

Introducing data visualization dashboards in the technological ecosystems

Francisco José García-Peñalvo

GRIAL Research Group, Computer Science Department, Research Institute for Educational Sciences, Universidad de Salamanca (<https://ror.org/02f40zc51>), Salamanca, Spain
fgarcia@usal.es
<http://grial.usal.es>
<http://twitter.com/frangp>
<https://orcid.org/0000-0001-9987-5584>

Abstract

Invited keynote in the International Conference on Cyber Security, Privacy and Networking (ICSPN-2022), celebrated in Thailand (Virtual Mode) on September 9-11, 2022. The keynote introduces the concept of the technological ecosystem as a set of people and software components that relate to each other through information flows in a physical environment that supports these flows, which is extended to introduce the data dashboards as a new component in the ecosystem that allows visualizing the data and interacting with them. The integration of the dashboards in the technological ecosystem is made at the metamodel level through the User metaclass.

Keywords

Technological ecosystem; Dashboard; Meta-modelling; Model-Driven Development

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References

- [1] F. J. García-Peñalvo, M. J. Rodríguez-Conde, R. Therón, A. García-Holgado, F. Martínez-Abad and A. Benito-Santos, "Grupo GRIAL," *IE Comunicaciones. Revista Iberoamericana de Informática Educativa*, no. 30, pp. 33-48, 2019.
- [2] R. Therón, A. Benito-Santos, R. Santamaría y A. Losada, "Towards an Uncertainty-Aware Visualization in the Digital Humanities," *Informatics*, vol. 6, no. 3, art. 31, 2019. doi: 10.3390/informatics6030031.
- [3] F. J. García-Peñalvo, "Avoiding the Dark Side of Digital Transformation in Teaching. An Institutional Reference Framework for eLearning in Higher Education," *Sustainability*, vol. 13, no. 4, art. 2023, 2021. doi: 10.3390/su13042023.
- [4] F. Huang, T. Teo, J. C. Sánchez-Prieto, F. J. García-Peñalvo and S. Olmos-Migueláñez, "Cultural values and technology adoption: A model comparison with university teachers from China and Spain," *Computers & Education*, vol. 133, pp. 69-81, 2019. doi: 10.1016/j.compedu.2019.01.012.

- [5] T. Ferreras-Fernández, F. J. García-Peña, J. A. Merlo-Vega y H. Martín-Rodero, "Providing open access to PhD theses: Visibility and citation benefits," *Program: Electronic library and information systems*, vol. 50, no. 4, pp. 399-416, 2016. doi: 10.1108/PROG-04-2016-0039.
- [6] M. J. Casany *et al.*, "Moodbile: A Framework to Integrate m-Learning Applications with the LMS," *Journal of Research and Practice in Information Technology (JRPIT)*, vol. 44, no. 2, pp. 129-149, 2012.
- [7] F. J. García-Peña y J. García Carrasco, "Educational hypermedia resources facilitator," *Computers & Education*, vol. 44, no. 3, pp. 301-325, 2005. doi: 10.1016/j.compedu.2004.02.004.
- [8] A. J. Berlanga and F. J. García-Peña, "Learning Technology Specifications: Semantic Objects for Adaptive Learning Environments," *International Journal of Learning Technology*, vol. 1, no. 4, pp. 458-472, 2005. doi: 10.1504/IJLT.2005.007155.
- [9] F. J. García-Peña, A. Corell, V. Abella-García and M. Grande-de-Prado, "Recommendations for Mandatory Online Assessment in Higher Education During the COVID-19 Pandemic," in *Radical Solutions for Education in a Crisis Context. COVID-19 as an Opportunity for Global Learning*, D. Burgos, A. Tili and A. Tabacco, Eds. Lecture Notes in Educational Technology, pp. 85-98, Singapore, Singapore: Springer Nature, 2021. doi: 10.1007/978-981-15-7869-4_6.
- [10] F. J. García-Peña *et al.*, "Gaming for Social Inclusion and Civic Participation: the INGAME project," in *Proceedings of the 2021 International Symposium on Computers in Education (SIIE) (23-24 September 2021, Málaga, Spain)*, A. Balderas, A. J. Mendes and J. M. Dodero, Eds., USA: IEEE, 2021. doi: 10.1109/SIIE53363.2021.9583646.
- [11] F. J. García-Peña, M. Á. Conde, M. Johnson and M. Alier, "Knowledge co-creation process based on informal learning competences tagging and recognition," *International Journal of Human Capital and Information Technology Professionals (IJHCITP)*, vol. 4, no. 4, pp. 18-30, 2013. doi: 10.4018/ijhcitp.2013100102.
- [12] A. García-Holgado, S. Marcos-Pablos, R. Therón and F. J. García-Peña, "Technological ecosystems in the health sector: A mapping study of European research projects," *Journal of Medical Systems*, vol. 43, art. 100, 2019. doi: 10.1007/s10916-019-1241-5.
- [13] D. A. Gómez-Aguilar, R. Therón and F. J. García-Peña, "Semantic Spiral Timelines Used as Support for e-Learning," *Journal of Universal Computer Science*, vol. 15, no. 7, pp. 1526-1545, 2009. doi: 10.3217/jucs-015-07-1526.
- [14] M. Á. Conde-González, F. J. García-Peña, M. J. Casany and M. Alier, "Adapting LMS architecture to the SOA: an Architectural Approach," in *Proceedings of the Fourth International Conference on Internet and Web Applications and Services – ICIW 2009 (Venice/Mestre, Italy, 24-28 May 2009)*, H. Sasaki, G. O. Bellot, M. Ehmann and O. Dini, Eds. pp. 322-327, Los Alamitos, California, USA: IEEE Computer Society, 2009. doi: 10.1109/iciw.2009.54.
- [15] F. J. García-Peña, A. Bello, A. Dominguez y R. M. Romero Chacón, "Gender Balance Actions, Policies and Strategies for STEM: Results from a World Café Conversation," *Education in the Knowledge Society*, vol. 20, art. 31, pp. 31-1 – 31-15, 2019. doi: 10.14201/eks2019_20_a31.
- [16] F. J. García-Peña, A. García-Holgado, A. Dominguez and J. Pascual Eds., "Women in STEM in Higher Education. Good Practices of Attraction, Access and Retainment in Higher Education," Lecture Notes in Educational Technology (LNET) Singapore: Springer Singapore, 2022. doi: 10.1007/978-981-19-1552-9.
- [17] M. Á. Conde, F. J. Rodríguez-Sedano, C. Fernández-Llamas, J. Gonçalves, J. Lima and F. J. García-Peña, "Fostering STEAM through Challenge Based Learning, Robotics and Physical Devices: A systematic mapping literature review," *Computer Application in Engineering Education*, vol. 29, pp. 46-65, 2021. doi: 10.1002/cae.22354.
- [18] F. J. García-Peña *et al.*, "KoopaML: A graphical platform for building machine learning pipelines adapted to health professionals," *International Journal of Interactive Multimedia and Artificial Intelligence*, In Press. 2022.
- [19] I. Nonaka and H. Takeuchi, *The knowledge creating company. How Japanese companies create the dynamics of innovation*. New York, NY: Oxford University Press, 1995.
- [20] E. Rubio-Royo, A. Ocón, M. Galán, L. Álvarez, S. R. Marrero and J. C. Nelson, "A personal and corporative process-oriented knowledge manager: Suricata Model," presented in European University Information Systems EUNIS- 2004, Ljubljana, Slovenia, 2004.
- [21] Á. Fidalgo-Blanco, M. L. Sein-Echaluce and F. J. García-Peña, "Knowledge spirals in higher education teaching innovation," *International Journal of Knowledge Management*, vol. 10, no. 4, pp. 16-37, 2014. doi: 10.4018/ijkm.2014100102.
- [22] K. C. Laudon and J. P. Laudon, *Business Information Systems: A Problem Solving Approach* (Dryden Press series in information systems). Chicago, USA: Dryden Press, 1991.

- [23] B. Langefors, "Information systems theory," *Information Systems*, vol. 2, no. 4, pp. 207-219, 1977. doi: 10.1016/0306-4379(77)90009-6.
- [24] J. F. Moore, "Predators and prey: a new ecology of competition," *Harvard Business Review*, vol. 71, no. 3, pp. 75-86, 1993.
- [25] M. Iansiti and R. Levien, "Strategy as ecology," *Harvard Business Review*, vol. 82, no. 3, pp. 68-78, 2004.
- [26] F. J. García-Peñalvo, "Technological ecosystems," *IEEE Revista Iberoamericana de Tecnologías del Aprendizaje (IEEE RITA)*, vol. 11, no. 1, pp. 31-32, 2016. doi: 10.1109/RITA.2016.2518458.
- [27] A. García-Holgado, "Análisis de integración de soluciones basadas en software como servicio para la implantación de ecosistemas tecnológicos educativos," PhD, Programa de Doctorado en Formación en la Sociedad del Conocimiento, Universidad de Salamanca, Salamanca, 2018. Available from: <https://bit.ly/3wtZ11j>
- [28] A. García-Holgado and F. J. García-Peñalvo, "Human interaction in learning ecosystems based on open source solutions," in *Learning and Collaboration Technologies. Design, Development and Technological Innovation. 5th International Conference, LCT 2018, Held as Part of HCI International 2018, Las Vegas, NV, USA, July 15-20, 2018, Proceedings, Part I*, P. Zaphiris and A. Ioannou, Eds. Lecture Notes in Computer Science, no. 10924, pp. 218-232, Cham, Switzerland: Springer, 2018. doi: 10.1007/978-3-319-91743-6_17.
- [29] F. J. García-Peñalvo, M. A. Conde, M. Alier and M. J. Casany, "Opening Learning Management Systems to Personal Learning Environments," *Journal of Universal Computer Science*, vol. 17, no. 9, pp. 1222-1240, 2011. doi: 10.3217/jucs-017-09-1222.
- [30] F. J. García-Peñalvo *et al.*, "Enhancing Education for the Knowledge Society Era with Learning Ecosystems," in *Open Source Solutions for Knowledge Management and Technological Ecosystems*, F. J. García-Peñalvo and A. García-Holgado, Eds. Advances in Knowledge Acquisition, Transfer, and Management (AKATM), pp. 1-24, Hershey PA, USA: IGI Global, 2017. doi: 10.4018/978-1-5225-0905-9.ch001.
- [31] A. J. Berlanga and F. J. García-Peñalvo, "IMS LD reusable elements for adaptive learning designs," *Journal of Interactive Media in Education*, vol. 11, 2005.
- [32] A. J. Berlanga and F. J. García-Peñalvo, "Learning Design in Adaptive Educational Hypermedia Systems," *Journal of Universal Computer Science*, vol. 14, no. 22, pp. 3627-3647, 2008. doi: 10.3217/jucs-014-22-3627.
- [33] M. Á. Conde-González, F. J. García-Peñalvo, M. J. Casany and M. Alier, "Adapting LMS architecture to the SOA: an Architectural Approach," in *Proceedings of the Fourth International Conference on Internet and Web Applications and Services – ICIW 2009 (Venice/Mestre, Italy, 24-28 May 2009)*, H. Sasaki, G. O. Bellot, M. Ehmann and O. Dini, Eds. pp. 322-327, Los Alamitos, California, USA: IEEE Computer Society, 2009. doi: 10.1109/iciw.2009.54.
- [34] M. J. Casany, M. Alier, M. Á. Conde and F. J. García-Peñalvo, "SOA initiatives for eLearning. A Moodle case," in *23rd International Conference on Advanced Information Networking and Applications, AINA 2009, Workshops Proceedings. The International Symposium on Mining and Web (MAW 2009)* pp. 750-755, Los Alamitos, California, USA: IEEE Computer Society, 2009. doi: 10.1109/waina.2009.196.
- [35] A. García-Holgado and F. J. García-Peñalvo, "A metamodel proposal for developing learning ecosystems," in *Learning and Collaboration Technologies. Novel Learning Ecosystems. 4th International Conference, LCT 2017. Held as Part of HCI International 2017, Vancouver, BC, Canada, July 9–14, 2017. Proceedings, Part I*, P. Zaphiris and A. Ioannou, Eds. Lecture Notes in Computer Science, no. 10295, pp. 100-109, Switzerland: Springer International Publishing, 2017. doi: 10.1007/978-3-319-58509-3_10.
- [36] A. García-Holgado and F. J. García-Peñalvo, "Preliminary validation of the metamodel for developing learning ecosystems," in *Fifth International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM'17) (Cádiz, Spain, October 18-20, 2017)* J. M. Dodero, M. S. Ibarra Sáiz and I. Ruiz Rube, Eds. ACM International Conference Proceeding Series (ICPS), New York, NY, USA: ACM, 2017. doi: 10.1145/3144826.3145439.
- [37] A. García-Holgado and F. J. García-Peñalvo, "Validation of the learning ecosystem metamodel using transformation rules," *Future Generation Computer Systems*, vol. 91, pp. 300-310, 2019. doi: 10.1016/j.future.2018.09.011.
- [38] A. Sarikaya, M. Correll, L. Bartram, M. Tory and D. Fisher, "What Do We Talk About When We Talk About Dashboards?," *IEEE Transactions on Visualization Computer Graphics*, vol. 25, no. 1, pp. 682-692, 2018. doi: 10.1109/TVCG.2018.2864903.

- [39] V. Dibia and Ç. Demiralp, "Data2Vis: Automatic generation of data visualizations using sequence to sequence recurrent neural networks," *IEEE computer graphics and applications*, vol. 39, no. 5, pp. 33-46, 2019. doi: 10.1109/MCG.2019.2924636.
- [40] A. Vázquez-Ingelmo, F. J. García-Peñalvo and R. Therón, "Taking advantage of the software product line paradigm to generate customized user interfaces for decision-making processes: A case study on university employability," *PeerJ Computer Science*, vol. 5, art. e203, 2019. doi: 10.7717/peerj-cs.203.
- [41] A. Vázquez-Ingelmo, F. J. García-Peñalvo and R. Therón, "Capturing high-level requirements of information dashboards' components through meta-modeling," in *TEEM'19 Proceedings of the Seventh International Conference on Technological Ecosystems for Enhancing Multiculturality (Leon, Spain, October 16th-18th, 2019)*, M. A. Conde-González, F. J. Rodríguez-Sedano, C. Fernández-Llamas and F. J. García-Peñalvo, Eds. ICPS: ACM International Conference Proceedings Series, pp. 815-821, New York, NY, USA: ACM, 2019. doi: 10.1145/3362789.3362837.
- [42] A. Vázquez-Ingelmo, F. J. García-Peñalvo, R. Therón and M. Á. Conde, "Extending a dashboard meta-model to account for users' characteristics and goals for enhancing personalization," in *Proceedings of LASI-SPAIN 2019. Learning Analytics Summer Institute Spain 2019: Learning Analytics in Higher Education (Vigo, Spain, June 27-28, 2019)*, M. Caeiro-Rodríguez, Á. Hernández-García and P. J. Muñoz-Merino, Eds. CEUR Workshop Proceedings Series, no. 2415, pp. 35-42, Aachen, Germany: CEUR-WS.org, 2019.
- [43] A. Vázquez-Ingelmo, F. J. García-Peñalvo, R. Therón and M. Á. Conde, "Representing Data Visualization Goals and Tasks Through Meta-Modeling to Tailor Information Dashboards," *Applied Sciences*, vol. 10, no. 7, art. 2306, 2020. doi: 10.3390/app10072306.
- [44] A. Vázquez-Ingelmo, F. J. García-Peñalvo, R. Therón and A. García-Holgado, "Specifying information dashboards' interactive features through meta-model instantiation," in *Proceedings of LASI-SPAIN 2020. Learning Analytics Summer Institute Spain 2020: Learning Analytics. Time for Adoption? (Valladolid, Spain, June 15-16, 2020)*, A. Martínez-Monés, A. Álvarez, M. Caeiro-Rodríguez and Y. Dimitriadis, Eds. CEUR Workshop Proceedings Series, no. 2671, pp. 47-59, Aachen, Germany: CEUR-WS.org, 2020.
- [45] A. Vázquez-Ingelmo, A. García-Holgado, F. J. García-Peñalvo and R. Therón, "A Meta-modeling Approach to Take into Account Data Domain Characteristics and Relationships in Information Visualizations," in *Trends and Innovations in Information Systems and Technologies, WorldCIST 2021*, vol. 2, Á. Rocha, H. Adeli, G. Dzemyda, F. Moreira and A. M. Ramalho Correia, Eds. Advances in Intelligent Systems and Computing Series Series, no. 1366, pp. 570-580, Cham, Switzerland: Springer Nature, 2021. doi: 10.1007/978-3-030-72651-5_54.
- [46] A. Vázquez-Ingelmo, F. J. García-Peñalvo, R. Therón, D. Amo-Filvà and D. Fonseca-Escudero, "Connecting domain-specific features to source code: Towards the automatization of dashboard generation," *Cluster Computing. The Journal of Networks, Software Tools and Applications*, vol. 23, pp. 1803-1816, 2020. doi: 10.1007/s10586-019-03012-1.
- [47] A. Vázquez-Ingelmo, A. García-Holgado, F. J. García-Peñalvo and R. Therón, "A Meta-Model Integration for Supporting Knowledge Discovery in Specific Domains: A Case Study in Healthcare," *Sensors*, vol. 20, no. 15, art. 4072, 2020. doi: 10.3390/s20154072.
- [48] A. Vázquez-Ingelmo, A. García-Holgado, F. J. García-Peñalvo and R. Therón, "A meta-model to develop learning ecosystems with support for knowledge discovery and decisionmaking processes," in *Proceedings of the 2020 15th Iberian Conference on Information Systems and Technologies (CISTI) (Seville, Spain, 24-27 June 2020)*, A. Rocha, B. E. Pérez, F. J. García-Peñalvo, M. M. Miras and R. Gonçalves, Eds., USA: IEEE, 2020. doi: 10.23919/CISTI49556.2020.9140986.
- [49] A. Vázquez-Ingelmo, A. García-Holgado, F. J. García-Peñalvo and R. Therón, "A Dashboard to Support Decision-Making Processes in Learning Ecosystems: A Metamodel Integration," in *Proceedings of the 2020 European Symposium on Software Engineering - ESSE 2020 (November 6-8, 2020, Rome, Italy)*. International Conference Proceedings Series, pp. 80-87, New York, NY, USA: ACM, 2020. doi: 10.1145/3393822.3432326.