesaikan tesis ini. Untuk itu dengan penuh kerendahan dan keikhlasan hati, izinkanlah penyusun untuk mengucapkan terima kasih kepada:

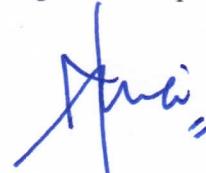
1. Allah SWT, yang telah memberikan hidayah, nikmat dan karunia-Nya kepada penyusun dalam menyelesaikan tesis ini.
2. Kedua orang tua tercinta, Bapak Nano Sutisna, Ibu Imas Julaeha dan adik-adik Ayu Amelia, Ropi Na'uf, Alm. Sarah Pebriyanti serta saudara-saudara penulis, yang tak pernah henti selalu memberikan do'a dan dukungan baik moril maupun materil kepada penyusun yang tak akan pernah terganti.
3. Suami tercinta, Diky Zakaria beserta keluarga yang senantiasa memberikan do'a, semangat dan motivasi serta dukungan selama melaksanakan penyusunan tesis ini.
4. Bapak Dr. Ade Gafar Abdullah, M.Si., selaku Ketua Program Studi Pendidikan Teknologi dan Kejuruan, dosen pembimbing akademik, dan dosen pembimbing I yang telah banyak memberikan arahan, masukan, serta semangat kepada penyusun dalam menyelesaikan tesis ini.
5. Bapak Dr. Yadi Mulyadi, M.T., selaku dosen pembimbing II yang telah banyak memberikan arahan, masukan, serta semangat kepada penyusun dalam menyelesaikan tesis ini.
6. Seluruh dosen dan staf di Program Studi Pendidikan Teknologi dan Kejuruan, terima kasih atas seluruh ilmu yang telah diberikan kepada penyusun selama ini.
7. PT. Rumah Publikasi Indonesia, selaku donatur yang telah memberikan program beasiswa kepada penyusun selama masa studi yang sangat bermanfaat bagi penyusun.
8. Rekan – rekan seperjuangan S-2 Pendidikan Teknologi dan Kejuruan 2017 yang selalu memberikan dinamika kehidupan kepada penyusun.
9. Keluarga besar PT. Rumah Publikasi Indonesia yang tak hentinya memberikan dukungan serta ilmu tentang kehidupan.

10. Nur Wulandari, yang telah membantu penyusun dalam mengembangkan *fuzzy logic*.
11. Mahasiswa elektro UPI angkatan 2016, yang telah membantu penyusun dalam mengisi instrumen *self-efficacy*.
12. Semua pihak yang telah memberikan bantuan dan dukungan yang besar dalam penyelesaian tesis ini yang tidak dapat dituliskan satu per satu.

Atas kebaikan dan kemurahan yang telah penyusun terima, semoga Allah SWT membalasnya dengan segala kemurahan dan rahmannya. Penyusun menyadari bahwa masih banyak kekurangan dan kesalahan dalam penyusunan tesis ini. Oleh karena itu, penyusun berharap untuk mendapatkan kritik dan saran sehingga penyusun dapat belajar lagi dan memperbaiki kesalahan dan kekurangan yang ada sehingga tesis ini dapat bermanfaat bagi penyusun pada khususnya dan pembaca pada umumnya.

Bandung, Juli 2019

Yang membuat pernyataan,



Nia Amelia

NIM. 1706828

ABSTRAK

Penelitian ini dilakukan untuk membuat *self-evaluation* berbasis FES tentang mengukur tingkat *self-efficacy* menggunakan tiga model *membership function* (mf). Metode penelitian yang digunakan dalam penelitian ini adalah survey berdasarkan kuisioner dan analisis dokumen. Instrumen yang digunakan adalah gabungan dari beberapa kuisioner *Motivational Strategies for Learning Questionnaire* (MSLQ) dan *Self-Efficacy Questionnaire* (SEQ). Temuan dari penelitian ini menunjukkan bahwa *self-evaluation* berbasis FES dapat diimplementasikan. Model kurva gauss merupakan model terbaik jika dibandingkan dengan model kurva triangular maupun trapesium. Model *self-evaluation* berbasis FES menggunakan kurva gauss dapat mengukur tingkat *self-efficacy* dengan baik. Model *self-evaluation* berbasis FES diharapkan mendapat *trend* yang baik dan bisa menjadi petunjuk untuk mengembangkan model evaluasi yang diadopsi dalam proses kegiatan belajar mengajar di lembaga pendidikan.

Kata kunci: *Self-evaluation, fuzzy expert system, self-efficacy*

ABSTRACT

This study was conducted to make FES-based self-evaluation about measuring the level of self-efficacy using three models of membership function (mf). The research method used in this study is a survey based on questionnaires and document analysis. The instrument used is a combination of several Motivational Strategies for Learning Questionnaire (MSLQ) and Self-Efficacy Questionnaire (SEQ) questionnaires. The findings of this study indicate that self-evaluation of self-efficacy FES-based can be implemented. The gauss curve model is the best model compared to triangular or trapesium curve models. The FES-based self-evaluation model using the gauss curve can measure the level of self-efficacy well. The self-evaluation FES-based model is expected to get a good trend and can be a guide to develop an evaluation model adopted in the process of teaching and learning activities in educational institutions.

Keywords: Self-evaluation, fuzzy expert system, self-efficacy

DAFTAR ISI

LEMBAR PENGESAHAN	ii
PERNYATAAN.....	iii
UCAPAN TERIMA KASIH.....	iv
ABSTRAK	vi
ABSTRACT	vii
DAFTAR ISI.....	viii
DAFTAR TABEL.....	x
DAFTAR GAMBAR	xi
BAB I	
PENDAHULUAN	1
1.1 Latar Belakang Penelitian	1
1.2 Rumusan Masalah Penelitian	3
1.3 Tujuan Penelitian.....	3
1.4 Manfaat Penelitian.....	3
1.5 Struktur Organisasi Tesis	3
BAB II	
KAJIAN PUSTAKA.....	5
2.1 <i>Self-Evaluation</i>	5
2.2 Motivasi.....	6
2.3 <i>Self-Efficacy</i>	7
2.4 <i>Fuzzy Logic</i>	8
2.5 <i>Fuzzy Expert System</i>	8
2.6 Metode Fuzzy Mamdani.....	9
2.7 <i>Software MATLAB</i>	10
2.8 Pengaplikasian <i>Fuzzy Logic</i> dalam Proses Evaluasi	11
2.9 Hasil Penelitian yang Relevan.....	12
BAB III	
METODE PENELITIAN.....	19
3.1 Desain Penelitian.....	19
3.2 Partisipan	19
3.3 Populasi dan Sampel	20
3.4 Instrumen Penelitian.....	21
3.5 Prosedur Penelitian.....	21
3.6 Analisis Data	23

BAB IV	
TEMUAN DAN PEMBAHASAN	35
4.1 Hasil Pembuatan <i>Self-Evaluation</i> tentang <i>Self-Efficacy</i> Berbasis FES ..	35
4.2 Perbandingan antara Model Kurva Gauss, Trapesium, dan Triangular .	37
4.3 Hasil Penerapan Instrumen <i>Self-Efficacy</i> dalam FES.....	40
BAB V	
SIMPULAN, IMPLIKASI, DAN REKOMENDASI	49
5.1 Simpulan.....	49
5.2 Implikasi	49
5.3 Rekomendasi	50
DAFTAR PUSTAKA	51
LAMPIRAN	59

DAFTAR TABEL

Tabel 2.1 Kajian Literatur Penelitian yang Relevan	12
Tabel 3.1 Data Mahasiswa Departemen Pendidikan Teknik Elektro UPI Angkatan 2016.....	20
Tabel 4.1 Perbandingan Hasil Output Berdasarkan Input.....	39
Tabel 4.2 Rubrik Pengukuran <i>Self-Efficacy</i>	41
Tabel 4.3 Data Pengukuran <i>Self-Efficacy</i> Menggunakan FES.....	41
Tabel 4.4 Kategori Kecenderungan Tingkat <i>Self-Efficacy</i>	44

DAFTAR GAMBAR

Gambar 3.1	Tahapan Utama Desain Penelitian.....	19
Gambar 3.2	Prosedur Penelitian	22
Gambar 3.3	Arsitektur <i>Fuzzy Expert System</i>	24
Gambar 3.4	Diagram Blok <i>Self-Evaluation</i> untuk Pengambilan Keputusan Subjektif Tentang <i>Self-Efficacy</i> Menggunakan FES	25
Gambar 3.5	<i>Gaussian Membership Function (Magnitude)</i>	26
Gambar 3.6	<i>Gaussian Membership Function (Strength)</i>	27
Gambar 3.7	<i>Gaussian Membership Function (Generality)</i>	27
Gambar 3.8	<i>Trapesium Membership Function (Magnitude)</i>	28
Gambar 3.9	<i>Trapesium Membership Function (Strength)</i>	29
Gambar 3.10	<i>Trapesium Membership Function (Generality)</i>	30
Gambar 3.11	<i>Triangular Membership Function (Magnitude)</i>	31
Gambar 3.12	<i>Triangular Membership Function (Strength)</i>	32
Gambar 3.13	<i>Triangular Membership Function (Generality)</i>	33
Gambar 3.14	<i>Rules Editor</i>	33
Gambar 4.1	<i>Surface Viewer (Gaussian Membership Function)</i>	35
Gambar 4.2	<i>Surface Viewer (Trapesium Membership Function)</i>	36
Gambar 4.3	<i>Surface Viewer (Triangular Membership Function)</i>	36
Gambar 4.4	Perbandingan antara Model Kurva Gauss, Trapesium, dan Triangular Berdasarkan Hasil Output (a), Hasil Output Model Kurva Gauss (b), Hasil Output Model Kurva Trapesium (c), dan Hasil Output Model Kurva Triangular (d).....	38
Gambar 4.5	Proses Defuzzifikasi	40
Gambar 4.6	Hasil Pengukuran <i>Self-Efficacy</i> Menggunakan FES	44

DAFTAR PUSTAKA

- Abeysekera, L. & Dawson, P. (2015). Motivation and cognitive load in the flipped classroom: definition, rationale and a call for research. *Higher Education Research & Development*, 34(1), 1-14.
- Ahmad, H., Razali, S. & Mohamed, M.R. (2013). Fuzzy logic controller design for a robot grasping system with different membership functions. *IOP Conference Series: Materials Science and Engineering*, 53(1), 012051.
- Ali, O.A.M., Ali, A.Y. & Sumait, B.S. (2015). Comparison between the effects of different types of membership functions on fuzzy logic controller performance. *International Journal*, 76, 76-83.
- Alkin, M.C., Christie, C.A. & Vo, A.T. (2012). Evaluation theory. *Evaluation roots: A wider perspective of theorists' views and influences*, 386.
- Almohammadi, K. & Hagras, H. (2013). An adaptive fuzzy logic based system for improved knowledge delivery within intelligent E-Learning platforms. In *Fuzzy Systems (FUZZ), 2013 IEEE International Conference on* (pp. 1-8). IEEE.
- Amelia, N., Abdullah, A.G. & Mulyadi, Y. (2019). Meta-analysis of Student Performance Assessment Using Fuzzy Logic. *Indonesian Journal of Science and Technology*, 4(1), 78-91.
- Anggraini, L. (2018). Anfis Dengan Membership Function Untuk Prediksi Curah Hujan Pada Data Rentet Waktu Multivariate (Anfis With Membership Function For Rainfall Prediction On Rentet Time Multivariate Data). *Technologia: Jurnal Ilmiah*, 9(1), 18-25.
- Arguedas, M., Xhafa, F., Casillas, L., Daradoumis, T., Peña, A. & Caballé, S. (2018). A model for providing emotion awareness and feedback using fuzzy logic in online learning. *Soft Computing*, 22(3), 963-977.
- Arora, N. & Saini, J.R. (2013). A fuzzy probabilistic neural network for student's academic performance prediction. *International Journal of Innovative Research in Science, Engineering and Technology*, 2(9), 4425-4432.
- Aziz, A.A., Yusof, K.M. & Yatim, J.M. (2012). Evaluation on the Effectiveness of Learning Outcomes from Students' Perspectives. *Procedia-Social and Behavioral Sciences*, 56, 22-30.
- Baba, A.F., Cin, F.M. & Bakanay, D. (2012). A fuzzy system for evaluating students' project in engineering education. *Computer Applications in Engineering Education*, 20(2), 287-294.
- Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist*, 44, 1175–1184.
- Bandura, A. (2012). On the functional properties of perceived self-efficacy revisited. *Journal of Management*, 38(1), 9-44.

- Barlybayev, A., Sharipbay, A., Ulyukova, G., Sabyrov, T. & Kuzenbayev, B. (2016). Student's Performance Evaluation by Fuzzy Logic. *Procedia Computer Science*, 102, 98-105.
- Bhatt, R. & Bhatt, D. (2011). Fuzzy logic based student performance evaluation model for practical components of engineering institutions subjects. *International Journal of Technology and Engineering Education*, 8(1), 1-7.
- Bhosale, G.A. & Kamath, R.S. (2013). Fuzzy inference system for teaching staff performance appraisal. *International journal of computer and information technology*, 2(3), 381-385.
- Borkar, S. & Rajeswari, K. (2013). Predicting students academic performance using education data mining. *International Journal of Computer Science and Mobile Computing*, 2(7), 273-279.
- Bouslama, F., Housley, M. & Steele, A. (2014). A fuzzy logic-based emotional intelligence framework for evaluating and orienting new students at HCT Dubai colleges. In *Hybrid Intelligent Systems (HIS), 2014 14th International Conference on* (pp. 85-90). IEEE.
- Chang, C.H., Ferris, D.L., Johnson, R.E., Rosen, C.C. & Tan, J.A. (2012). Core self-evaluations: A review and evaluation of the literature. *Journal of management*, 38(1), 81-128.
- Chen, H.T. (2016). Interfacing theories of program with theories of evaluation for advancing evaluation practice: Reductionism, systems thinking, and pragmatic synthesis. *Evaluation and program planning*, 59, 109-118.
- Chen, K.C. & Jang, S.J. (2010). Motivation in online learning: Testing a model of self-determination theory. *Computers in Human Behavior*, 26(4), 741-752.
- Chrysafiadi, K. & Virvou, M. (2012). Evaluating the integration of fuzzy logic into the student model of a web-based learning environment. *Expert Systems with Applications*, 39(18), 13127-13134.
- Daniel, W.W. & Cross, C.L. (2018). Biostatistics: a foundation for analysis in the health sciences. New York: John Wiley & Sons.
- Darwish, S.M. (2016). Uncertain measurement for student performance evaluation based on selection of boosted fuzzy rules. *IET Science, Measurement & Technology*, 11(2), 213-219.
- Daud, W.S.W., Aziz, K.A.A. & Sakib, E. (2011). An evaluation of students' performance in oral presentation using fuzzy approach. In *Proceedings of Universiti Malaysia Terengganu 10th International Annual Symposium* (pp. 1-6). Malaysia: Universiti Malaysia Terengganu.
- Deborah, L.J., Sathyaseelan, R., Audithan, S. & Vijayakumar, P. (2015). Fuzzy-logic based learning style prediction in e-learning using web interface information. *Sadhana*, 40(2), 379-394.
- Dias, S.B. & Diniz, J.A. (2013). FuzzyQoI Model: A fuzzy logic-based modelling of users' quality of interaction with a learning management system under blended learning. *Computers & Education*, 69, 38-59.

- Diseth, Å. (2011). Self-efficacy, goal orientations and learning strategies as mediators between preceding and subsequent academic achievement. *Learning and Individual Differences*, 21(2), 191-195.
- Do, Q.H. & Chen, J.F. (2013). A neuro-fuzzy approach in the classification of students' academic performance. *Computational intelligence and neuroscience*, 2013, 6.
- Dočekal, V. & Dvořáková, M. (2015). Evaluation levels in education. *Procedia-Social and Behavioral Sciences*, 174, 3743-3749.
- Ellis, T.J. & Levy, Y. (2010). A guide for novice researchers: Design and development research methods. In *Proceedings of Informing Science & IT Education Conference (InSITE)* (pp. 107-118). USA: Informing Science Institute.
- Gao, Z., Lee, A. M. & Harrison, L. (2008). Understanding students' motivation in sport and physical education: From the expectancy-value model and self-efficacy theory perspectives. *Quest*, 60(2), 236-254.
- Giesbers, B., Rienties, B., Tempelaar, D. & Gijselaers, W. (2013). Investigating the relations between motivation, tool use, participation, and performance in an e-learning course using web-videoconferencing. *Computers in Human Behavior*, 29(1), 285-292.
- Goodier, S., Field, C. & Goodman, S. (2018). The need for theory evaluation in global citizenship programmes: The case of the GCSA programme. *Evaluation and program planning*, 66, 7-19.
- Gokmen, G., Akinci, T.Ç., Tektaş, M., Onat, N., Kocyigit, G. & Tektaş, N. (2010). Evaluation of student performance in laboratory applications using fuzzy logic. *Procedia-Social and Behavioral Sciences*, 2(2), 902-909.
- Hameed, I.A. (2011). Using Gaussian membership functions for improving the reliability and robustness of students' evaluation systems. *Expert systems with Applications*, 38(6), 7135-7142.
- Handayani, A.S., Meylani, A. & Ciksadan, C. (2017, November). Perbedaan Sistem Logika Fuzzy Tipe-1 dan Interval Tipe-2 pada Aplikasi Mobile Robot (Difference between Type-1 Fuzzy Logic System and Type-2 Interval in Mobile Robot Applications). In *Annual Research Seminar (ARS)*, 3(1), 209-214.
- Hanus, M.D. & Fox, J. (2015). Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. *Computers & Education*, 80, 152-161.
- Harks, B., Rakoczy, K., Hattie, J., Besser, M. & Klieme, E. (2014). The effects of feedback on achievement, interest and self-evaluation: the role of feedback's perceived usefulness. *Educational Psychology*, 34(3), 269-290.
- Henriques, P.L., Matos, P.V., Jerónimo, H.M., Mosquera, P., da Silva, F.P. & Bacalhau, J. (2018). University or polytechnic? A fuzzy-set approach of

- prospective students' choice and its implications for higher education institutions' managers. *Journal of Business Research*, 89, 435-441.
- Herrera-Viedma, E., López-Herrera, A.G., Alonso, S., Moreno, J.M., Cabrerizo, F.J., & Porcel, C. (2009). A computer-supported learning system to help teachers to teach fuzzy information retrieval systems. *Information Retrieval*, 12(2), 179-200.
- Hevner, A. & Chatterjee, S. (2010). Design science research in information systems. In *Design research in information systems* (pp. 9-22). Springer, Boston, MA.
- Hidayah, I., Permanasari, A.E. & Ratwastuti, N. (2013). Student classification for academic performance prediction using neuro fuzzy in a conventional classroom. In *Information Technology and Electrical Engineering (ICITEE), 2013 International Conference on* (pp. 221-225). IEEE.
- Jafari, M. & Khotanlou, H. (2013). A Routing Algorithm Based on Ant Colony, Local Search and Fuzzy Inference to Improve Energy Consumption in Wireless Sensor Networks. *International Journal of Electrical and Computer Engineering*, 3(5), 640-650.
- Jakešová, J. (2014). The validity and reliability study of the Czech version of the Motivated Strategies for Learning Questionnaire (MSLQ). *The New Educational Review*, 35(1), 54-65.
- Jakešová, J., Gavora, P., Kalenda, J. & Vávrová, S. (2016). Czech validation of the self-regulation and self-efficacy questionnaires for learning. *Procedia-Social and Behavioral Sciences*, 217, 313-321.
- Jamali, R. & Sayyadi Tooranloo, H. (2009). Prioritizing academic library service quality indicators using fuzzy approach: case study: libraries of Ferdowsi University. *Library Management*, 30(4/5), 319-333.
- Jyothi, G., Parvathi, C., Srinivas, P. & Rahaman, S.A. (2014). Fuzzy expert model for evaluation of faculty performance in Technical educational Institutions. *International Journal of Engineering Research and Applications*, 4(5), 41-50.
- Kabra, R.R. & Bichkar, R.S. (2011). Performance prediction of engineering students using decision trees. *International Journal of Computer Applications*, 36(11), 8-12.
- Kersh, N., Evans, K., Kontiainen, S. & Bailey, H. (2011). Use of conceptual models in self-evaluation of personal competences in learning and in planning for change. *International Journal of Training and Development*, 15(4), 290-305.
- Khan, A.R., Amin, H.U. & Rehman, Z.U. (2011). Application of expert system with fuzzy logic in teachers 'performance evaluation. *International Journal of Advanced Computer Science and Applications*, 2(2), 51-57.
- Komarraju, M. & Nadler, D. (2013). Self-efficacy and academic achievement: Why do implicit beliefs, goals, and effort regulation matter?. *Learning and Individual Differences*, 25, 67-72.

- Kong, S.C. & Song, Y. (2015). An experience of personalized learning hub initiative embedding BYOD for reflective engagement in higher education. *Computers & Education*, 88, 227-240.
- Kustiawan, I. & Chi, K.H. (2015). Handoff decision using a Kalman filter and fuzzy logic in heterogeneous wireless networks. *IEEE Communications Letters*, 19(12), 2258-2261.
- Kusumadewi, S. & Purnomo, H. (2010). *Fuzzy Logic Applications for Decision Support*. Yogyakarta: Graha Science.
- Lee, J.C.K., Yin, H. & Zhang, Z. (2010). Adaptation and analysis of Motivated Strategies for Learning Questionnaire in the Chinese setting. *International Journal of Testing*, 10(2), 149-165.
- Liem, A.D., Lau, S. & Nie, Y. (2008). The role of self-efficacy, task value, and achievement goals in predicting learning strategies, task disengagement, peer relationship, and achievement outcome. *Contemporary educational psychology*, 33(4), 486-512.
- Likert, R. (1932). A Technique for the Measurement of Attitudes. *Archives of Psychology*, 140(55).
- Lunenburg, F.C. (2011). Self-efficacy in the workplace: Implications for motivation and performance. *International journal of management, business, and administration*, 14(1), 1-6.
- Machado, M.A.S., Moreira, T.D.R.G., Gomes, L.F.A.M., Caldeira, A.M. & Santos, D.J. (2016). A fuzzy logic application in virtual education. *Procedia Computer Science*, 91, 19-26.
- Mamdani, E. H. & Assilian, S. (1975). An experiment in linguistic synthesis with a fuzzy logic controller. *International journal of man-machine studies*, 7(1), 1-13.
- MathWorks. (2018). *What Is MATLAB?* Retrieved from <https://www.mathworks.com>
- Mendez, J.A. & Gonzalez, E.J. (2011). Implementing motivational features in reactive blended learning: Application to an introductory control engineering course. *IEEE Transactions on Education*, 54(4), 619-627.
- Nunamaker Jr, J.F., Chen, M. & Purdin, T.D. (1990). Systems development in information systems research. *Journal of management information systems*, 7(3), 89-106.
- Olunloyo, V.O., Ajofoyinbo, A.M. & Ibidapo-Obe, O. (2011). On development of fuzzy controller: The case of gaussian and triangular membership functions. *Journal of Signal and Information Processing*, 2(04), 257.
- Owais, M.A. (2009). Subjective decision making using type-2 fuzzy logic advisor. In *Information and Communication Technologies, 2009. ICICT'09. International Conference on* (pp. 127-133). IEEE.
- Oyelade, O.J., Oladipupo, O.O. & Obagbuwa, I.C. (2010). Application of k Means Clustering algorithm for prediction of Students Academic Performance. arXiv preprint arXiv:1002.2425. Retrieved from <https://arxiv.org/pdf/1002.2425>

- Ozdemir, O. & Tekin, A. (2016). Evaluation of the presentation skills of the pre-service teachers via fuzzy logic. *Computers in Human Behavior*, 61, 288-299.
- Patel, J. & Yadav, R. (2014). Survey on soft computing based approaches in academic performance evaluation. In *9th National Conf. on Smarter Approaches in Computing Technologies and Applications, India* (pp. 78-86).
- Patil, S., Mulla, A. & Mudholkar, R.R. (2012). Best student award—A fuzzy evaluation approach. *International Journal of Computer Science and Communication*, 3(1), 9-12.
- Pavani, S., Gangadhar, P.V.S.S. & Gulhare, K.K. (2012). Evaluation of teacher's performance using fuzzy logic techniques. *International Journal of Computer Trends and Technology*, 3(2), 200-205.
- Peffers, K., Tuunanen, T., Rothenberger, M.A. & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of management information systems*, 24(3), 45-77.
- Petrudi, S.H.J., Pirouz, M. & Pirouz, B. (2013). Application of fuzzy logic for performance evaluation of academic students. In *Fuzzy Systems (IFSC), 2013 13th Iranian Conference on* (pp. 1-5). IEEE.
- Popa, D. & Voicu, B.C. (2015). Motivational Aspects Engaged in Performance of Preadolescent Students. *Procedia-Social and Behavioral Sciences*, 203, 186-191.
- Pöysä-Tarhonen, J., Elen, J. & Tarhonen, P. (2016). Student teams' development over time: Tracing the relationship between the quality of communication and teams' performance. *Higher Education Research & Development*, 35(4), 787-799.
- Prokhorov, S. & Kulikovskikh, I. (2015). Fuzzy learning performance assessment based on decision making under internal uncertainty. In *Computer Science and Electronic Engineering Conference (CEEC), 2015 7th* (pp. 65-70). IEEE.
- Reddy, C.S. & Raju, K.V.S.N. (2009). An improved fuzzy approach for COCOMO's effort estimation using gaussian membership function. *Journal of software*, 4(5), 452-459.
- Richey, R. & Klein, J. (2007). *Design and Development Research*. New York: Routledge.
- Rusli, N.M., Ibrahim, Z. & Janor, R.M. (2008). Predicting students' academic achievement: Comparison between logistic regression, artificial neural network, and Neuro-fuzzy. In *Information Technology, 2008. ITSim 2008. International Symposium on* (Vol. 1, pp. 1-6). IEEE.
- Sakthivel, E., Kannan, K.S. & Arumugam, S. (2013). Optimized evaluation of students performances using fuzzy logic. *International Journal of Scientific & Engineering Research*, 4(9), 1128-1133.
- Saleh, I. & Kim, S.I. (2009). A fuzzy system for evaluating students' learning achievement. *Expert systems with Applications*, 36(3), 6236-6243.

- Sandhopi, S., Novianto, S. & Astuti, E.Z. (2015). Optimasi Fungsi Keanggotaan Fuzzy Menggunakan Metode Mamdani Terhadap Prediksi Perilaku Pembeli (Optimization of Fuzzy Membership Functions Using the Mamdani Method Against Buyer Behavior Predictions). *Techno. Com*, 14(4), 266-271.
- Saputra, D.I., Abdullah, A.G. & Hakim, D.L. (2013). Pengembangan Model Evaluasi Pembelajaran Project Based Learning Berbasis Logika Fuzzy (Development of learning project based learning model based on fuzzy logic). *Innovation of Vocational Technology Education*, 9(1), 13-34.
- Schunk, D.H., Pintrich, P.R. & Meece, J.L. (2008). *Motivation in education: Theory, research and applications* (3rd ed.). Upper Saddle River, NJ: Merrill-Prentice Hall.
- Şen, C.G. & Cenkçi, D. (2009). An Integrated Approach to Determination and Evaluation of Production Planning Performance Criteria. *Journal of Engineering and Natural Sciences, Sigma*, 27, 1-19.
- Sripan, R. & Suksawat, B. (2010). Propose of fuzzy logic-based students' learning assessment. In *Control Automation and Systems (ICCAS), 2010 International Conference on* (pp. 414-417). IEEE.
- Stufflebeam, D.L. & Shinkfield, A.J. (2012). *Systematic evaluation: A self-instructional guide to theory and practice* (Vol. 8). Springer Science & Business Media.
- Suprapto, B.Y., Wahab, W. & Salam, M.A. (2013). Pengaruh Perubahan Set Point pada Pengendali Fuzzy Logic untuk Pengendalian Versi online (e-ISSN. 2252-620x) Suhu Mini Boiler (Effect of Change of Set Points on Fuzzy Logic Controllers for Online Version Control (e-ISSN. 2252-620x) Mini Boiler Temperature). *Jurnal Rekayasa Elektrika*, 10(4), 172-179.
- Vesely, S., Klöckner, C.A. & Dohnal, M. (2016). Predicting recycling behaviour: Comparison of a linear regression model and a fuzzy logic model. *Waste management*, 49, 530-536.
- Voskoglou, M.G. (2012). A fuzzy model for analogical problem solving. arXiv preprint arXiv:1204.6415. Retrieved from <https://arxiv.org/pdf/1204.6415>
- Voskoglou, M.G. (2013). Problem solving, fuzzy logic and computational thinking. *Egyptian Computer Science Journal*, 37(1), 131-145.
- Wang, Y., Peng, H., Huang, R., Hou, Y. & Wang, J. (2008). Characteristics of distance learners: Research on relationships of learning motivation, learning strategy, self-efficacy, attribution and learning results. *Open Learning: The Journal of Open, Distance and e-Learning*, 23(1), 17-28.
- Yadav, R.S. & Singh, V.P. (2011). Modeling academic performance evaluation using soft computing techniques: A fuzzy logic approach. *International Journal on computer science and Engineering*, 3(2), 676-686.
- Yadav, R.S. & Singh, V.P. (2012). Modeling academic performance evaluation using fuzzy c-means clustering techniques. *International Journal of Computer Applications*, 60(8), 15-23.

- Yadav, R.S., Soni, A.K. & Pal, S. (2014). A study of academic performance evaluation using Fuzzy Logic techniques. In *Computing for Sustainable Global Development (INDIACom), 2014 International Conference on* (pp. 48-53). IEEE.
- Yildiz, Z. & Baba, A.F. (2014). Evaluation of student performance in laboratory applications using fuzzy decision support system model. In *Global Engineering Education Conference (EDUCON), 2014 IEEE* (pp. 1023-1027). IEEE.
- Yildiz, O., Bal, A. & Gulsecen, S. (2013). Improved fuzzy modelling to predict the academic performance of distance education students. *The international review of research in open and distributed learning*, 14(5), 144-165.
- Yousif, M.K. & Shaout, A. (2016). Fuzzy logic computational model for performance evaluation of Sudanese Universities and academic staff. *Journal of King Saud University-Computer and Information Sciences*, xxx, xxx-xxx. doi: <http://dx.doi.org/10.1016/j.jksuci.2016.08.002>
- Yunus, M., Suraya, A. & Ali, W.Z.W. (2008). Metacognition and Motivation in Mathematical Problem Solving. *International Journal of Learning*, 15(3).
- Yusuf, M. (2011). The impact of self-efficacy, achievement motivation, and self-regulated learning strategies on students' academic achievement. *Procedia-Social and Behavioral Sciences*, 15, 2623-2626.
- Zadeh, L.A. (1965). Information and control. *Fuzzy sets*, 8(3), 338-353.
- Zimmermann, H.J. (2011). *Fuzzy set theory—and its applications*. Berlin, Germany: Springer Science & Business Media.