

Bibliography on Knowledge Spaces

Maintained by Cord Hockemeyer*

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- Albert, D. (1993). Mathematische Modellierung von Wissensstrukturen. In L. Montada (Ed.), *Bericht über den 38. Kongreß der Deutschen Gesellschaft für Psychologie in Trier 1992* (Vol. 2, pp. 835–837). Göttingen: Hogrefe.
- Albert, D. (Ed.). (1994a). *Knowledge structures*. New York: Springer Verlag.
- Albert, D. (1994b). Neuere Entwicklungen in der Wissensdiagnostik. In H. Janig (Ed.), *Psychologische Forschung in Österreich* (pp. 25–29). Klagenfurt, Austria: Universitätsverlag Carinthia. Bericht über die 1. Wissenschaftliche Tagung der Österreichischen Gesellschaft für Psychologie.
- Albert, D. (1996). Die Repräsentation von individuellen Werten. In G. Trommsdorff & H.-J. Kornadt (Eds.), *Gesellschaftliche und individuelle Entwicklung in Japan und Deutschland* (pp. 299–315). Universitäts-Verlag Konstanz.
- Albert, D. (2003). Contributions of the psychology of knowledge to learning science and education. *Journal of Learning and Curriculum Development*, 2, 111–116.
- Albert, D., Bahrick, H. P., Falmagne, J.-C., Witteveen, C., d’Ydewalle, G., & Toda, M. (1990). Representation and assessment of knowledge. In B. Wilpert, H. Motoaki, & J. Mitsumi (Eds.), *General Psychology and Environmental Psychology* (Vol. 2, pp. 9–98). Proceedings of the 22nd International Congress of Applied Psychology.
- Albert, D., Dowling, C. E., & Riesenhuber, E. (1994). Empirische Validierung von Expertenwissen zu Sprachfertigkeiten von Kindern. In K. Pawlik (Ed.), *Bericht über den 39. Kongreß der Deutschen Gesellschaft für Psychologie in Hamburg 1994* (p. 23). Hogrefe.
- Albert, D. & Held, T. (1994). Establishing knowledge spaces by systematical problem construction. In D. Albert (Ed.), *Knowledge Structures* (pp. 78–112). New York: Springer Verlag.

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- Albert, D. & Held, T. (1996). Wissensstrukturen für Leistungen in Sprachtests. In M. Jirasko, J. Glück, & B. Rollett (Eds.), *Perspektiven psychologischer Forschung in Österreich* (pp. 65–68). Wien, Austria: WUV-Universitätsverlag.
- Albert, D. & Held, T. (1999). Component based knowledge spaces in problem solving and inductive reasoning. In D. Albert & J. Lukas (Eds.), *Knowledge Spaces: Theories, Empirical Research, Applications* (pp. 15–40). Mahwah, NJ: Lawrence Erlbaum Associates.
- Albert, D. & Hockemeyer, C. (1997). Adaptive and dynamic hypertext tutoring systems based on knowledge space theory. In B. du Boulay & R. Mizoguchi (Eds.), *Artificial Intelligence in Education: Knowledge and Media in Learning Systems* (pp. 553–555). Amsterdam: IOS Press.
- Albert, D. & Hockemeyer, C. (1999). Developing curricula for tutoring systems based on prerequisite relationships. In G. Cumming, T. Okamoto, & L. Gomez (Eds.), *Advanced Research in Computers and Communications in Education: New Human Abilities for the Networked Society* (Vol. 2, pp. 325–328). Amsterdam: IOS Press. Proceedings of the 7th International Conference on Computers in Education (ICCE), Chiba, Japan.
- Albert, D. & Hockemeyer, C. (2002). Applying demand analysis of a set of test problems for developing an adaptive course. In *Proceedings of the International Conference on Computers in Education ICCE 2002* (pp. 69–70). Los Alamitos, CA: IEEE Computer Society.
- Albert, D., Hockemeyer, C., Conlan, O., & Wade, V. (2001). Reusing adaptive learning resources. In C.-H. L. et al. (Ed.), *Proceedings of the International Conference on Computers in Education ICCE/SchoolNet2001* (Vol. 1, pp. 205–210).
- Albert, D., Hockemeyer, C., Kickmeier-Rust, M. D., Nussbaumer, A., & Steiner, C. M. (2012). E-learning based on metadata, ontologies and competence-based knowledge space theory. In D. Lukose, A. R. Ahmad, & A. Suliman (Eds.), *Knowledge Technology. Third Knowledge Technology Week, KTW 2011* (pp. 24–36). Berlin: Springer.
- Albert, D., Hockemeyer, C., Kickmeier-Rust, M. D., Peirce, N., & Conlan, O. (2007). Microadaptivity within complex learning situations — a personalized approach based on competence structures and problem spaces. In B. Chang, A. Kashiara, J. Kay, J. Lee, T. Matsui, R. Okamoto, D. Suthers, & F. Y. Yu (Eds.), *Proceedings of the international Conference on Computers in Education (ICCE 2007)*. IOS Press.
- Albert, D., Hockemeyer, C., Kulcsar, Z., & Shorten, G. (2007). Competence assessment for spinal anaesthesia. In A. Holzinger (Ed.), *HCI and Usability for Medicine and Health Care. Proceedings of the Third Symposium of the Workgroup Human-Computer Interaction and Usability Engineering of the Austrian Computer Society, USAB 2007 Graz, Austria, November, 22, 2007* (pp. 165–170). Berlin: Springer.

- Albert, D., Hockemeyer, C., Mayer, B., & Steiner, C. (2007). Cognitive structural modelling of skills for technology enhanced learning. In J. Spector, D. Sampson, T. Okamoto, Kinshuk, S. Cerri, M. Ueono, & A. Kashihara (Eds.), *Proceedings of the 7th IEEE International Conference on Advanced Learning Technologies (ICALT)* (pp. 322–324).
- Albert, D., Hockemeyer, C., & Mori, T. (2006). Memory, knowledge, and e-learning. In L.-G. Nilsson & N. Ohta (Eds.), *Memory and Society* (pp. 87–108). Hove, UK: Psychology Press.
- Albert, D., Hockemeyer, C., & Wesiak, G. (2002). Current trends in elearning based on knowledge space theory and cognitive psychology. *Psychologische Beiträge*, *44*, 478–494.
- Albert, D. & Kaluscha, R. (1997). Adapting knowledge structures in dynamic domains. In C. Herzog (Ed.), *Beiträge zum Achten Arbeitstreffen der GI-Fachgruppe 1.1.5/7.0.1 "Intelligente Lehr-/Lernsysteme", September 1997, Duisburg, Germany* (pp. 89–100). TU München.
- Albert, D., Kickmeier-Rust, M. D., & Matsuda, F. (2008). A formal framework for modelling the developmental course of competence and performance in the distance, speed, and time domain. *Developmental Review*, *28*, 401–420.
- Albert, D. & Lukas, J. (Eds.). (1999). *Knowledge spaces: Theories, empirical research, applications*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Albert, D. & Mori, T. (2001). Contributions of cognitive psychology to the future of e-learning. *Bulletin of the Graduate School of Education, Hiroshima University, Part I (Learning and Curriculum Development)*, *50*, 25–34.
- Albert, D. & Musch, J. (1996a). Knowledge space modeling of Ravens advanced progressive matrices (APM) test. In V. Kolesaric & D. Ivanec (Eds.), *Abstracts of the 4th Alps Adria Psychology Symposium* (p. 39). Zagreb, Croatia: Department of Psychology, Faculty of Philosophy, University of Zagreb.
- Albert, D. & Musch, J. (1996b). Ravens advanced progressive matrices. In A. Schorr (Ed.), *Experimentelle Psychologie: 38. Tagung experimentell arbeitender Psychologen, 1.–4. April 1996, Marburg, Germany* (p. 3). Lengerich, Germany: Pabst Science Publishers.
- Albert, D., Nussbaumer, A., Kuo, B., Foltz, P., & Hu, X. (2017). Competence-based knowledge structures and current challenges for e-assessment. In R. Sottolare, A. Graesser, X. Hu, & G. Goodwin (Eds.), *Design recommendations for intelligent tutoring systems: Volume 5 - assessment methods* (pp. 21–28). Orlando, FL, USA: U.S. Army Research Laboratory (ARL).

- Albert, D., Nussbaumer, A., & Steiner, C. (2008). Using visual guidance and feedback based on competence structures for personalising e-learning experience. In *ICCE 2008 — The 16th International Conference on Computers in Education* (pp. 3–10).
- Albert, D., Nussbaumer, A., & Steiner, C. (2010). Towards generic visualisation tools and techniques for adaptive e-learning. In *Proceedings of the 18th International Conference on Computers in Education* (pp. 61–65).
- Albert, D., Nussbaumer, A., Steiner, C., Hendrix, M., & Cristea, A. (2009). Design and development of an authoring tool for pedagogical relationship types between concepts. In *Proceedings of the 17th International Conference on Computer in Education (ICCE 2009)* (pp. 194–196).
- Albert, D. & Pilgerstorfer, M. (2007). Preliminary considerations on personalized assessment of logical and moral thinking skills. In D. Camhy (Ed.), *Philosophical Foundations of Innovative Learning. Proceedings of the International Conference on Philosophy for Children 2005* (pp. 55–61). St. Augustin, Germany: Academia Verlag.
- Albert, D. & Schrepp, M. (1999). Structure and design of an intelligent tutoring system based on skill assignments. In D. Albert & J. Lukas (Eds.), *Knowledge Spaces: Theories, Empirical Research, Applications* (pp. 179–196). Mahwah, NJ: Lawrence Erlbaum Associates.
- Albert, D., Schrepp, M., & Held, T. (1994). Construction of knowledge spaces for problem solving in chess. In G. H. Fischer & D. Laming (Eds.), *Contributions to Mathematical Psychology, Psychometrics, and Methodology* (pp. 123–135). New York: Springer-Verlag.
- Albert, D. & Stefanutti, L. (2003a). Knowledge structures and didactic model selection in learning object navigation. In F. W. Hesse & Y. Tamura (Eds.), *The Joint Workshop of Cognition and Learning through Media-Communication for Advanced E-Learning (JWCL)* (pp. 1–10). Japanisch-Deutsches Zentrum Berlin (JDZB).
- Albert, D. & Stefanutti, L. (2003b). Ordering and combining learning objects through skill maps and asset structures. In *Proceedings of the International Conference on Computers in Education ICCE 03*. Hong Kong.
- Albert, D. & Steiner, C. M. (2005a). Empirical validation of concept maps: Preliminary methodological considerations. In P. Goodyear, D. G. Sampson, D. J. Yang, Kinshuk, T. Okamoto, R. Hartley, & N. Chen (Eds.), *The 5th IEEE International Conference on Advanced Learning Technologies, Kaohsiung, Taiwan, 5–8 July 2005* (pp. 216–218). Los Alamitos, CA: IEEE Computer Society.
- Albert, D. & Steiner, C. M. (2005b). Representing domain knowledge by concept maps: How to validate them? In T. Okamoto, D. Albert, T. Honda, & F. W. Hesse (Eds.), *The 2nd Joint Workshop of Cognition and Learning through Media-Communication for Advanced e-Learning* (pp. 169–174).

- Albert, D., Wesiak, G., & Ünlü, A. (2013). Generating and validating relations between sets/tests. In J.-C. Falgagne, D. Albert, C. Doble, D. Eppstein, & X. Hu (Eds.), *Knowledge Spaces: Applications in Education* (pp. 193–228). Heidelberg: Springer.
- Albert, D., Wong, S., & Wesiak, G. (2009). Structure for assessing teachers it states. In *Proceedings of the 1st International Conference on Educational Research and Practice (ICERP): Enhancing Human Capital through Teacher Education* (pp. 1017–1032).
- Anselmi, P., Heller, J., Stefanutti, L., & Robusto, E. (2022). Constructing, improving, and shortening tests for skill assessment. *Journal of Mathematical Psychology*, *106*, 102621.
- Anselmi, P., Heller, J., Stefanutti, L., & Robusto, E. (2024). Constructing tests for skill assessment with competence-based test development. *British Journal of Mathematical and Statistical Psychology*.
- Anselmi, P., Pobusto, E., & Stefanutti, L. (2012). Uncovering the best skill multimap by constraining the error probabilities of the gain–loss model. *Psychometrika*, *77*(4), 763–781.
- Anselmi, P., Pobusto, E., & Stefanutti, L. (2013). A procedure for identifying the best skill multimap in the gain–loss model. *Electronic Notes in Discrete Mathematics*, *42*, 9–16.
- Anselmi, P., Robusto, E., Stefanutti, L., & de Chiusole, D. (2016). An upgrading procedure for adaptive assessment of knowledge. *Psychometrika*, *81*(2), 461–482.
- Anselmi, P., Stefanutti, L., de Chiusole, D., & Robusto, E. (2017). The assessment of knowledge and learning in competence spaces: The gain–loss model for dependent skills. *British Journal of Mathematical and Statistical Psychology*, *70*, 457–479.
- Anselmi, P., Stefanutti, L., de Chiusole, D., & Robusto, E. (2021). Modeling learning in knowledge space theory through bivariate Markov processes. *Journal of Mathematical Psychology*, *103*, 102549.
- Arasasingham, R. D., Taagepera, M., Potter, F., & Lonjers, S. (2004). Using Knowledge Space Theory to assess student understanding of stoichiometry. *Journal of Chemical Education*, *81*, 1517–1523.
- Arasasingham, R. D., Taagepera, M., Potter, F., Martorell, I., & Lonjers, S. (2005). Assessing the effect of WEeb–based learning tools on student understanding of stoichiometry. *Journal of Chemical Education*, *82*, 1251–1262.
- Arracher, A. (2000). Effekte der Anordnung visueller Information am Bildschirm auf das ALEPH-Benutzerverhalten. Diplomarbeit, Karl–Franzens–Universität Graz, Austria.

- Augustin, T., Hockemeyer, C., Kickmeier-Rust, M., & Albert, D. (2011). Individualized skill assessment in digital learning games: Basic definitions and mathematical formalism. *IEEE Transactions on Learning Technologies*, *4*, 138–148.
- Augustin, T., Hockemeyer, C., Kickmeier-Rust, M. D., Podbregar, P., Suck, R., & Albert, D. (2013). The simplified updating rule in the formalization of digital educational games. *Journal of Computational Sciences*, *4*, 293–303.
- Augustin, T., Hockemeyer, C., Suck, R., Podbregar, P., Kickmeier-Rust, M. D., & Albert, D. (2015). Individualized skill assessment in educational games: The mathematical foundations of partitioning. *Journal of Mathematical Psychology*, *67*, 1–7.
- Bartl, E. & Belohlávek, R. (2007). Knowledge spaces, attribute dependencies, and graded knowledge states. In *IEEE Fuzzy Systems Conference 2007* (pp. 1–6). IEEE.
- Bartl, E. & Belohlávek, R. (2008). Knowledge spaces with graded knowledge states. In *International Symposium on Knowledge Acquisition and Modeling* (pp. 3–8). IEEE.
- Bartl, E. & Belohlávek, R. (2011). Knowledge spaces with graded knowledge states. *Information Sciences*, *181*, 1426–1439.
- Baumunk, K. (1995). Die empirische Erhebung einer Struktur von Schulwissen im Fach Mathematik. Diplomarbeit, Technische Universität Carolo-Wilhelmina, Braunschweig, Germany.
- Baumunk, K. (1996). Die Validierung von Wissensstrukturen im Bruchrechnen. In *Festschrift zur Verleihung des Georg-Sieber-Preises 1996* (pp. 34–37).
- Baumunk, K. & Dowling, C. E. (1996). Die Validität von Wissensstrukturen im Bruchrechnen. In A. Schorr (Ed.), *Experimentelle Psychologie: 38. Tagung experimentell arbeitender Psychologen, 1.–4. April 1996, Eichstätt, Germany* (pp. 17–18). Lengerich, Germany: Pabst Science Publishers.
- Baumunk, K. & Dowling, C. E. (1997). Validity of spaces for assessing knowledge about fractions. *Journal of Mathematical Psychology*, *41*, 99–105.
- Baumunk, K. & Dowling, C. E. (1998). Der Einfluß von Frageformulierungen und Fragestrategien auf Fehltritteile bei der Expertenbefragung. In H. Lachnit, A. Jacobs, & F. Rösler (Eds.), *Experimentelle Psychologie: Abstracts der 40. Tagung experimentell arbeitender Psychologen, 6.–9. April 1998, Marburg, Germany* (p. 17). Lengerich, Germany: Pabst Science Publishers.
- Belohlávek, R. (2003). Birkhoff variety theorem and fuzzy logic. *Archive for Mathematical Logic*, *42*, 781–790.

- Bloom, C., Villano, M., & VanLehn, K. (1992). *Application of artificial intelligence technologies to training systems: Computer-based diagnostic testing systems*. Tech. Rep. Contract No. F41624-91-C-5002, Technical Training Research Division, Human Resources Directorate, Brooks AFB, TX.
- Brandt, S., Albert, D., & Hockemeyer, C. (1999). Surmise relations between tests - preliminary results of the mathematical modelling. *Electronic Notes in Discrete Mathematics*, 2.
- Brandt, S., Albert, D., & Hockemeyer, C. (2003). Surmise relations between tests - mathematical considerations. *Discrete Applied Mathematics*, 127(2), 221–239.
- Breen, D., Aboulaflia, A., Zhang, D., Hockemeyer, C., Albert, D., & Shorten, G. (2014). Defining a competence map for a practical skill. *The Clinical Teacher*, 11(7), 531–536.
- Bruchmann, F. (1993). Die Erhebung ausgewählter Wissensstrukturen von Lehrern zur Diagnose von Schulwissen im Fach Mathematik. Diplomarbeit, Technische Universität Carolo-Wilhelmina, Braunschweig, Germany.
- Bull, S., Kickmeier-Rust, M. D., Vatrappu, R. K., Johnson, M. D., Hammermueller, K., Byrne, W., Hernandez-Munoz, L., Giorgini, F., & Meissl-Egghart, G. (2013). Learning, learning analytics, activity visualisation and open learner model: Confusing? In D. Hernandez-Leo, T. Ley, R. Klamma, & A. Harrer (Eds.), *Scaling up Learning for Sustained Impact: 8th European Conference on Technology Enhanced Learning, EC-TEL 2013* (pp. 532–535). Berlin, Heidelberg: Springer.
- Bull, S., Wasson, B., Kickmeier-Rust, M. D., Johnson, M. D., Moe, E., Handsen, C., Meissl-Egghart, G., & Hammermueller, K. (2012). Assessing english as a second language: From classroom data to a competence-based open learner model. In *ICCE2012: The 20th International Conference on Computers in Education*.
- Bullock, D., Callahan, J., Ban, Y., Ahlgren, A., & Schrader, C. (2009). The implementation of an online mathematics placement exam and its effects on student success in precalculus and calculus. In *Proceedings of the ASEE Annual Conference and Exposition*.
- Callahan, J., Chyung, S. Y., Guild, J., Clement, W., Guarino, J., & Bullock, D. (2008). Enhancing precalculus curricula with e-learning: Implementation and assessment. In *Proceedings of the ASEE Annual Conference and Exposition*.
- Cao, X., Lin, F., Sun, W., & Li, J. (2021). *A note on knowledge structures delineated by fuzzy skill multimaps*. , Arxiv.org. Electronic Preprint arXiv:2112.08108, arXiv.org.
- Carmona, C., Millan, E., de-la Cruz, J. L. P., Trella, M., & Conejo, R. (2005). Introducing prerequisite relations in a multi-layered Bayesian student model. In *User Modelling 2005* (pp. 347–356). Heidelberg: Springer.

- Carvalho, M. B., Bellotti, F., Berta, R., Gloria, A. D., Gazzarata, G., Hu, J., & Kickmeier-Rust, M. (2015). A case study on service-oriented architecture for serious games. *Entertainment Computing*, 6, 1–10.
- Cathcart, L. A., Stieff, M., Marbach-Ad, G., Smith, A. C., & Frauwirth, K. A. (2010). Using knowledge space theory to analyze concept maps. In S. R. Goldman, J. Pellegrino, K. Gomez, L. Lyons, & J. Radinsky (Eds.), *Learning in the Disciplines: Proceedings of the 9th International Conference of the Learning Sciences, ICLS '10* (Vol. 1, pp. 952–959). International Society of the Learning Sciences / ACM DL.
- Chen, Y. (2013). Adaptive non-graded assessment based on knowledge space theory. In *13th International Conference on Advanced Learning Technologies, ICALT 2013* (pp. 63–64). IEEE.
- Chen, Y., Wuillemin, P.-H., & Labat, J.-M. (2015). Discovering prerequisite structure of skills through probabilistic association rules mining. In O. C. Santos, J. G. Boticario, C. Romero, M. Pechenizkiy, A. Merceron, P. Mitros, J. M. Luna, C. Mihaescu, P. Moreno, A. Hershkovitz, S. Ventura, & M. Desmarais (Eds.), *Conference: Proceedings of the 8th International Conference on Educational Data Mining, At Madrid, Spain* (pp. 117–124).
- Chiu, C.-Y., Kohn, H. F., & Ma, W. (2022). Commentary on "Extending the basic local independence model to polytomous data" by Stefanutti, de Chiusole, Anselmi, and Spoto. *Psychometrika*.
- Conlan, O., Hampson, C., Peirce, N., & Kickmeier-Rust, M. D. (2009). Realtime knowledge space skill assessment for personalized digital educational games. In *The 9th IEEE International Conference on Advanced Learning Technologies, ICALT 2009* (pp. 538–542). IEEE.
- Conlan, O., Hockemeyer, C., Lefrere, P., Wade, V., & Albert, D. (2001). Extending educational metadata schemas to describe adaptive learning resources. In H. Davies, Y. Douglas, & D. G. Durand (Eds.), *Hypertext '01: Proceedings of the twelfth ACM Conference on Hypertext and Hypermedia* (pp. 161–162). New York: ACM.
- Conlan, O., Hockemeyer, C., Wade, V., & Albert, D. (2002). Metadata driven approaches to facilitate adaptivity in personalized eLearning systems. *The Journal of Information and Systems in Education*, 1, 38–44.
- Conlan, O., Hockemeyer, C., Wade, V., Albert, D., & Gargan, M. (2002). An architecture for integrating adaptive hypermedia service with open learning environments. In *Proceedings of ED-MEDIA 2002* (pp. 344–350).
- Conlan, O., O’Keeffe, I., Hampson, C., & Heller, J. (2006). Using knowledge space theory to support learner modeling and personalization. In T. Reeves & S. Yamashita

- (Eds.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2006* (pp. 1912–1919). Chesapeake, VA: AACE.
- Cosyn, E. (2002). Coarsening a knowledge structure. *Journal of Mathematical Psychology*, *46*, 123–139.
- Cosyn, E., Doble, C., Falmagne, J.-C., Lenoble, A., Thiéry, N., & Uzun, H. (2013). Assessing mathematical knowledge in a learning space. In J.-C. Falmagne, D. Albert, C. Doble, D. Eppstein, & X. Hu (Eds.), *Knowledge Spaces: Applications in Education* (pp. 27–50). Heidelberg: Springer.
- Cosyn, E. & Thiéry, N. (2000). A practical procedure to build a knowledge structure. *Journal of Mathematical Psychology*, *44*, 383–407.
- Cosyn, E., Uzun, H., Doble, C., & Matayoshi, J. (2021). A practical perspective on knowledge space theory: Aleks and its data. *Journal of Mathematical Psychology*, *101*, 102512.
- Cosyn, E. & Uzun, H. B. (2009a). Note on two necessary and sufficient axioms for a well-graded knowledge space. *Journal of Mathematical Psychology*, *53*(1), 40–42.
- Cosyn, E. & Uzun, H. B. (2009b). Note on two sufficient axioms for a well-graded knowledge space. *Journal of Mathematical Psychology*, *53*(1), 40–42.
- Craig, S. D., Hu, X., Graesser, A. C., Bargagliotti, A. E., Sterbinsky, A., Cheney, K. R., & Okwumabua, T. (2013). The impact of a technology-based mathematics after-school program using ALEKS on student's knowledge and behaviors. *Computers & Education*, *68*, 495–504.
- Cui, X. (2010). Online java assessment system based on knowledge space theory. Master's thesis, The University of Edinburgh.
- Dani, A. (2016). Students' patterns of interaction with a mathematics intelligent tutor: Learning analytics application. *International Journal on Integrating Technology in Education*, *5*(2).
- Danilov, V. I. (2009). Knowledge spaces from a topological point of view. *Journal of Mathematical psychology*, *53*(6), 510–517.
- de Chiusole, D., Anselmi, P., Stefanutti, L., & Robusto, E. (2013). The gain–loss model: Bias of the parameter estimates. *Electronic Notes in Discrete Mathematics*, *42*, 33–40.
- de Chiusole, D. & Stefanutti, L. (2013). Modeling skill dependence in probabilistic competence structures. *Electronic Notes in Discrete Mathematics*, *42*, 41–48.
- de Chiusole, D., Stefanutti, L., Anselmi, P., & Robusto, E. (2013). Assessing parameter invariance in the BLIM: Bipartition models. *Psychometrika*, *78*(4), 710–724.

- de Chiusole, D., Stefanutti, L., Anselmi, P., & Robusto, E. (2015a). Modeling missing data in knowledge space theory. *Psychological Methods*, 20(4), 506–522.
- de Chiusole, D., Stefanutti, L., Anselmi, P., & Robusto, E. (2015b). Naïve tests of basic local independence model's invariance. *The Spanish Journal of Psychology*, 18.
- de Chiusole, D., Stefanutti, L., Anselmi, P., & Robusto, E. (2016). Testing the actual equivalence of automatically generated items. *Behavior Research Methods*, 50(1), 39–56.
- de Chiusole, D., Stefanutti, L., Anselmi, p., & Robusto, E. (2018). Testing the actual equivalence of automatically generated items. *Behavior Research methods*, 50(1), 39–56.
- de Chiusole, D., Stefanutti, L., Anselmi, P., & Robusto, E. (2020). Stat-Knowlab. assessment and learning of statistics with competence-based knowledge space theory. *International Journal of Artificial Intelligence in Education*, 30, 668–700.
- de Chiusole, D., Stefanutti, L., & Spoto, A. (2017). A class of k-modes algorithms for extracting knowledge structures from data. *Behavior Research Methods*, 49(4), 1212–1226.
- Dean, R. E. (2016). Active learning and the ALEKS placement test in college algebra : An observational study. Masters thesis, Oregon State University.
- Degreef, E., Doignon, J.-P., Ducamp, A., & Falmagne, J.-C. (1986). Languages for the assessment of knowledge. *Journal of Mathematical Psychology*, 30, 243–256.
- Desmarais, M., Giroux, L., & Larochelle, S. (1993). An advice giving interface based on plan-recognition and user-knowledge assessment. *International Journal of Man-Machine Studies*, 39, 901–924.
- Desmarais, M. C. & d. Baker, R. S. J. (2012). A review of recent advances in learner and skill modeling in intelligent learning environments. *User Modeling and User Adaptive Interaction*, 22(1–2), 9–38.
- Desmarais, M. C., Fu, S., & Pu, X. (2005). Tradeoff analysis between knowledge assessment approaches. In C.-K. Looi, G. McCalla, B. Bredeweg, & J. Breuker (Eds.), *Artificial Intelligence in Education* (pp. 209–216). Amsterdam, NL: IOS Press.
- Desmarais, M. C. & Gagnon, M. (2006). Bayesian student models based on item to item knowledge structures. In W. Nejdl & K. Tochtermann (Eds.), *Innovative Approaches for learning and Knowledge Sharing. First European Conference on Technology Enhanced learning, EC-TEL 2006* (pp. 111–124). Heidelberg: Springer.

- Desmarais, M. C. & Maluf, A. (1996). User–expertise modeling with empirically derived probabilistic implication networks. *User Modeling and User–Adapted Interaction*, 5, 283–315.
- Desmarais, M. C., Meshkinfam, P., & Gagmnon, M. (2006). Learned student models with item to item knowledge structures. *User Modeling and User-adapted Interaction*, 16, 403–434.
- Desmarais, M. C. & Pu, X. (2005). Computer adaptive testing: Comparison of a probabilistic network approach with item response theory. In L. Ardissono, P. Brna, & A. Mitrovic (Eds.), *User Modeling 2005: 10th International Conference* (pp. 392–396). Berlin: Springer Verlag.
- Desmarais, M. C. & Pu, X. (in press). A Bayesian student model without hidden nodes and its comparison with item response theory. *International Journal of Artificial Intelligence in Education*, 15.
- Dimache, A., Roche, T., Kopeinik, S., Winter, L., Nussbaumer, A., & Albert, D. (2015). Suitability of adaptive self-regulated e-learning to vocational training: A pilot study in heat pump system installation. *International Journal of Online Pedagogy and Course Design (IJOPCD)*, 5(3), 31–46.
- Doble, C., Matayoshi, J., Cosyn, E., Uzun, H., & Karami, A. (2019). A data-based simulation study of reliability for an adaptive assessment based on knowledge space theory. *International Journal of Artificial Intelligence in Education*, 29, 258–282.
- Doignon, J.-P. (1994a). Knowledge spaces and skill assignments. In G. H. Fischer & D. Laming (Eds.), *Contributions to Mathematical Psychology, Psychometrics, and Methodology* (pp. 111–121). New York: Springer–Verlag.
- Doignon, J.-P. (1994b). Probabilistic assessment of knowledge. In D. Albert (Ed.), *Knowledge Structures* (pp. 1–56). New York: Springer Verlag.
- Doignon, J.-P. (1999). Dimensions of chains of relations. *Electronic Notes in Discrete Mathematics*, 2. Abstract of a Talk presented at the OSDA98, Amherst, MA, September 1998.
- Doignon, J.-P. (2001). Knowledge spaces. In N. J. Smelser & P. B. Baltes (Eds.), *International Encyclopedia of the Social and Behavioral Sciences* (pp. 8148–8151). Amsterdam: Elsevier.
- Doignon, J.-P. (2013). Identifiability in knowledge space theory: a survey of recent results. In P. Cellier, F. Distel, & B. Ganter (Eds.), *Contributions to the 11th International Conference on Formal Concept Analysis (ICFCA 2013)* (pp. 1–4). Online available at <http://www.qucosa.de/fileadmin/data/qucosa/documents/11311/001.pdf>.

- Doignon, J.-P. (2014). Learning spaces, and how to build them. In C. V. Glodeanu, M. Kaytoue, & C. Sacarea (Eds.), *Formal Concept Analysis: 12th International Conference, ICFCA 2014, Cluj-Napoca, Romania, June 10-13, 2014. Proceedings* (pp. 1–14). Cham: Springer International Publishing.
- Doignon, J.-P. (2015). Cognition: Knowledge spaces. In J. D. Wright (Ed.), *International Encyclopedia of the Social and Behavioral Sciences* (second ed.) (Vol. 4, pp. 6–9). Amsterdam: Elsevier.
- Doignon, J.-P. (2021). A correct response model in knowledge structure theory. *Journal of Mathematical Psychology*, *102*, 102519.
- Doignon, J.-P., Ducamp, A., & Falmagne, J.-C. (1984). On realizable biorders and the biorder dimension of a relation. *Journal of Mathematical Psychology*, *28*(1), 73–109.
- Doignon, J.-P. & Falmagne, J.-C. (1985). Spaces for the assessment of knowledge. *International Journal of Man-Machine Studies*, *23*, 175–196.
- Doignon, J.-P. & Falmagne, J.-C. (1987). Knowledge assessment: A set theoretical framework. In B. Ganter, R. Wille, & K. Wolfe (Eds.), *Beiträge zur Begriffsanalyse: Vorträge der Arbeitstagung Begriffsanalyse, Darmstadt 1986* (pp. 129–140). Mannheim: BI Wissenschaftsverlag.
- Doignon, J.-P. & Falmagne, J.-C. (1988). Parametrization of knowledge structures. *Discrete Applied Mathematics*, *21*, 87–100.
- Doignon, J.-P. & Falmagne, J.-C. (Eds.). (1991). *Mathematical psychology: Current developments*. New York: Springer-Verlag.
- Doignon, J.-P. & Falmagne, J.-C. (1997). Well-graded families of relations. *Discrete Mathematics*, *173*, 35–44.
- Doignon, J.-P. & Falmagne, J.-C. (1999). *Knowledge spaces*. Berlin: Springer-Verlag.
- Doignon, J.-P. & Falmagne, J.-C. (2015). *Knowledge spaces and learning spaces*. , Arxiv.org. Electronic Preprint arXiv:1511.06757v1, arXiv.org.
- Doignon, J.-P. & Falmagne, J.-C. (2017). Knowledge spaces and learning spaces. In W. H. Batchelder, H. Colonius, E. N. Dzhafarov, & J. Myung (Eds.), *New Handbook of Mathematical Psychology* (Vol. 1, pp. 274–321). Cambridge University Press.
- Doignon, J.-P., Falmagne, J.-C., & Cosyn, E. (2013). Learning spaces: A mathematical compendium. In J.-C. Falmagne, D. Albert, C. Doble, D. Eppstein, & X. Hu (Eds.), *Knowledge Spaces: Applications in Education* (pp. 131–146). Heidelberg: Springer.

- Doignon, J.-P., Heller, J., & Stefanutti, L. (2018). Identifiability of probabilistic models, with examples from knowledge structure theory. In W. H. Batchelder, H. Colonius, & E. N. Dzhafarov (Eds.), *New Handbook of Mathematical Psychology* (Vol. 2, pp. 128–184). Cambridge University Press.
- Donadello, I., Spoto, A., Sambo, F., Badaloni, S., Granziol, U., & Vidotto, G. (2017). ATS–PD: An adaptive testing system for psychological disorders. *Educational and Psychological Measurement*, 77(5), 792–815.
- Dösinger, G. (1999). Empirische Untersuchung der Voraussetzungen des Rechnens im Vorschulalter unter Anwendung der Wissensraumtheorie. Diplomarbeit, Karl–Franzens–Universität Graz, Austria.
- Dösinger, G. (2002). Adaptive competence testing in eLearning. *European Journal of Open and Distance Learning*.
- Dösinger, G. (2003). *Die Struktur kognitiver Voraussetzungen von Rechenleistungen — Empirische Untersuchungen mit Vorschulkindern*. Inauguraldissertation, Karl–Franzens–Universität Graz, Graz, Austria.
- Dösinger, G. & Albert, D. (2002). Adaptive competence testing in elearning. In M. Auer & U. Auer (Eds.), *Interactive computer aided learning (ICL) 2002. International Workshop*. Kassel University Press.
- Dowling, C. E. (1991a). Constructing knowledge spaces from judgements with differing degrees of certainty. In J.-P. Doignon & J.-C. Falmagne (Eds.), *Mathematical Psychology: Current Developments* (pp. 221–231). New York: Springer–Verlag.
- Dowling, C. E. (1991b). *Constructing knowledge structures from the judgements of experts*. Habilitationsschrift, Technische Universität Carolo-Wilhelmina, Braunschweig, Germany.
- Dowling, C. E. (1993a). Applying the basis of a knowledge space for controlling the questioning of an expert. *Journal of Mathematical Psychology*, 37, 21–48.
- Dowling, C. E. (1993b). On the irredundant construction of knowledge spaces. *Journal of Mathematical Psychology*, 37, 49–62.
- Dowling, C. E. (1994a). Combinatorial structures for the representation of knowledge. In D. Albert (Ed.), *Knowledge Structures* (pp. 57–76). New York: Springer Verlag.
- Dowling, C. E. (1994b). Integrating different knowledge spaces. In G. H. Fischer & D. Laming (Eds.), *Contributions to Mathematical Psychology, Psychometrics, and Methodology* (pp. 149–158). New York: Springer–Verlag.

- Dowling, C. E. (1994c). Verfahren zur Erhebung von Expertenurteilen über Voraussetzungsbeziehungen zwischen Wissensinhalten. In K. Pawlik (Ed.), *Bericht über den 39. Kongreß der Deutschen Gesellschaft für Psychologie in Hamburg 1994* (pp. 129–130). Hogrefe.
- Dowling, C. E. & Hockemeyer, C. (1995). *Wissensdiagnose in der beruflichen Ausbildung*. Unpublished technical report, Institut für Psychologie, Technische Universität Braunschweig, Germany.
- Dowling, C. E. & Hockemeyer, C. (1998). Computing the intersection of knowledge spaces using only their basis. In C. E. Dowling, F. S. Roberts, & P. Theuns (Eds.), *Recent Progress in Mathematical Psychology* (pp. 133–141). Mahwah, NJ: Lawrence Erlbaum Associates Ltd.
- Dowling, C. E. & Hockemeyer, C. (1999). Integrating knowledge spaces obtained by querying different experts. *Electronic Notes in Discrete Mathematics*, 2. Abstract of a Talk presented at the OSDA98, Amherst, MA, September 1998.
- Dowling, C. E. & Hockemeyer, C. (2001). Automata for the assessment of knowledge. *IEEE Transactions on Knowledge and Data Engineering*, 13(3), 451–461.
- Dowling, C. E., Hockemeyer, C., & Ludwig, A. H. (1996). Adaptive assessment and training using the neighbourhood of knowledge states. In C. Frasson, G. Gauthier, & A. Lesgold (Eds.), *Intelligent Tutoring Systems* (pp. 578–586). Berlin: Springer Verlag.
- Dowling, C. E. & Kaluscha, R. (1995). Prerequisite relationships for the adaptive assessment of knowledge. In J. Greer (Ed.), *Artificial Intelligence in Education, 1995* (pp. 43–50). Charlottesville, VA: Association for the Advancement of Computing in Education (AACE).
- Dowling, C. E., Koch, U., & Quante, K. A. (1996). A new interface for querying experts on prerequisite relationships. In J. Grundy & M. Apperley (Eds.), *Proceedings of the Sixth Australian Conference on Computer–Human Interaction (OzCHI 96)* (pp. 320–321). Los Alamitos, California: IEEE Computer Society Press.
- Dowling, C. E. & Nitzsche, S. (1996). Der Einfluß einer Arbeitsanreicherung bei der Befragung auf die Validität von Expertenurteilen. In A. Schorr (Ed.), *Experimentelle Psychologie: 38. Tagung experimentell arbeitender Psychologen, 1.–4. April 1996, Eichstätt, Germany* (p. 60). Lengerich, Germany: Pabst Science Publishers.
- Dowling, C. E., Roberts, F. S., & Theuns, P. (Eds.). (1998). *Recent progress in mathematical psychology*. Scientific Psychology Series. Mahwah, NJ: Lawrence Erlbaum Associates Ltd.
- Düntsche, I. & Gediga, G. (1995). Skills and knowledge structures. *British Journal of Mathematical and Statistical Psychology*, 48, 9–27.

- Düntsch, I. & Gediga, G. (1996). On query procedures to build knowledge structures. *Journal of Mathematical Psychology*, *40*, 160–168.
- Düntsch, I. & Gediga, G. (1998). Knowledge structures and their applications in CALL. In S. Jager, J. Nerbonne, & A. van Essen (Eds.), *Language teaching and Language Technology* (pp. 177–186). Lisse: Swets and Zeitlinger.
- Düntsch, I. & Gediga, G. (2001). A note on the correspondence among entail relations, rough set dependencies, and logical consequence. *Journal of Mathematical Psychology*, *43*, 393–401.
- Eichler, J. F. & Peebles, J. (2013). Online homework put to the test: A report on the impact of two online learning systems on student performance in general chemistry. *Journal of Chemical Education*, *90*, 1137–1143.
- El-Kechai, N., Melero, J., & Labat, J.-M. (2015). Quelques enseignements tirés de l'application de la Competence-based Knowledge Space Theory aux Serious Games. In *IC2015*. Rennes, France.
- Encheva, S. & Tumin, S. (2006). Automated knowledge assessment and knowledge spaces. In *Proceedings of the 5th WSEAS Conference on Education and Educational Technology* (pp. 82–86).
- Encheva, S. & Tumin, S. (2010). Diagnostic tests based on knowledge states. In J.-S. Pan, S.-M. Chen, & N. T. Nguyen (Eds.), *Computational Collective Intelligence—Technologies and Applications. Second International Conference, ICCCI 2010 Proceedings, Part III* (pp. 133–141). Berlin: Springer.
- Encheva, S., Tumin, S., & Solesvik, M. Z. (2007). Federated knowledge spaces. In M. Morne (Ed.), *The Third ADvanced International Convergence on Telecommunications (AICT'07)* (p. 26). Los Alamitos, CA: IEEE Computer Society.
- Eppstein, D. (2008). *Learning sequences*. , Arxiv.org. Online available at <http://arxiv.org/abs/0803.4030>.
- Eppstein, D. (2013a). Learning sequences: An efficient data structure for learning spaces. In J.-C. Falmagne, D. Albert, C. Doble, D. Eppstein, & X. Hu (Eds.), *Knowledge Spaces: Applications in Education* (pp. 287–304). Heidelberg: Springer.
- Eppstein, D. (2013b). Projection, decomposition, and adaption of learning spaces. In J.-C. Falmagne, D. Albert, C. Doble, D. Eppstein, & X. Hu (Eds.), *Knowledge Spaces: Applications in Education* (pp. 305–322). Heidelberg: Springer.
- Eppstein, D. & Falmagne, J.-C. (2002). *Algorithms for media*. , Arxiv.org. Electronic Preprint cs/0206033, arXiv.org.

- Eppstein, D., Falmagne, J.-C., & Ovchinnikov, S. (2008). *Media theory*. Berlin/Heidelberg: Springer.
- Eppstein, D., Falmagne, J.-C., & Uzun, H. B. (2007). *On verifying and engineering the well-gradedness of a union-closed family*. , Arxiv.org. Electronic Preprint 0704.2919, arXiv.org.
- Eppstein, D., Falmagne, J.-C., & Uzun, H. B. (2009). On verifying and engineering the wellgradedness of a union-closed family. *Journal of Mathematical Psychology*, 53(1), 34–39.
- Falmagne, J.-C. (1988). Parametrization of knowledge structures. *Discrete Applied Mathematics*, 21(2), 87–100.
- Falmagne, J.-C. (1989a). A latent trait theory via stochastic learning theory for a knowledge space. *Psychometrika*, 53, 283–303.
- Falmagne, J.-C. (1989b). Probabilistic knowledge spaces: A review. In F. S. Roberts (Ed.), *Applications of Combinatorics and Graph Theory to the Biological and Social Sciences* (pp. 283–303). New York: Springer Verlag.
- Falmagne, J.-C. (1993). Stochastic learning paths in a knowledge structure. *Journal of Mathematical Psychology*, 37, 489–512.
- Falmagne, J.-C. (1994a). Finite markov learning models for knowledge structures. In G. H. Fischer & D. Laming (Eds.), *Contributions to Mathematical Psychology, Psychometrics, and Methodology* (pp. 75–89). New York: Springer–Verlag.
- Falmagne, J.-C. (1994b). Foreword. In D. Albert (Ed.), *Knowledge Structures* (pp. V–VII). New York: Springer Verlag.
- Falmagne, J.-C. (1996). Errata to SLP. *Journal of Mathematical Psychology*, 40, 169–174.
- Falmagne, J.-C. (1997). Stochastic token theory. *Journal of Mathematical psychology*, 41(2), 129–143.
- Falmagne, J.-C. (1999). ALEKS, an application of knowledge space theory. *Electronic Notes in Discrete Mathematics*, 2. Tutorial given at the OSDA98, Amherst, MA, September 1998.
- Falmagne, J.-C. (2001). Markov processes for knowlede spaces. In N. J. Smelser & P. B. Baltes (Eds.), *International Encyclopedia of the Social and Behavioral Sciences* (pp. 9251–9253). Amsterdam: Elsevier.
- Falmagne, J.-C. (2008). *Projections and symmetric expansions of a learning space*. , Arxiv.org.

- Falmagne, J.-C. (2015). Markov processes in learning spaces. In J. D. Wright (Ed.), *International Encyclopedia of the Social and Behavioral Sciences* (second ed.) (Vol. 14, pp. 584–590). Amsterdam: Elsevier.
- Falmagne, J.-C., Albert, D., Doble, C., Eppstein, D., & Hu, X. (Eds.). (2013). *Knowledge spaces: Applications in education*. Heidelberg: Springer.
- Falmagne, J.-C., Cosyn, E., Doignon, J.-P., & Thiéry, N. (2006). The assessment of knowledge, in theory and in practice. In R. Missaoui & J. Schmid (Eds.), *Formal Concept Analysis. 4th International Conference, ICFCA 2006, Dresden, Germany, February 13-17, 2006* (pp. 61–79). Berlin: Springer.
- Falmagne, J.-C. & Doble, C. (2013). Overview. In J.-C. Falmagne, D. Albert, C. Doble, D. Eppstein, & X. Hu (Eds.), *Knowledge Spaces: Applications in Education* (pp. 3–26). Heidelberg: Springer.
- Falmagne, J.-C. & Doignon, J.-P. (1988a). A class of stochastic procedures for the assessment of knowledge. *British Journal of Mathematical and Statistical Psychology*, *41*, 1–23.
- Falmagne, J.-C. & Doignon, J.-P. (1988b). A Markovian procedure for assessing the state of a system. *Journal of Mathematical Psychology*, *32*, 232–258.
- Falmagne, J.-C. & Doignon, J.-P. (1993). A stochastic theory for system failure assessment. In B. Bouchon-Meunier, L. Valverde, & R. Yager (Eds.), *Uncertainty in Intelligent Systems* (pp. 431–440). Amsterdam: North-Holland.
- Falmagne, J.-C. & Doignon, J.-P. (1997). Stochastic evolution of rationality. *Theory and Decision*, *43*, 107–138.
- Falmagne, J.-C. & Doignon, J.-P. (1998). Meshing knowledge structures. In C. E. Dowling, F. S. Roberts, & P. Theuns (Eds.), *Recent Progress in Mathematical Psychology* (pp. 143–153). Mahwah, NJ: Lawrence Erlbaum Associates Ltd.
- Falmagne, J.-C. & Doignon, J.-P. (2011). *Learning spaces*. Berlin/Heidelberg: Springer.
- Falmagne, J.-C., Koppen, M., Villano, M., Doignon, J.-P., & Johannesen, L. (1990). Introduction to knowledge spaces: How to build, test and search them. *Psychological Review*, *97*, 201–224.
- Falmagne, J.-C. & Lakshminarayan, K. (1994). Stochastic learning paths — estimation and simulation. In G. H. Fischer & D. Laming (Eds.), *Contributions to Mathematical Psychology, Psychometrics, and Methodology* (pp. 91–110). New York: Springer-Verlag.
- Falmagne, J.-C. & Ovchinnikov, S. (2002). Media theory. *Discrete Applied Mathematics*, *121*, 83–101.

- Fanusi, A. D. (2016). *The effect of ALEKS math support on standardized math test scores in middle school*. Phd thesis, Liberty University, School of Education.
- Fasching, T. (1998). Empirische Überprüfung einer vermuteten Wertestruktur im Bereich der mütterlichen Erziehung von Kindern. Diplomarbeit, Karl-Franzens-Universität Graz, Austria.
- Fischer, G. H. & Laming, D. (Eds.). (1994). *Contributions to mathematical psychology, psychometrics, and methodology*. New York: Springer-Verlag.
- Freitag, O. (1999). Graphische Darstellung von Expertenurteilen. Diplomarbeit, Technische Universität Braunschweig, Germany.
- Fries, S. (1997). Empirical validation of a markovian learning model for knowledge structures. *Journal of Mathematical Psychology*, 41, 65–70.
- Fuhrmann, F. (1995). Experimente zur Validierung von Expertenbefragungen. Diplomarbeit, Technische Universität Braunschweig, Germany.
- Fuhrmann, F. & Dowling, C. E. (1996). Der Einfluss von Frageformulierungen auf die Validität von Expertenurteilen. In A. Schorr (Ed.), *Experimentelle Psychologie: 38. Tagung experimentell arbeitender Psychologen, 1.–4. April 1996, Eichstätt, Germany* (p. 81). Lengerich, Germany: Pabst Science Publishers.
- Ganter, B., Bedek, M., Heller, J., & Suck, R. (2017). An invitation to knowledge space theory. In K. Bertet, D. Borchmann, P. Cellier, & S. Ferré (Eds.), *Formal Concept Analysis. 14th International Conference, ICFCA 2017* (pp. 3–19). Cham, Switzerland: Springer.
- Ge, X. & Li, J. (2020). A note on the separability of items in knowledge structures delineated by skill multimaps. *Journal of Mathematical Psychology*, 98.
- Ge, X. & Lin, S. (2021). Notes on attribution functions. *British Journal on Mathematical and Statistical Psychology*, 74, 131–156.
- Gediga, G. & Düntsch, I. (2002). Skill set analysis in knowledge structures. *British Journal of Mathematical and Statistical Psychology*, 55, 361–384.
- George, A. C. & Ünlü, A. (2013). Parameter estimation in skills-based knowledge space theory and cognitive diagnosis models: A comparison. In D. Conesa, A. Forte, A. López-Quílez, & F. Muñoz (Eds.), *Proceedings of the International Workshop on Statistical Modelling* (pp. 258–262). Valencia, Spain.
- Görgün, I., Turker, A., Ozan, Y., & Heller, J. (2005). Learner modeling to facilitate personalized e-learning experience. In Kinshuk, D. G. Sampson, & P. T. Isaias (Eds.), *CELDA'05: Cognition and Exploratory Learning in Digital Age* (pp. 231–237). IADIS.

- Grayce, C. J. (2013). A commercial implementation of knowledge space theory in college general chemistry. In J.-C. Falmagne, D. Albert, C. Doble, D. Eppstein, & X. Hu (Eds.), *Knowledge Spaces: Applications in Education* (pp. 93–114). Heidelberg: Springer.
- Hagerty, G. W. & Smith, S. (2005). Using the web-based interactive software ALEKS to enhance college algebra. *Mathematics and Computer Education*, 39, 183–194.
- Harp, S. A., Samad, T., & Villano, M. (1995). Modeling student knowledge with self-organizing feature maps. *IEEE Transactions on Systems, Man, and Cybernetics*, 25(5), 727–737.
- He, Z. & Sun, W. (2022). Competence-based skill functions and minimal sets of skills. *Symmetry*, 14, 884.
- Heck, D. W. & Noventa, S. (2020). Representing probabilistic models of knowledge space theory by multinomial processing tree models. *Journal of Mathematical Psychology*, 96.
- Held, T. (1993). *Establishment and empirical validation of problem structures based on domain specific skills and textual properties*. Dissertation, Universität Heidelberg, Germany.
- Held, T. (1999). An integrated approach for constructing, coding, and structuring a body of word problems. In D. Albert & J. Lukas (Eds.), *Knowledge Spaces: Theories, Empirical Research, Applications* (pp. 67–102). Mahwah, NJ: Lawrence Erlbaum Associates.
- Held, T. & Korossy, K. (1998). Data analysis as a heuristic for establishing theoretically founded item structures. *Zeitschrift für Psychologie*, 206, 169–188.
- Held, T. & Schrepp, M. (1995). Eine Simulationsstudie zu Urteilsfehlern bei Expertenbefragungen. In O. Güntürkün, R. Guski, C. Walter, & A. Wohlschläger (Eds.), *Experimentelle Psychologie: Beiträge zur 37. Tagung experimentell arbeitender Psychologen, 9.–13. April 1995, Bochum, Germany* (p. 141). Regensburg, Germany: S. Roderer Verlag. Abstract.
- Held, T., Schrepp, M., & Fries, S. (1994). *Vergleich von Methoden zur Ableitung von Wissensräumen*. Bericht aus dem Psychologischen Institut 81, Universität Heidelberg, Germany.
- Held, T., Schrepp, M., & Fries, S. (1995). Methoden zur Bestimmung von Wissensstrukturen — Eine Vergleichsstudie. *Zeitschrift für Experimentelle Psychologie*, XLII(2), 205–236.
- Heller, J. (1994). Semantic structures. In D. Albert (Ed.), *Knowledge Structures* (pp. 117–149). New York: Springer Verlag.

- Heller, J. (2000). Representation and assessment of individual semantic knowledge. *Methods of Psychological Research — Online*, 5(2), 1–37.
- Heller, J. (2004). A formal framework for characterizing querying algorithms. *Journal of Mathematical Psychology*, 48, 1–8.
- Heller, J. (2017). Identifiability in probabilistic knowledge structures. *Journal of Mathematical Psychology*, 77, 46–57.
- Heller, J. (2019). Assessment structures in psychological testing. *Journal of Mathematical Psychology*, 91, 1–13.
- Heller, J. (2021). Generalizing quasi-ordinal knowledge spaces to polytomous items. *Journal of Mathematical Psychology*, 101, 102515.
- Heller, J. (2023). Assessment-based correct rates in learning spaces. *Journal of Mathematical Psychology*, 112, 102740.
- Heller, J., Albert, D., Kickmeier-Rust, M. D., & Kertz, M. (2006). Achievement motivation, performance structure, and adaptive hypertext learning. In M. Pivec, F. Thissen, & K. Baumann (Eds.), *Affective and Emotional Aspects of Human–Computer Interaction: Emphasis on Game–Based and Innovative Learning Approaches*. Washington, D.C.: IOS Press.
- Heller, J., Anselmi, P., Stefanutti, L., & Robusto, E. (2017). A necessary and sufficient condition for unique skill assessment. *Journal of Mathematical Psychology*, 79, 23–28.
- Heller, J., Augustin, T., Hockemeyer, C., Stefanutti, L., & Albert, D. (2013). Recent developments in competence–based knowledge space theory. In J.-C. Falmagne, D. Albert, C. Doble, D. Eppstein, & X. Hu (Eds.), *Knowledge Spaces: Applications in Education* (pp. 243–286). Heidelberg: Springer.
- Heller, J., Hockemeyer, C., & Albert, D. (2004). Applying competence structures for peer tutor recommendations in CSCL environments. In Kinshuk, C. Looi, E. Sutinen, D. Sampson, I. Aedo, L. Uden, & E. Kähkönen (Eds.), *The 4th IEEE International Conference on Advanced Learning Technologies* (pp. 1050–1051). Los Alamitos, CA: IEEE Computer Society.
- Heller, J., Keenoy, K., Levene, M., Hassan, M. M., Hockemeyer, C., & Albert, D. (2004). *Cognitive and pedagogical aspects of trails: A case study*. , Birkbeck, University of London. Public Report of the JEIRP Trails within the NoE Kaleidoscope.
- Heller, J., Levene, M., Keenoy, K., Albert, D., & Hockemeyer, C. (2007). Cognitive aspects of trails: A stochastic model linking navigation behaviour to the learner’s cognitive state. In J. Schoonenboom, J. Heller, K. Keenoy, M. Levene, & M. Turcsanyi-Szabo (Eds.), *Trails in Education: Technologies that Support Navigational Learning* (pp. 119–146). Rotterdam: Sense Publisher.

- Heller, J., Levene, M., Keenoy, K., Hockemeyer, C., & Albert, D. (2004). *An e-learning perspective of cognitive and pedagogical aspects of trails.* , Birkbeck, University of London. Public Report of the JEIRP Trails within the NoE Kaleidoscope.
- Heller, J., Mayer, B., Hockemeyer, C., & Albert, D. (2005). Competence-based knowledge structures for personalised learning. In G. Albano, P. Ritrovato, & S. Salerno (Eds.), *1st International ELeGI-Conference on Advanced Technology for Enhanced Learning*. The British Computer Society (BCS).
- Heller, J. & Repitsch, C. (2008). Distributed skill functions and the meshing of knowledge structures. *Journal of Mathematical Psychology*, *52*, 147–157.
- Heller, J. & Repitsch, C. (2012). Exploiting prior information in stochastic knowledge assessment. *Methodology*, *8*, 12–22.
- Heller, J. & Stefanutti, L. (Eds.). (2024). *Knowledge structures: Recent developments in theory and application*, (Vol. 7) of *Advanced Series on Mathematical Psychology*. Singapore: World Scientific.
- Heller, J., Stefanutti, L., Anselmi, P., & Robusto, E. (2015). On the link between cognitive diagnostic models and knowledge space theory. *Psychometrika*, *80*(4), 995–1019.
- Heller, J., Stefanutti, L., Anselmi, P., & Robusto, E. (2016). Erratum to: On the link between cognitive diagnostic models and knowledge space theory. *Psychometrika*, *81*, 250–251.
- Heller, J., Steiner, C., Hockemeyer, C., & Albert, D. (2006). Competence-based knowledge structures for personalised learning. *International Journal on E-Learning*, *5*(1), 75–88.
- Heller, J., Ünlü, A., & Albert, D. (2013). Skills, competencies and knowledge structures. In J.-C. Falmagne, D. Albert, C. Doble, D. Eppstein, & X. Hu (Eds.), *Knowledge Spaces: Applications in Education* (pp. 229–242). Heidelberg: Springer.
- Heller, J. & Wickelmaier, F. (2013). Minimum discrepancy estimation in probabilistic knowledge structures. *Electronic Notes in Discrete Mathematics*, *42*, 49–56.
- Hermann, G. (1998). Empirische Überprüfung eines Wissensraumes für Textaufgaben zur elementaren Wahrscheinlichkeitsrechnung. Diplomarbeit, Karl-Franzens-Universität Graz, Austria.
- Hillemann, E. C., Kickmeier-Rust, M. D., & Albert, D. (2012). Tackling the challenges of the 21st century classroom: The perspective of Austrian teachers. In *4th International Conference on Education and New Learning Technologies (EDULEARN)* (pp. 6857–6866). Barcelona, Spain: IATED.

- Hillemann, E. C., Kickmeier-Rust, M. D., & Albert, D. (2013). The usage of new technologies in the 21st century classroom: A question of teachers' personality? In 5th *International Conference on Education and New Learning Technologies (EDULEARN)* (pp. 2206–2215). Barcelona, Spain: IATED.
- Hirschenberger, U. (1998). Empirische Untersuchung zu Rechenfertigkeiten der ersten und zweiten Schulstufe auf Basis der Wissensraumtheorie. Diplomarbeit, Karl-Franzens-Universität Graz, Austria.
- Hockemeyer, C. (1993). Wissensdiagnose auf Wissensräumen. Diplomarbeit, Technische Universität Carolo-Wilhelmina, Braunschweig, Germany.
- Hockemeyer, C. (1997a). *RATH — a relational adaptive tutoring hypertext WWW-environment*. Technical Report 1997/3, Institut für Psychologie, Karl-Franzens-Universität Graz, Austria. <https://resources.cord-hockemeyer.info/techreports/RATH-TechReport.pdf>.
- Hockemeyer, C. (1997b). Using the basis of a knowledge space for determining the fringe of a knowledge state. *Journal of Mathematical Psychology*, 41, 275–279.
- Hockemeyer, C. (2000a). *CRATH: A collaborative adaptive tutoring hypertext system*. Unpublished technical report, Institut für Psychologie, Karl-Franzens-Universität Graz, Austria. <https://resources.cord-hockemeyer.info/techreports/crath-Bericht.pdf>.
- Hockemeyer, C. (2000b). *Documentation of the libsrbi library*. Unpublished technical report, Institut für Psychologie, Karl-Franzens-Universität Graz, Austria. https://resources.cord-hockemeyer.info/techreports/libsrbi_TechRep_FWF00.pdf.
- Hockemeyer, C. (2001). *KST tools user manual* (2nd ed.). Unpublished technical report, Institut für Psychologie, Karl-Franzens-Universität Graz, Austria. https://resources.cord-hockemeyer.info/techreports/KST-Tools_TechRep_FWF01.pdf.
- Hockemeyer, C. (2002). A comparison of non-deterministic procedures for the adaptive assessment of knowledge. *Psychologische Beiträge*, 44, 495–503.
- Hockemeyer, C. (2003). Competence based adaptive e-learning in dynamic domains. In F. W. Hesse & Y. Tamura (Eds.), *The Joint Workshop of Cognition and Learning through Media-Communication for Advanced E-Learning (JWCL)* (pp. 79–82). Japanisch-Deutsches Zentrum Berlin (JDZB).
- Hockemeyer, C. (2009). Multi-modal competence assessment based on users' performance on complex tasks. In *The Challenge of Demographic Change—Sustainable Life-Long Learning and Digital Media*. Japanisch-Deutsches Zentrum Berlin (JDZB).

- Hockemeyer, C. (2022). *R packages for knowledge space theory*. Unpublished technical report, Institut für Psychologie, Karl–Franzens–Universität Graz, Austria.
- Hockemeyer, C. (2023a). *CDSS: Course–dependent skill structures*. R package version 0.2-0.
- Hockemeyer, C. (2023b). *kstIO: Knowledge space theory input/output*. R package version 0.4-0.
- Hockemeyer, C. (2024). *R packages for knowledge space theory* (2nd ed.). Unpublished technical report, Institut für Psychologie, Karl–Franzens–Universität Graz, Austria.
- Hockemeyer, C. & Albert, D. (1999). The adaptive tutoring system RATH—a prototype. In M. E. Auer & U. Ressler (Eds.), *ICL99 Workshop Interactive Computer aided Learning: Tools and Applications*. Villach, Austria: Carinthia Tech Institute.
- Hockemeyer, C. & Albert, D. (2003). Adaptive eLearning and the learning GRID. In P. Ritrovato, S. Salerno, & M. Gaeta (Eds.), *1st LEGE–WG International Workshop on Educational Models for GRID Based Services, Lausanne, Switzerland, 16 September 2002*. Wiltshire, UK: British Computer Society (BCS).
- Hockemeyer, C., Albert, D., & Brandt, S. (1998). Surmise relations between courses. *Journal of Mathematical Psychology*, 42, 508. Abstract of a talk presented at the 29th EMPG meeting, Keele, UK, September 1998.
- Hockemeyer, C., Albert, D., Stefanuti, L., Lewis, D., & Conlan, O. (2004). Adaptive knowledge services based on grid architecture. In L. Aroyo & C. Tasso (Eds.), *AH2004: Workshop Proceedings, Part II* (pp. 491–498). Eindhoven, The Netherlands: Technische Universiteit Eindhoven, Department of Mathematics and Computer Science.
- Hockemeyer, C., Conlan, O., Wade, V., & Albert, D. (2003). Applying competence prerequisite structures for eLearning and skill management. *Journal of Universal Computer Science*, 9, 1428–1436.
- Hockemeyer, C. & Dowling, C. (1996). *KST tools user manual*. Unpublished technical report, Institut für Psychologie, Technische Universität Braunschweig, Germany. https://resources.cord-hockemeyer.info/techreports/KST-Tools_TechRep_BS-96.pdf.
- Hockemeyer, C., Held, T., & Albert, D. (1998). RATH — a relational adaptive tutoring hypertext WWW–environment based on knowledge space theory. In C. Alvegård (Ed.), *CALISCE'98: Proceedings of the Fourth International Conference on Computer Aided Learning in Science and Engineering* (pp. 417–423). Göteborg, Sweden: Chalmers University of Technology.

- Hockemeyer, C., Nussbaumer, A., Lövquist, E., Aboulafia, A., Breen, D., Shorten, G., & Albert, D. (2009). Applying a web and simulation-based system for adaptive competence assessment of spinal anaesthesia. In M. Spaniol, Q. Li, R. Klamma, & R. Lau (Eds.), *Advances in Web-Based learning — ICWL 2009* (pp. 182–191). Berlin: Springer Verlag.
- Hockemeyer, C. & Pötzi, S. (2001). *Documentation of the libsrbi library*. Unpublished technical report, Institut für Psychologie, Karl-Franzens-Universität Graz, Austria.
- Hockemeyer, C. & Wong, W. (2024). *kstMatrix: Basic functions in knowledge space theory using matrix representations*. R package version 1.0-1.
- Holotta, E. (1999). Experimentelle Untersuchung zu Grundlagen des Lesen- und Schreibenlernens auf Basis der Wissensraumtheorie. Diplomarbeit, Karl-Franzens-Universität Graz, Austria.
- Holzinger, A., Kickmeier-Rust, M. D., Wassertheurer, S., & Hessinger, M. (2009). Learning performance with interactive simulations in medical education: Lessons learned from results of learning complex physiological models with the HAEMOdynamics SIMulator. *Computers & Education*, 52(2), 292–301.
- Hu, X., Xu, Y. J., Hall, C., Walker, K., & Okwumabua, T. (2013). A potential technological solution for reducing the achievement gap between white and black students. In J.-C. Falmagne, D. Albert, C. Doble, D. Eppstein, & X. Hu (Eds.), *Knowledge Spaces: Applications in Education* (pp. 79–92). Heidelberg: Springer.
- Huang, X., Craigh, S. D., Xie, J., Graesser, A., & Hu, X. (2016). Intelligent tutoring systems work as a math gap reducer in 6th grade after-school program. *Learning and Individual Differences*, 47, 258–265.
- Idrissi, M. K., Hnida, M., & Bennani, S. (2017). Competency-based assessment: From conceptual model to operational tool. In E. Cano & G. Ion (Eds.), *Innovative Practices for Higher Education Assessment and Measurement* (pp. 57–78). Hershey, PA: IGI Global.
- Kaluscha, R. (1994). Ein effizienter Algorithmus zur Expertenbefragung. Diplomarbeit, Technische Universität Carolo-Wilhelmina, Braunschweig, Germany.
- Kambouri, M. (1991). *Knowledge assessment: A comparison between human experts and computerized procedure*. Doctoral Dissertation, New York University.
- Kambouri, M., Koppen, M., Villano, M., & Falmagne, J.-C. (1994). Knowledge assessment: Tapping human expertise by the QUERY routine. *International Journal of Human-Computer-Studies*, 40, 119–151.
- Karner, M. L. (2016). *An analysis of the effectiveness of ALEKS within a high school mathematics setting*. Phd thesis, Aurora University.

- Khuwaja, R., Desmarais, M., & Cheng, R. (1996). Intelligent guide: Combining user knowledge assessment with pedagogical guidance. In C. Frasson, G. Gauthier, & A. Lesgold (Eds.), *Intelligent Tutoring Systems* (pp. 225–233). Berlin: Springer Verlag.
- Kickmeier, M. D. & Albert, D. (Eds.). (2012). *An aliens guide to multi-adaptive educational computer games*. Santa Rosa, CA: Informing Science Press.
- Kickmeier, M. D. & Albert, D. (2016a). Competence-based knowledge space theory: Options for the 21st century classroom. In P. Reimann, S. Bull, M. Kickmeier-Rust, R. Vatraru, & B. Wasson (Eds.), *Measuring and visualizing learning in the information-rich classroom* (pp. 109–120). New York: Routledge.
- Kickmeier, M. D. & Albert, D. (2016b). *Support teachers' predictions of learning success by structural competence modelling*.
- Kickmeier, M. D. & Albert, D. (2016c). Visualizing competence models and individual learning paths. In *Proceedings of the 2016 International Conference on Modelling, Simulation, and Visualization (MSV 2016)* (pp. 180–184).
- Kickmeier-Rust, M. D. (2010). *Ontology-based, non-invasive interventions in educational computer games*. Dissertation, Universität Graz, Graz, Austria.
- Kickmeier-Rust, M. D. & Albert, D. (2007). The ELEKTRA ontology model: A learner-centered approach to resource description. In H. Leung, F. Li, R. Lau, & Q. Li (Eds.), *Advances in Web-based Learning — ICWL 2007* (pp. 78–89). New York, Heidelberg: Springer.
- Kickmeier-Rust, M. D. & Albert, D. (2010). Micro-adaptivity: Protecting immersion in didactically adaptive digital educational games. *Journal of Computer Assisted Learning*, 26(2), 95–105.
- Kickmeier-Rust, M. D. & Albert, D. (2012a). A domain model for smart 21st century skills training in game-based virtual worlds. In I. Aedo, R. M. Bottino, N.-S. Chen, C. Giovannella, Kinshuk, & D. G. Sampson (Eds.), *12th IEEE International Conference on Advanced Learning Technologies* (pp. 680–681). Los Alamitos, CA: IEEE Press.
- Kickmeier-Rust, M. D. & Albert, D. (2012b). Educationally adaptive: Balancing serious games. *International Journal of Computer Science in Sport*, 11(Edition 1 (Special Edition)), 15–28.
- Kickmeier-Rust, M. D. & Albert, D. (2013a). Learning analytics to support the use of virtual worlds in the classroom. In A. Holzinger & G. Pasi (Eds.), *Human-Computer Interaction and Knowledge Discovery in Complex, Unstructured, Big Data: Third International Workshop, HCI-KDD 2013* (pp. 358–365). Berlin, Heidelberg: Springer.

- Kickmeier-Rust, M. D. & Albert, D. (2013b). Supporting formative assessment and appraisal by smart, competence-based, probabilistic systems. In *Proceedings of the 3rd Conference on the Future of Education (FoE) 2013* (pp. 253–257).
- Kickmeier-Rust, M. D. & Albert, D. (2013c). Using hasse diagrams for competence-oriented learning analytics. In A. Holzinger & G. Pasi (Eds.), *Human-Computer Interaction and Knowledge Discovery in Complex, Unstructured, Big Data: Third International Workshop, HCI-KDD 2013* (pp. 59–64). Berlin, Heidelberg: Springer.
- Kickmeier-Rust, M. D., Albert, D., Hockemeyer, C., & Augustin, T. (2007). Not breaking the narrative: Individualized competence assessment in educational games. In D. Remenyi (Ed.), *Proceedings of the European Conference on Games Based Learning* (pp. 161–168). Reading, UK: Academic Conferences Ltd.
- Kickmeier-Rust, M. D., Hockemeyer, C., Albert, D., & Augustin, T. (2008). Micro adaptive, non-invasive assessment in educational games. In M. Eisenberg, Kinshuk, M. Chang, & R. McGreal (Eds.), *Proceedings of the Second IEEE International Conference on Digital Games and Intelligent Toy Enhanced Learning (DIGITEL)* (pp. 135–137).
- Kickmeier-Rust, M. D., Marte, B., Linek, S. B., Lalonde, T., & Albert, D. (2008). Learning with computer games: Micro level feedback and interventions. In M. E. Auer (Ed.), *Proceedings of the International Conference on Interactive Computer Aided Learning (ICL)*. Kassel: Kassel University Press. CD-ROM publication.
- Kickmeier-Rust, M. D., Peirce, N., Owen, Schwarz, D., Verpoorten, D., & Albert, D. (in press). Immersive digital games: The interfaces for next-generation e-learning. In *Proceedings of the HCI International 2007, 22–27 July 2007, Beijing*. New York, Heidelberg: Springer.
- Kickmeier-Rust, M. D., Steiner, C. M., & Albert, D. (2011). Apt to adapt: Micro- and macro-level adaptation in educational games. In T. Daradoumis, S. Caballé, A. A. Juan, & F. Xhafa (Eds.), *Technology-Enhanced Systems and Adaptation Methods for Collaborative Learning Scaffolding* (pp. 221–238). Heidelberg: Springer.
- Kickmeier-Rust, M. D., Steiner, C. M., & Albert, D. (2015). Uncovering learning processes using competence-based knowledge structuring and hasse diagrams. In *Proceedings of the First International Workshop on Visual Aspects of Learning Analytics Co-Located with 5th International Learning Analytics and Knowledge Conference (LAK 2015)* (pp. 36–40).
- Koch, U. (1996). Plattformübergreifende GUI-Entwicklung: Flexible und optimierte Strategien zur Expertenbefragung. Diplomarbeit, Technische Universität Carolo-Wilhelmina, Braunschweig, Germany.

- Kopeinik, S., Nussbaumer, A., Bedek, M., & Albert, D. (2012). Using CbKST for learning path recommendation in game-based learning. In *ICCE2012: The 20th International Conference on Computers in Education*.
- Kopeinik, S., Nussbaumer, A., Winter, L.-C., Albert, D., Dimache, A., & Roche, T. (2014). Combining self-regulation and competence-based guidance to personalise the learning experience in Moodle. In *Proceedings of the 14th International Conference on Advanced Learning Technologies (ICALT 2014)* (pp. 62–64).
- Koppen, M. (1989). *Ordinal data analysis: Biororder representation and knowledge spaces*. Doctoral Dissertation, Katholieke Universiteit te Nijmegen, Nijmegen, The Netherlands.
- Koppen, M. (1993). Extracting human expertise for constructing knowledge spaces: An algorithm. *Journal of Mathematical Psychology*, *37*, 1–20.
- Koppen, M. (1994). The construction of knowledge spaces by querying experts. In G. H. Fischer & D. Laming (Eds.), *Contributions to Mathematical Psychology, Psychometrics, and Methodology* (pp. 137–147). New York: Springer-Verlag.
- Koppen, M. (1998). On alternative representations for knowledge spaces. *Mathematical Social Sciences*, *36*, 127–143.
- Koppen, M. & Doignon, J.-P. (1990). How to build a knowledge space by querying an expert. *Journal of Mathematical Psychology*, *34*, 311–331.
- Körner, C. (1998). *Comprehension of visualized ordered sets — an empirical approach based on the theory of knowledge spaces*. Inauguraldissertation, Karl-Franzens-Universität Graz, Graz, Austria.
- Körner, C. (2001). Comprehension of visualized ordered data structures. In T. Arnold & C. Herrmann (Eds.), *Cognitive Systems & Mechanisms: KogWis 2001. Abstracts of the 5th Meeting of the German Cognitive Science Society* (p. 91). Leipzig: Universitätsverlag.
- Körner, C. & Albert, D. (1998). Experimentelle Untersuchungen zur Verständlichkeit von Graphen. In H. Lachnit, A. Jacobs, & F. Rösler (Eds.), *Experimentelle Psychologie: Abstracts der 40. Tagung experimentell arbeitender Psychologen, 6.–9. April 1998, Marburg, Germany* (p. 193). Lengerich, Germany: Pabst Science Publishers.
- Körner, C. & Albert, D. (2001). Comprehension efficiency of graphically presented ordered sets. In K. Kallus, N. Posthumus, & P. Jimenez (Eds.), *Current psychological research in Austria. Proceedings of the 4th scientific conference of the Austrian Psychological Society (ÖGP)* (pp. 179–182). Graz: Akademische Druck- u. Verlagsanstalt.

- Korossy, K. (1993). *Modellierung von Wissen als Kompetenz und Performanz*. Inauguraldissertation, Fakultät für Sozial- und Verhaltenswissenschaften, Universität Heidelberg, Heidelberg, Germany.
- Korossy, K. (1996a). Kompetenz und Performanz beim Lösen von Geometrie-Aufgaben. *Zeitschrift für Experimentelle Psychologie*, *XLIII*(2), 279–318.
- Korossy, K. (1996b). *A qualitative–structural approach to the modeling of knowledge*. Bericht aus dem Psychologischen Institut 83, Universität Heidelberg.
- Korossy, K. (1997a). Extending the theory of knowledge spaces: A competence–performance approach. *Zeitschrift für Psychologie*, *205*, 53–82.
- Korossy, K. (1997b). Kompetenz und Performanz beim Lösen von Aufgaben aus der elementaren Teilbarkeitslehre. In E. van der Meer, T. Bachmann, R. Beyer, C. Goertz, H. Hagendorf, B. Krause, W. Sommer, H. Wandke, & M. Zießler (Eds.), *Experimentelle Psychologie: Abstracts der 39. Tagung experimentell arbeitender Psychologen, 24.–27. März 1997, Berlin, Germany* (p. 371). Lengerich, Germany: Pabst Science Publishers.
- Korossy, K. (1998). Solvability and uniqueness of linear-recursive number sequence tasks. *Methods of Psychological Research — Online*, *3*(1).
- Korossy, K. (1999a). Modeling knowledge as competence and performance. In D. Albert & J. Lukas (Eds.), *Knowledge Spaces: Theories, Empirical Research, Applications* (pp. 103–132). Mahwah, NJ: Lawrence Erlbaum Associates.
- Korossy, K. (1999b). Organizing and controlling learning processes within competence–performance structures. In D. Albert & J. Lukas (Eds.), *Knowledge Spaces: Theories, Empirical Research, Applications* (pp. 157–178). Mahwah, NJ: Lawrence Erlbaum Associates.
- Krause, R. & Körndle, H. (2003). The electronic exercise. In F. W. Hesse & Y. Tamura (Eds.), *The Joint Workshop of Cognition and Learning through Media–Communication for Advanced E-Learning (JWCL)* (pp. 104–107). Japanisch–Deutsches Zentrum Berlin (JDZB).
- Kremser, M. (2000). Component–based construction of a knowledge space for children’s second language english knowledge. Diplomarbeit, Karl–Franzens–Universität Graz, Austria.
- Kremser, M. (2002). The construction of an intelligent tutoring system for foreign language english learning. In M. Auer & U. Auer (Eds.), *Interactive computer aided learning (ICL) 2002. International Workshop*. Kassel University Press.
- LaGrange, J. D. & Ratliff, M. L. (2021). Curriculum spaces and mathematical models for curriculum design. *Journal of Mathematical Psychology*, *102*.

- Lakshminarayan, K. & Gilson, F. (1998). An application of a stochastic knowledge structure model. In C. E. Dowling, F. S. Roberts, & P. Theuns (Eds.), *Recent Progress in Mathematical Psychology* (pp. 155–172). Mahwah, NJ: Lawrence Erlbaum Associates Ltd.
- Lamprecht, C. (1998). Empirische Untersuchung mit Kindern zum Inventar impliziter Rechtschreibregeln (IiR) auf Basis der Wissensraumtheorie. Diplomarbeit, Karl-Franzens-Universität Graz, Austria.
- Lee, S., Belkasim, S., Chahine, I. C., & Grinshpon, M. S. (2014). A web application for the knowledge space theory analysis: KST Web. *International Journal of Engineering Research & Technology (IJERT)*, 3.
- Ley, T. & Albert, D. (2003a). Identifying employee competencies in dynamic work domains: Methodological considerations and a case study. *Journal of Universal Computer Science*, 9, 1500–1518.
- Ley, T. & Albert, D. (2003b). Kompetenzmanagement als formalisierbare Abbildung von Wissen und Personalwesen. *Wirtschaftspsychologie*, 5(3), 86–93.
- Ley, T. & Albert, D. (2004). Quality criteria for competency assignments: Examples from a project management case study. In P. Dadam & M. Reichert (Eds.), *INFORMATIK 2004 — Informatik verbindet, Beiträge der 34. Jahrestagung der Gesellschaft für Informatik e. V. (GI), Ulm, 20.–24. September 2004* (Vol. 2, pp. 342–246).
- Ley, T., Albert, D., & Lindstaedt, S. (2007). Competence management using the competence performance approach: Modeling, assessment, validation, and use. In M. A. Sicilia (Ed.), *Competencies in Organizational E-learning: Concepts and Tools* (pp. 83–119). Idea Group Inc.
- Ley, T., Lindstaedt, S. N., & Albert, D. (2005). Supporting competency development in informal workplace learning. In K.-D. Althoff, A. Dengel, R. Bergmann, M. Nick, & T. Roth-Berghofer (Eds.), *Professional Knowledge Management: Third Biennial Conference, WM 2005, Kaiserslautern, Germany, April 10-13, 2005*. Heidelberg: Springer Verlag.
- Ley, T., Ulbrich, A., Scheir, P., Lindstaedt, S. N., Kump, B., & Albert, D. (2008). Modeling competencies for supporting work-integrated learning in knowledge work. *Journal of Knowledge Management*, 12(6), 31–47. doi: 10.1108/13673270810913603; 15.
- Lin, F., Cao, X., & Li, J. (2021). *The language of pre-topology in knowledge spaces*. , Arxiv.org.
- Lövquist, E., Aboulafia, A., Breen, D., Shorten, G., Zhang, D., & Albert, D. (2008). Designing a simulation supported assessment system architecture for spinal anesthesia. In *Proceedings of the 11th IASTED International Conference on Computers and Advanced Technology in Education (CATE)* (pp. 316–321).

- Ludwig, A. H. (1995). Eine themenorientierte Programmiersprache für die Präsentation und Auswertung computergestützter Test- und Übungsaufgaben. Diplomarbeit, Technische Universität Carolo-Wilhelmina, Braunschweig, Germany.
- Lugaric, L., Kostanjcar, Z., & Petkovic, T. (2005). Using ICT for transfer of knowledge with application in solving technical science problems. In M. Mustac & J. Dezeljin (Eds.), *Proceedings of MIPRO 2005* (pp. 84–89).
- Lukas, J. (1994). Zur Ableitung von Wissensstrukturen aus Aufgaben–Fähigkeits–Zuordnungen. In K. Pawlik (Ed.), *Bericht über den 39. Kongreß der Deutschen Gesellschaft für Psychologie in Hamburg 1994* (p. 446). Hogrefe.
- Lukas, J. (1996). Die Ordnungsstruktur der wichtigsten Ordnungsrelationen. In A. Schorr (Ed.), *Experimentelle Psychologie: 38. Tagung experimentell arbeitender Psychologen, 1.–4. April 1996, Marburg, Germany* (p. 195). Lengerich, Germany: Pabst Science Publishers.
- Lukas, J. (1997). Modellierung von Fehlkonzepten in Wissensstrukturen. *Kognitionswissenschaft*, 6(4), 196–204.
- Lukas, J. & Albert, D. (1993). Knowledge assessment based on skill assignment and psychological task analysis. In G. Strube & K. F. Wender (Eds.), *The Cognitive Psychology of Knowledge* (pp. 139–160). Amsterdam: North–Holland.
- Lukas, J. & Albert, D. (1999). Knowledge structures: What they are and how they can be used in cognitive psychology, test theory, and the design of learning environments. In D. Albert & J. Lukas (Eds.), *Knowledge Spaces: Theories, Empirical Research, Applications* (pp. 3–12). Mahwah, NJ: Lawrence Erlbaum Associates.
- Lukas, J., Albert, D., & Dowling, C. E. (1994). Formale Modelle in der Wissenspsychologie: Theorien — Methoden — Anwendungen. In K. Pawlik (Ed.), *Bericht über den 39. Kongreß der Deutschen Gesellschaft für Psychologie in Hamburg 1994* (p. 446). Hogrefe.
- Lynch, D. J. & Howlin, C. P. (2014). Uncovering latent knowledge: A comparison of two algorithms. In *User Modeling, Adaptation, and Personalization: 22nd International Conference, UMAP 2014, Aalborg, Denmark, July 7-11, 2014* (pp. 363–368). Springer.
- Marte, B., Steiner, C. M., Heller, J., & Albert, D. (2008). Activity– and taxonomy–based knowledge representation framework. *International Journal of Knowledge and Learning*, 4, 189–202.
- Matayoshi, J. (2017). On the properties of well-graded partially union-closed families. *Journal of Mathematical Psychology*, 80, 15–21.
- Matayoshi, J. (2021). Approximately counting and sampling knowledge states. *British Journal of mathematical and Statistical Psychology*, 75, 293–318.

- matayoshi, J. (2022). Approximately counting and sampling knowledge states. *British Journal of mathematical and Statistical Psychology*, 75, 293–316.
- Matayoshi, J., Cosyn, E., & Uzun, H. (2021). Are we there yet? evaluating the effectiveness of a recurrent neural network-based stopping algorithm for an adaptive assessment. *International Journal of Artificial Intelligence in Education*.
- Matayoshi, J. & Uzun, H. (2022). Learning, forgetting, and the correlation of knowledge in knowledge space theory. *Journal of Mathematical Psychology*, 109.
- Máth, J. & Abari, K. (2011). Knowledge spaces and historical knowledge in practice. *Applied Psychology in Hungary*, 2011(1), 126–152.
- Mbatchou, G. (2019). *Vers un modle d'accompagnement de l'apprentissage dans les learning management systems*. PhD thesis, Sorbonne Universite, Paris.
- Mbatchou, G., Bouchet, F., Carron, T., & Philippe, P. (2018). Proposing and evaluating a model of co-construction of the learning scenario by the learner. In *15th International Conference Cognition and Exploratory Learning in Digital Age (CELDA 2018)*.
- Melero, J., El-Kechai, N., & Labat, J.-M. (2015). Comparing two cbkst approaches for adapting learning paths in serious games. In G. Conole, T. Klobučar, C. Rensing, J. Konert, & E. Lavoué (Eds.), *Design for Teaching and Learning in a Networked World* (pp. 211–224). Cham: Springer International Publishing.
- Melero, J., El-Kechai, N., Yessad, A., & Labat, J.-M. (2015). Adapting learning paths in serious games: An approach based on teachers requirements. In S. Zvacek, M. Restivo, J. Uhomoihi, & M. Helfert (Eds.), *Computer Supported Education. CSEDU 2015* (pp. 376–394). Springer.
- Mertes, E. S. (2013). *A mathematics education comparative analysis of ALEKS technology and direct classroom instruction*. Phd thesis, Bethel University, Ann Arbor, Arkansas.
- Müller, C. E. (1989). A procedure for facilitating an expert's judgments on a set of rules. In E. E. Roskam (Ed.), *Mathematical Psychology in Progress* (pp. 157–170). Berlin: Springer-Verlag.
- Müller, H. R. & Regenwetter, M. (1991). *A procedure for facilitating an expert's judgments on a set of rules*. Official final report of the research project: "Systèmes dynamiques simulés par ordinateur", MEN/IPE/87/009, Ministère de l'Education Nationale, Luxembourg. Copies available from Michel Regenwetter.
- Nakamura, Y., Tsuji, H., Seta, K., Hashimoto, K., & Albert, D. (2011). Visualization of learner's state and learning paths with knowledge structures. In A. König, A. Dengel, K. Hinkelmann, K. Kise, R. J. Howlett, & L. C. Jain (Eds.), *Knowledge-Based and*

- Intelligent Information and Engineering Systems: 15th International Conference, KES 2011, Kaiserslautern, Germany, September 12-14, 2011, Proceedings, Part IV* (pp. 261–270). Berlin, Heidelberg, Germany: Springer Berlin Heidelberg.
- Narciss, S. (1994). *Empirische Untersuchungen zur kognitiven Repräsentation bewegungsstruktureller Merkmale. ein wissenspsychologischer Ansatz zur theoretischen Fundierung des mentalen Trainings*. Dissertation, Universität Heidelberg, Germany.
- Narciss, S. (1999). Application of doignon and falmagne’s theory of knowledge structures to the assessment of motor learning processes. In D. Albert & J. Lukas (Eds.), *Knowledge Spaces: Theories, Empirical Research, Applications* (pp. 197–220). Mahwah, NJ: Lawrence Erlbaum Associates.
- Nasar, S. (2016). *Knowledge space framework: An api for representation, persistence and visualization of knowledge spaces*. , Arxiv.org. Electronic Preprint arXiv:1612.02111, arXiv.org.
- Nicotra, E. F. & Spoto, A. (2019). Connections and dissimilarities among formal concept analysis, knowledge space theory and cognitive diagnostic models in a systemic perspective. In G. Minati, M. R. Abram, & E. Pessa (Eds.), *Systemics of Incompleteness and Quasi-Systems* (pp. 235–241). Cham: Springer International Publishing.
- Nitzsche, S. (1996). Experimentelle Überprüfung von Strukturen zur Wissensdiagnose — Anwendungsfeld: gezielte Aus- und Weiterbildung. Diplomarbeit, Technische Universität Carolo-Wilhelmina, Braunschweig, Germany.
- Noventa, S., Heller, J., & Stefanutti, L. (2021). Some considerations on the factorization of state probabilities in knowledge structures. *Journal of Mathematical Psychology*, *102*, 102542.
- Noventa, S., Spoto, A., Heller, J., & Kelava, A. (2019). On a generalization of local independence in item response theory based on knowledge space theory. *Psychometrika*, *84*, 395–421.
- Noventa, S., Ye, S., Kelava, A., & Spoto, A. (2024). On the identifiability of 3- and 4-parameter item response theory models from the perspective of knowledge space theory. *Psychometrika*.
- Nussbaumer, A., Dahn, I., Kroop, S., Mikroyannidis, A., & Albert, D. (2015). Supporting self-regulated learning. In S. Kroop, A. Mikroyannidis, & M. Wolpers (Eds.), *Responsive Open Learning Environments* (pp. 17–48). Heidelberg: Springer.
- Nussbaumer, A., Gütl, C., & Albert, D. (2007a). Supporting technology-enhanced learning through semi-automatic detection and management of skill and competence structures. In *Proceedings of the 10th International Conference on Interactive Computer aided Learning (ICL 2007)*, 26 . 28 September 2007, Villach, Austria.

- Nussbaumer, A., Gütl, C., & Albert, D. (2007b). Towards a web service for competence-based learning and testing. In *Proceedings of the World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED-MEDIA 2007), 25-29 June 2007, Vancouver, Canada*.
- Nussbaumer, A., Gütl, C., Albert, D., & Helic, D. (2009). Competence-based adaptation of learning environments in 3D space. In *Proceedings of the 4th International Conference on Interactive Mobile and Computer Aided Learning (IMCL 2009)* (pp. 103–108).
- Nussbaumer, A., Gütl, C., & Hockemeyer, C. (2007). A generic solution approach for integrating adaptivity into web-based e-learning platforms. In *Proceedings of the International Conference on Interactive Mobile and Computer Aided Learning (IMCL 2007)*. Amman, Jordan.
- Nussbaumer, A., Hillemann, E.-C., Gütl, C., & Albert, D. (2015). A competence-based service for supporting self-regulated learning in virtual environments. *Journal of Learning Analytics*, 2, 101–133.
- Nussbaumer, A., Maurer, M. T., Malicet, S., Steiner, C., & Albert, D. (2019). A novel approach and software component for supporting competence-based learning with serious games. In *Proceedings of INTED2019 Conference* (pp. 6009–6015). International Academy of Technology, Education and Development.
- Nussbaumer, A., Steiner, C., & Albert, D. (2008). Visualisation tools for supporting self-regulated learning through exploiting competence structures. In *Proceedings of I-KNOW '08 and I-MEDIA '08* (pp. 288–295).
- Perucci, V., Heller, J., & Agnoli, F. (2004). Identifying solution strategies in a cube comparison task using a knowledge structure approach. *Testing Psicometria Metodologia*, 11(3), 163–189.
- Pilato, G., Pirrone, R., & Rizzo, R. (2008). A KST-based system for student tutoring. *Applied Artificial Intelligence*, 22, 283–308.
- Pilgerstorfer, M., Albert, D., & Camhy, D. G. (2006). Considerations on personalized training in philosophy for children. In D. G. Camhy & R. Born (Eds.), *Encouraging Philosophical Thinking: Proceedings of the International Conference on Philosophy for Children in Graz, Austria* (pp. 85–89). Sankt Augustin, Germany: Academia-Verlag.
- Pötzi, S. (2001). *Documentation of the libsrbt library*. Unpublished technical report, Institut für Psychologie, Karl-Franzens-Universität Graz, Austria. https://resources.cord-hockemeyer.info/techreports/libsrbt_TechRep_FWF01.pdf.

- Pötzi, S. & Wesiak, G. (2001). *SRbT tools user manual*. Unpublished technical report, Institut für Psychologie, Karl-Franzens-Universität Graz, Austria. https://resources.cord-hockemeyer.info/techreports/SRBT-Tools_TechRep_FWF01.pdf.
- Prediger, S. (to appear). Formal concept analysis for general objects. *Electronic Notes in Discrete Mathematics*, 2.
- Preis, A. (2000). Component-based structuring of children's reading and writing competencies in German. Diplomarbeit, Karl-Franzens-Universität Graz, Austria.
- Ptucha, J. (1994). Kognitive Operationen beim Fortsetzen von Zahlenfolgen: Eine experimentelle Untersuchung zur Theorie der Wissensräume. *Zeitschrift für Psychologie*, 202, 253–274.
- Quante, K. A. (1996). Plattformübergreifende GUI-Entwicklung: Integration und Optimierung eines Programms zur Expertenbefragung. Diplomarbeit, Technische Universität Carolo-Wilhelmina, Braunschweig, Germany.
- Rachdi-Sakac, M. (2000). Graphische veranschaulichungen im Bereich der elementaren Wahrscheinlichkeitsrechnung — eine Untersuchung im Rahmen der Wissensraumtheorie. Diplomarbeit, Karl-Franzens-Universität Graz, Austria.
- Rappitsch, M. (1997). Konstruktion und empirische überprüfung eines Schlagzeugtests auf Basis der Wissensraumtheorie. Unveröffentlichte Naturwissenschaftliche Diplomarbeit, Karl-Franzens-Universität, Graz, Austria.
- Reddy, A. A. & Harper, M. (2013). ALEKS-based placement at the University of Illinois. In J.-C. Falmagne, D. Albert, C. Doble, D. Eppstein, & X. Hu (Eds.), *Knowledge Spaces: Applications in Education* (pp. 51–68). Heidelberg: Springer.
- Reed, A. E. (2017). *The influence of adaptive instructional technology on student achievement in reading*. PhD thesis, Capella University, Harold Abel School of Social and Behavioral Sciences, US.
- Reimann, P., Kickmeier-Rust, M. D., & Albert, D. (2013). Problem solving learning environments and assessment: A knowledge space theory approach. *Computers & Education*, 64, 183–193.
- Riegler, K. (1999). Konstruktion von Wissensräumen im Symptombereich der Panikattacke. Diplomarbeit, Karl-Franzens-Universität Graz, Austria.
- Riesenhuber, E. (1995). Empirische überprüfung einer Komponentenstruktur zu Schreib- und Lesefähigkeiten. Unveröffentlichte Naturwissenschaftliche Diplomarbeit, Karl-Franzens-Universität, Graz, Austria.

- Robusto, E. & Stefanutti, L. (2014). Extracting a knowledge structure from the data by a maximum residuals method. *Testing, Psychometrics, Methodology in Applied Psychology*, 21, 421–433.
- Robusto, E., Stefanutti, L., & Anselmi, P. (2010). The gain–loss model: A probabilistic skill multimap model for assessing learning processes. *Journal of Educational Measurement*, 47(3), 373–394.
- Rodenhause, H. (2011). *Knowledge description and galois correspondence: Practical impact of a structural idea*. Serie Mathematik. Herzogenrath: Shaker Verlag.
- Rusch, A. (1994). Wissensräume und formale Begriffsanalyse. Diplomarbeit, Technische Hochschule Darmstadt, Germany.
- Rusch, A. & Wille, R. (1996). Knowledge spaces and formal concept analysis. In H.-H. Bock & W. Polasek (Eds.), *Data Analysis and Information Systems* (pp. 427–436). Berlin, Germany: Springer–Verlag.
- Sabo, K. E., Atkinson, R. K., Barrus, A. L., Joseph, S. S., & Perez, R. S. (2013). Searching for the two sigma advantage: Evaluating algebra intelligent tutors. *Computers in Human Behavior*, 29, 1833–1840.
- Sargin, A. (2010). *Data analysis methods in knowledge space theory*. Phd thesis, Universität Augsburg, Germany.
- Sargin, A. & Ünlü, A. (2009). Inductive item tree analysis: Corrections, improvements, and comparisons. *Mathematical Social Sciences*, 58, 376–392.
- Sargin, A. & Ünlü, A. (2010). The R package DAKS: Basic functions and complex algorithms in knowledge space theory. In H. Locarek-Junge & C. Weihs (Eds.), *Classification as a Tool for Research* (pp. 263–270). Berlin, Heidelberg: Springer Berlin Heidelberg.
- Sargin, A. & Ünlü, A. (2016). *DAKS: Data analysis and knowledge spaces*. , Comprehensive R Archive Networ. R package version 2.1-3.
- Schoonenboom, J., Heller, J., Keenoy, K., Levene, M., & Turcsanyi-Szabo, M. (Eds.). (2007). *Trails in education: Technologies that support navigational learning*. Rotterdam: Sense Publisher.
- Schrepp, M. (1993). *Über die Beziehung zwischen kognitiven Prozessen und Wissensräumen beim Problemlösen*. Dissertation, Universität Heidelberg, Germany.
- Schrepp, M. (1995). Modeling interindividual differences in solving letter series completion problems. *Zeitschrift für Psychologie*, 203, 173–188.

- Schrepp, M. (1997). A generalization of knowledge space theory to problems with more than two answer alternatives. *Journal of Mathematical Psychology*, *41*, 237–243.
- Schrepp, M. (1999a). An empirical test of a process model for letter series completion problems. In D. Albert & J. Lukas (Eds.), *Knowledge Spaces: Theories, Empirical Research, Applications* (pp. 133–154). Mahwah, NJ: Lawrence Erlbaum Associates.
- Schrepp, M. (1999b). Extracting knowledge structures from observed data. *British Journal of Mathematical and Statistical Psychology*, *52*, 213–224.
- Schrepp, M. (1999c). On the empirical construction of implications between bi-valued test items. *Mathematical Social Sciences*, *38*, 361–375.
- Schrepp, M. (2001). A method for comparing knowledge structures concerning their adequacy. *Journal of Mathematical Psychology*, *45*, 480–496.
- Schrepp, M. (2002). Explorative analysis of empirical data by boolean analysis of questionnaires. *Zeitschrift für Psychologie*, *210*, 99–110.
- Schrepp, M. (2003). A method for the analysis of hierarchical dependencies between items of a questionnaire. *Methods of Psychological Research — Online*, *19*, 43–79.
- Schrepp, M. (2005). About the connection between knowledge structures and latent class models. *Methodology*, *1*(3), 92–102.
- Schrepp, M. (2006a). Properties of the correlational agreement coefficient: A comment to ünlü and Albert (2004). *Mathematical Social Sciences*, *51*, 117–123.
- Schrepp, M. (2006b). The use of configural frequency analysis for explorative data analysis. *British Journal of Mathematical and Statistical Psychology*, *59*, 59–73.
- Schrepp, M. (2007). On the evaluation of fit measures for quasi-orders. *Mathematical Social Sciences*, *53*, 196–208.
- Schrepp, M. & Held, T. (1995). A simulation study concerning the effect of errors on the establishment of knowledge spaces by querying experts. *Journal of Mathematical Psychology*, *39*, 376–382.
- Schrepp, M., Held, T., & Albert, D. (1999). Component-based construction of surmise relations for chess problems. In D. Albert & J. Lukas (Eds.), *Knowledge Spaces: Theories, Empirical Research, Applications* (pp. 41–66). Mahwah, NJ: Lawrence Erlbaum Associates.
- Schrepp, M. & Korossy, K. (1998). Fehlkonzepte und Fehlkonzeptanwendungen bei elementaren Aufgaben zum Vereinfachen von Bruchtermen. *Zeitschrift für Psychologie*, *206*, 47–73.

- Schrepp, M. & Ünlü, A. (2015). On the creation of representative samples of random quasi-orders. *Frontiers in Psychology*, 6, 1791–1798.
- Schwarz, W. (1999). Partizipatives Verhalten von Mitarbeitern an unternehmenskulturellen Werten. Diplomarbeit, Karl–Franzens–Universität Graz, Austria.
- Seffah, A., Desmarais, M., & Khuwaja, R. (1999). Mastering object-oriented technology using a self-learning and self-assessment system. *Applications in Engineering Education Journal*, 7(3), 162–170.
- Segedinac, M., Savic, G., Konjovic, Z., & Segedinac, M. (2010). Optimal counterexamples expectation based method for knowledge space construction. In *8th International Symposium on Intelligent Systems and Informatics (SISY 2010)* (pp. 273–278). Los Alamitos, CA: IEEE.
- Serra, F., Spoto, A., Ghisi, M., & Vidotto, G. (2015). Formal psychological assessment in evaluating depression: A new methodology to build exhaustive and irredundant adaptive questionnaires. *PLOS one*, 10(4), e0122131.
- Silly, M. (2000). Empirische Untersuchung zur Analyse und Strukturierung der physikalischen Dynamik mit den Methoden der Wissensraumtheorie. Diplomarbeit, Karl–Franzens–Universität Graz, Austria.
- Simon, T. (1999). Erfassung von Englischkenntnissen deutschsprachiger Schüler auf Basis der Wissensraumtheorie. Diplomarbeit, Karl–Franzens–Universität Graz, Austria.
- Sitthisak, O. & Gilbert, L. (2014). Integrating competence models with knowledge space theory for adaptive assessment. *International Journal of e-Assessment*, 1(1).
- Sitthisak, O., Gilbert, L., & Albert, D. (2013a). Adaptive learning using an integration of competence model with knowledge space theory. In *Proceedings of the International Conference on Advanced Applied Informatics (ICAAI 2013)* (pp. 199–202). IEEE.
- Sitthisak, O., Gilbert, L., & Albert, D. (2013b). Learning in moodle using competence-based knowledge space theory and IMS QTI. In *Proceedings of the International Computer Science and Engineering Conference (ICSEC 2013)* (pp. 53–57). IEEE.
- Smith, D. (2013). ALEKS: An artificial intelligence-based distance learning system. *Distance Learning*, 10(3), 51–66.
- Spoto, A., Bottesi, G., Sanavio, E., & Vidotto, G. (2013). Theoretical foundations and clinical implications of formal psychological assessment. *Psychotherapy and Psychosomatics*, 82, 197–199.
- Spoto, A., Serra, F., Donadello, I., Granzio, U., & Vidotto, G. (2018). New perspectives in the adaptive assessment of depression: The ATS-PD version of the QuEDS. *Frontiers in Psychology*, 9, 1101.

- Spoto, A. & Stefanutti, L. (2020). On the necessary and sufficient conditions for delineating forward- and backward-graded knowledge structures from skill maps. *Journal of Mathematical Psychology*, 99.
- Spoto, A. & Stefanutti, L. (2023). Empirical indistinguishability: From the knowledge structure to the skills. *British Journal of Mathematical and Statistical Psychology*, 76(2), 312–326.
- Spoto, A., Stefanutti, L., & Vidotto, G. (2010). Knowledge space theory, formal concept analysis, and computerized psychological assessment. *Behavior Research Methods*, 42(1), 342–350.
- Spoto, A., Stefanutti, L., & Vidotto, G. (2012). On the unidentifiability of a certain class of skill multi map based probabilistic knowledge structures. *Journal of Mathematical Psychology*, 56(4), 248–255.
- Spoto, A., Stefanutti, L., & Vidotto, G. (2013). Considerations about the identification of forward- and backward-graded knowledge structures. *Journal of Mathematical Psychology*, 57(5), 249–254.
- Spoto, A., Stefanutti, L., & Vidotto, G. (2016). An iterative procedure for extracting skill maps from data. *Behavior Research Methods*, 48(2), 729–741.
- Spoto, A., Vidotto, G., & Stefanutti, L. (2013). Skill map based knowledge structures: some considerations about their identifiability. *Electronic Notes in Discrete Mathematics*, 42, 73–80.
- Stahl, C. (2008). *Developing a framework for competence assessment*. Unpublished dissertation, Vienna University of Economics and Business.
- Stahl, C., Meyer, D., & Hockemeyer, C. (2022). *kst: Knowledge space theory*. R package version 0.5-4.
- Staudacher, C. (1999). Empirische Überprüfung einer Wissensraumhypothese zu einem Teilgebiet der psychologischen Entscheidungsforschung. Diplomarbeit, Karl-Franzens-Universität Graz, Austria.
- Stefanutti, L. (2002). Construction of an event structure for workflow analysis in an austrian competence center. In *14th Workshop of Marie Curie Fellows: Research Training in Progress* (p. 219). Poster at the Marie Curie Workshop at Donostia–San Sebastian, Spain, 28–30 November.
- Stefanutti, L. (2006). A logistic approach to knowledge structures. *Journal of Mathematical Psychology*, 50, 545–561.
- Stefanutti, L. (2008). A characterization of the concept of independence in knowledge structures. *Journal of Mathematical Psychology*, 52(4), 207–217.

- Stefanutti, L. (2012). Review of learning spaces: interdisciplinary applied mathematics. *Journal of Mathematical Psychology*, 56(5), 392–394.
- Stefanutti, L. (2019). On the assessment of procedural knowledge: From problem spaces to knowledge spaces. *British Journal of Mathematical and Statistical Psychology*, 72, 185–218.
- Stefanutti, L. & Albert, D. (2002). Efficient assessment of organizational action based on knowledge space theory. In K. Tochtermann & H. Maurer (Eds.), *2nd International Conference on Knowledge Management* (pp. 183–190).
- Stefanutti, L. & Albert, D. (2003a). Skill assessment in problem solving and simulated learning environments. *Journal of Universal Computer Science*, 9(12), 1455–1468.
- Stefanutti, L. & Albert, D. (2003b). Skill assessment in task simulation. In K. Tochtermann & H. Maurer (Eds.), *3rd International conference on Knowledge Management, Graz, Austria, 2–4 July 2003* (pp. 174–180).
- Stefanutti, L., Albert, D., & Hockemeyer, C. (2004). Structuring and merging distributed content. In T. Dimitrakos & P. Ritrovato (Eds.), *4th International LeGE-WG Workshop - Towards a European Learning Grid Infrastructure: Progressing with a European Learning Grid*. Wiltshire, UK: British Computer Society (BCS).
- Stefanutti, L., Albert, D., & Hockemeyer, C. (2005). Structuring and merging distributed content. In P. Ritrovato, C. Allison, S. A. Cerri, T. D. M. Gaeta, & S. Salerno (Eds.), *Towards the Learning Grid: Advances in Human Learning Services* (pp. 113–118). Amsterdam: IOS Press.
- Stefanutti, L., Anselmi, P., de Chiusole, D., & Spoto, A. (2020). On the polytomous generalization of knowledge space theory. *Journal of Mathematical Psychology*, 94.
- Stefanutti, L., Anselmi, P., & Robusto, E. (2011). Assessing learning processes with the gain–loss model. *Behavior Research Methods*, 43, 66–76.
- Stefanutti, L. & de Chiusole, D. (2017). On the assessment of learning in competence based knowledge space theory. *Journal of Mathematical Psychology*, 80, 22–32.
- Stefanutti, L., de Chiusole, D., Anselmi, P., & Spoto, A. (2020). Extending the basic local independence model to polytomous data. *Psychometrika*, 85, 684–715.
- Stefanutti, L., de Chiusole, D., & Brancaccio, A. (2021). Markov solution processes: Modeling human problem solving with procedural knowledge space theory. *Journal of Mathematical Psychology*, 103, 102552.
- Stefanutti, L., de Chiusole, D., Gondan, M., & Maurer, A. (2020). Modeling misconceptions in knowledge space theory. *Journal of Mathematical Psychology*, 99, 102435.

- Stefanutti, L., Heller, J., Anselmi, P., & Robusto, E. (2012). Assessing the local identifiability of probabilistic knowledge structures. *Behavior Research Methods*, *44*, 1197–1211.
- Stefanutti, L., Hockemeyer, C., & Albert, D. (2003). Derivation of knowledge structures for distributed learning objects. In T. Dimitrakos, P. Ritrovato, & S. Salerno (Eds.), *3rd LEGE–WG International Workshop on e–Learning and Grid Technologies, Berlin, 3 December 2003*. Wiltshire, UK: British Computer Society (BCS).
- Stefanutti, L., Hockemeyer, C., & Albert, D. (2005). Derivation of knowledge structures for distributed learning objects. In P. Ritrovato, C. Allison, S. A. Cerri, T. D. M. Gaeta, & S. Salerno (Eds.), *Towards the Learning Grid: Advances in Human Learning Services* (pp. 105–112). Amsterdam: IOS Press.
- Stefanutti, L. & Koppen, M. (2003). A procedure for the incremental construction of a knowledge space. *Journal of Mathematical Psychology*, *47*(3), 265–277.
- Stefanutti, L. & Robusto, E. (2009). Recovering a probabilistic knowledge structure by constraining its parameter space. *Psychometrika*, *72*, 83–96.
- Stefanutti, L. & Spoto, A. (2020). Blim’s identifiability and parameter invariance under backward and forward transformations. *Journal of Mathematical Psychology*, *95*.
- Stefanutti, L. & Spoto, A. (2021). On the empirical indistinguishability of knowledge structures. *British Journal of Mathematical and Statistical Psychology*, *74*, 465–486.
- Stefanutti, L., Spoto, A., Anselmi, P., & de Chiusole, D. (2023). Towards a competence-based polytomous knowledge structure theory. *Journal of Mathematical Psychology*, *115*, 102781.
- Stefanutti, L., Spoto, A., & Vidotto, G. (2018). Detecting and explaining BLIM’s unidentifiability: Forward and backward parameter transformation groups. *Journal of Mathematical Psychology*, *82*, 38–51.
- Steiner, C. & Albert, D. (2008). Personalising learning through prerequisite structures derived from concept maps. In H. Leung, F. Li, R. Lau, & Q. Li (Eds.), *Advances in Web Based learning — ICWL 2007* (pp. 45–54).
- Steiner, C., Albert, D., & Heller, J. (2007). Concept mapping as a means to build E–Learning. In N. A. Buzzetto-More (Ed.), *Advance principles of Effective e–Learning* (pp. 59–111). Santa Rosa, CA: Informing Science Press.
- Steiner, C. M. & Albert, D. (2011). Competence-based knowledge space theory as a framework for intelligent metacognitive scaffolding. In G. Biswas, S. Bull, J. Kay, & A. Mitrovic (Eds.), *Artificial Intelligence in Education—15th International Conference, AIED 2011* (pp. 563–565). Springer.

- Steiner, C. M., Marte, B., Heller, J., & Albert, D. (2012). Activity- and taxonomy-based knowledge representation. In N. M. Seel (Ed.), *Encyclopedia of the Sciences of Learning, Part 1* (pp. 80–83). Berlin: Springer.
- Steiner, C. M., Nussbaumer, A., & Albert, D. (2009). Supporting self-regulated personalised learning through competence-based knowledge space theory. *Policy Futures in Education, 7*(6), 645–661.
- Stockinger, D. (1999). Kompetenz und Performanz in einem Teilbereich der elementaren Algebra: Eine empirische Untersuchung zur Kompetenz-Performanz-Theorie von K. Korossy. Diplomarbeit, Karl-Franzens-Universität Graz, Austria.
- Suck, R. (1994). A theorem on order extensions: Embeddability of a system of weak orders to meet solvability constraints. *Journal of Mathematical Psychology, 38*(1), 128–134.
- Suck, R. (1998). Ordering orders. *Mathematical Social Sciences, 36*, 91–104.
- Suck, R. (1999a). The basis of a knowledge space and a generalized interval order. *Electronic Notes in Discrete Mathematics, 2*. Abstract of a Talk presented at the OSDA98, Amherst, MA, September 1998.
- Suck, R. (1999b). A dimension-related metric on the lattice of knowledge spaces. *Journal of Mathematical Psychology, 43*, 394–409.
- Suck, R. (2003). Parsimonious set representations of orders, a generalization of the interval order concept, and knowledge spaces. *Discrete Applied Mathematics, 127*(2), 373–386.
- Suck, R. (2004). Set representation of orders and a structural equivalent of saturation. *Journal of Mathematical Psychology, 48*(3), 159–166.
- Suck, R. (2011). Knowledge spaces regarded as set representations of skill structures. In E. Dzhafarov & L. Perry (Eds.), *Descriptive and Normative Approaches to Human Behavior* (pp. 249–270). London: World Scientific.
- Suck, R. (2021). Skills first – an alternative approach to construct knowledge spaces. *Journal of Mathematical Psychology, 101*, 102517.
- Sullins, J., Meister, R., Craig, S. D., Wilson, W. M., Baragliotti, A., & Hu, X. (2013). The impact of a mathematical intelligent tutoring system on students' performance on standardized high-stake tests. In J.-C. Falmagne, D. Albert, C. Doble, D. Eppstein, & X. Hu (Eds.), *Knowledge Spaces: Applications in Education* (pp. 69–78). Heidelberg: Springer.
- Sun, W., Li, J., Ge, X., & Lin, Y. (2021). Knowledge structures delineated by fuzzy skill maps. *Fuzzy Sets and Systems, 407*, 50–66.

- Sun, W., Li, J., He, Z., Ge, X., & Lin, Y. (2023). Well-graded polytomous knowledge structures. *Journal of Mathematical Psychology*, 114.
- Taagepera, M. & Arasasingham, R. D. (2013). Using knowledge space theory to assess student understanding of chemistry. In J.-C. Falmagne, D. Albert, C. Doble, D. Epstein, & X. Hu (Eds.), *Knowledge Spaces: Applications in Education* (pp. 115–128). Heidelberg: Springer.
- Taagepera, M., Arasasingham, R. D., King, S., Potter, F., Martorell, I., Ford, D., Wu, J., & Kearney, A. M. (2011). Integrating symmetry in stereochemical analysis in introductory organic chemistry. *Chemical Education Research and Practice*, 12, 322–330.
- Taagepera, M., Arasasingham, R. D., Potter, F., Soroudi, A., & Lam, G. (2002). Following the development of the bonding concept using knowledge space theory. *Journal of Chemical Education*, 79, 756–762.
- Taagepera, M. & Noori, S. (2000). Mapping students' thinking patterns in learning organic chemistry by the use of the kinowledge space theory. *Journal of Chemical Education*, 77, 1224–1229.
- Taagepera, M., Potter, F., Miller, G. E., & Lakshminarayan, K. (1997). Mapping students' thinking patterns by the use of knowledge space theory. *International Journal of Science Education*, 19, 283–302.
- Theuns, P. (1992). *Dichotomization methods in boolean analysis of co-occurrence data*. Doctoral Dissertation, Vrije Universiteit Brussel, Brussels, Belgium.
- Theuns, P. (1998). Building a knowledge space via boolean analysis of co-occurrence data. In C. E. Dowling, F. S. Roberts, & P. Theuns (Eds.), *Recent Progress in Mathematical Psychology* (pp. 173–194). Mahwah, NJ: Lawrence Erlbaum Associates Ltd.
- Thiéry, N. (2001). *Dynamically adapting knowledge spaces*. Doctoral Dissertation, University of California at Irvine.
- Thiéry, N., Cosyn, E., Lauly, D., Yu, L.-J., & Falmagne, J.-C. (1995). *Knowledge assessment via the web*. Tech. Rep. MBS 95–18, Institute for Mathematical Behavioral Science, UC Irvine.
- Ünlü, A. (2004). *The correlational agreement coefficient CA and an alternative kappa*. Unpublished doctoral dissertation, Graz University of Technology, Graz, Austria.
- Ünlü, A. (2005). Analysis of multinomial response data: A measure for evaluating knowledge structures. In J. Janssen & P. Lenca (Eds.), *Applied Stochastic Models and Data Analysis* (pp. 296–304). Brest, France: ENST Bretagne.

- Ünlü, A. (2006). Estimation of careless error and lucky guess probabilities for dichotomous test items: A psychometric application of a biometric latent class model with random effects. *Journal of Mathematical Psychology*, *50*, 309–328.
- Ünlü, A. (2007). Nonparametric item response theory axioms and properties under nonlinearity and their exemplification with knowledge space theory. *Journal of Mathematical Psychology*, *51*, 383–400.
- Ünlü, A. (2008). A note on monotone likelihood ratio of the total score variable in unidimensional item response theory. *British Journal of Mathematical and Statistical Psychology*, *61*, 179–187.
- Ünlü, A. (2009a). *The correlational agreement coefficient CA and an alternative κ* . Göttingen, Germany: Cuvillier Verlag.
- Ünlü, A. (2009b). *Statistical and probabilistic contributions to the theory of knowledge spaces*. Habilitation thesis, University of Augsburg, Germany.
- Ünlü, A. (2011). A note on the connection between knowledge structures and latent class models. *Methodology: European Journal of Research Methods*, *7*, 63–67.
- Ünlü, A. & Albert, D. (2004). The correlational agreement coefficient $CA(\leq, D)$ — a mathematical analysis of a descriptive goodness-of-fit measure. *Mathematical Social Sciences*, *48*, 281–314.
- Ünlü, A., Brandt, S., & Albert, D. (2007a). Corrigendum to "surmise relations between tests — mathematical considerations": [Discrete Applied Mathematics 127 (2003) 221–239]. *Discrete Applied Mathematics*, *155*, 2401–2402.
- Ünlü, A., Brandt, S., & Albert, D. (2007b). *Test surmise relations, test knowledge structures, and their characterizations*. Tech. Rep. 035/2007, Institute of Mathematics, University of Augsburg, Augsburg, Germany.
- Ünlü, A. & Kickmeier-Rust, M. D. (2006). Prediction of solvability dependencies between dichotomous test items: A local order-theoretic measure of association. In A. Rizzi & M. Vichi (Eds.), *COMPSTAT 2006: Proceedings in Computational Statistics* (pp. 631–638). Berlin: Springer.
- Ünlü, A. & Malik, W. A. (2008). Psychometric data analysis: A size/fit trade-off evaluation procedure for knowledge structures. *Journal of Data Science*, *6*, 491–514.
- Ünlü, A. & Sargin, A. (2008). *Maximum likelihood methodology for diff fit measures for quasi orders*. Tech. Rep. 030/2008, Institute of Mathematics, University of Augsburg, Augsburg, Germany.
- Ünlü, A. & Sargin, A. (2009). Interactive visualization of assessment data: the software package Mondrian. *Applied Psychological Measurement*, *33*, 148–156.

- Ünlü, A. & Sargin, A. (2010). DAKS: An R package for data analysis methods in knowledge space theory. *Journal of Statistical Software*, 37, 1–31.
- Ünlü, A. & Sargin, A. (2011). Mosaic displays for combinatorial psychometric models. In P. Cerchiello & C. Tarantola (Eds.), *Proceedings of the Classification and data Analysis Group of the Italian Statistical Society*. Pavia, Italy.
- Ünlü, A., Sargin, A., & Viehrig, M. (2013). Mosaics for visualizing knowledge structures. *Journal of data Science*, 11(3), 479–499.
- Ünlü, A. & Schrepp, M. (2016). Toward a principled sampling theory for quasi-orders. *Frontiers in Psychology*, 7, 1656–1678. doi: 10.3389/fpsyg.2016.01656.
- Ünlü, A. & Schrepp, M. (2021). Generalized inductive item tree analysis. *Journal of Mathematical Psychology*, 103, 102547.
- Ünlü, A., Schrepp, M., Heller, J., Hockemeyer, C., Wesiak, G., & Albert, D. (2013). Recent developments in performance-based knowledge space theory. In J.-C. Falmagne, D. Albert, C. Doble, D. Eppstein, & X. Hu (Eds.), *Knowledge Spaces: Applications in Education* (pp. 147–192). Heidelberg: Springer.
- Unnewehr, J. (1992). *Benutzerhandbuch Prozeduren zur Wissensdiagnose*. Bericht aus dem Psychologischen Institut 74, Universität Heidelberg.
- Unnewehr, J. (1993). *Knowledge Assessment Procedures 2.0*. Arbeitsbericht aus dem Projekt “Wissensstruktur”, Universität Heidelberg.
- Villano, M. (1991). *Computerized knowledge assessment: Building the knowledge structure and calibrating the assessment routine*. Doctoral Dissertation, New York University, New York.
- Villano, M. (1992). Probabilistic student models: Bayesian belief networks and knowledge space theory. In *Intelligent Tutoring System. Second International Conference* (pp. 491–498). New York: Springer-Verlag.
- Villano, M. & Bloom, C. (1992). *Probabilistic student modeling with knowledge space theory*. Tech. Rep. Contract No. F33615-91-C-0002., Technical Training Research Division, Human Resources Directorate, Brooks AFB, TX.
- Villano, M., Falmagne, J.-C., Johannesen, L., & Doignon, J.-P. (1987). Stochastic procedures for assessing an individual’s state of knowledge. In *Proceedings of the International Conference on Computer-assisted Learning in Post-Secondary Education, Calgary 1987* (pp. 369–371). Calgary: University of Calgary Press.
- Wang, B., Li, J., Chen, Z., Xu, B., & Xie, X. (2023). A new type of polytomous surmise system. *Journal of Mathematical Psychology*, 116.

- Wang, B., Li, J., & Sun, W. (2023). Cd-polytomous knowledge spaces and corresponding polytomous surmise systems. *British Journal of Mathematical and Statistical Psychology*, 76, 87–105.
- Wang, B., Li, J., Sun, W., & Luo, D. (2022). Notes on the polytomous generalization of knowledge space theory. *Journal of Mathematical Psychology*, 109, 1–5.
- Wang, S., He, F., & Andersen, E. (2017). A unified framework for knowledge assessment and progression analysis and design. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (pp. 937–948). New York, NY, USA: ACM.
- Wasner, G. (1998). Structure of user interface preferences. Diplomarbeit, Karl–Franzens–Universität Graz, Austria.
- Weißbacher, R. (2000). Wissensraumtheoretische Strukturierung eines Computerlehrcurses für klassische Mechanik und empirische Validierung. Diplomarbeit, Karl–Franzens–Universität Graz, Austria.
- Wesiak, G. (1998). Construction of attribute spaces for personality disorders by querying experts. Diplomarbeit, Karl–Franzens–Universität Graz, Austria.
- Wesiak, G. (2003). *Ordering inductive reasoning tests for adaptive knowledge assessments: An application of surmise relations between tests*. Unpublished doctoral dissertation, Karl–Franzens–Universität Graz, Graz, Austria. Available: <http://psydok.sulb.uni-saarland.de/volltexte/2004/380>.
- Wesiak, G. & Albert, D. (2001a). Knowledge spaces for inductive reasoning tests. In K. Kallus, N. Posthumus, & P. Jimenez (Eds.), *Current psychological research in Austria. Proceedings of the 4th scientific conference of the Austrian Psychological Society (ÖGP)* (pp. 157–160). Graz: Akademische Druck- u. Verlagsanstalt.
- Wesiak, G. & Albert, D. (2001b). Ordering inductive reasoning tests based on knowledge space theory. In T. Arnold & C. Herrmann (Eds.), *Cognitive Systems & Mechanisms: KogWis 2001. Abstracts of the 5th Meeting of the German Cognitive Science Society* (pp. 75–76). Leipzig: Universitätsverlag.
- Wickelmaier, F. (2002). Empirische Untersuchung zur Erfassung von Wissen durch deterministische und probabilistische Wissensstrukturen. Diplomarbeit, Universität Regensburg, Germany.
- Wickelmaier, F., Heller, J., Mollenhauer, J., & Anselmi, P. (2022). *pks: Probabilistic knowledge structures*. , Comprehensive R Archive Networ. R package version 0.5-0.
- Wille, R. (1999a). Formal concept analysis. *Electronic Notes in Discrete Mathematics*, 2. Abstract of a Tutorial given at the OSDA98, Amherst, MA, September 1998.

- Wille, R. (1999b). Mathematical support for empirical theory building. *Electronic Notes in Discrete Mathematics*, 2. Abstract of a Talk presented at the OSDA98, Amherst, MA, September 1998.
- Winkelmann, J. (1995). Ein objektorientiertes Maschinenmodell für die Präsentation und Auswertung computergestützter Test- und Übungsaufgaben. Diplomarbeit, Technische Universität Carolo-Wilhelmina, Braunschweig, Germany.
- Winter, L.-C., Albert, D., Dimache, A., Kopeinik, S., Brennan, A., & Roche, T. (2013). Applying pedagogical approaches to enhance learning: Linking self-regulated and skills-based learning with support from moodle extensions. In T. Matsuo, K. Hashimoto, & S. Hirokawa (Eds.), *IIAI AAI 2013 — IIAI International Conference on Advanced Applied Informatics 2013* (pp. 203–206). Los Alamitos, CA: IEEE Computer Society.
- Wriessnegger, S. (2000). Cognitive processes and knowledge spaces: An experimental approach of eye movements in solving letter series problems. Diplomarbeit, Karl-Franzens-Universität Graz, Austria.
- Xie, X., Xu, W., & Li, J. (2023). A novel concept-cognitive learning method: A perspective from competences. *Knowledge-Based Systems*, 265, 110382.
- Xu, B., Li, J., Sun, W., & Wang, B. (2023). On delineating forward- and backward-graded knowledge structures from fuzzy skill maps. *Journal of Mathematical Psychology*, 117.
- Yang, Y., Leung, H., Yue, L., & Deng, L. (2012). Automatic dance lesson generator. *IEEE Transactions on Learning Technologies*, 5(3), 191–198.
- Yoshikawa, H., Hirai, H., & Makino, K. (2016). A representation of antimatroids by Horn rules and its application to educational systems. *Journal of Mathematical Psychology*.
- Zakaria, R. & Zualkernan, I. A. (2015). Using knowledge space theory to personalize teaching for groups of students. In *Proceedings of the IEEE 15th International Conference on Advanced Learning Technologies* (pp. 58–60). IEEE.
- Zaluski, A. (2001a). Knowledge spaces Mathematica package. In *PrimMath 2001 — Mathematica u znanosti, tehnologiji i obrazovanju [Mathematica in Science Technology, and Education] Conference, Zagreb, Sept. 27–28* (pp. 287–325).
- Zaluski, A. (2001b). *Knowledge spaces Mathematica package*. Unpublished technical report, Institut für Psychologie, Karl-Franzens-Universität Graz, Austria.
- Zhang, D., Albert, D., Hockemeyer, C., Breen, D., Kulcsar, Z., Shorten, G., Aboulafia, A., & Lövquist, E. (2008). Developing competence assessment procedure for spinal anaesthesia. In S. Puuronen, M. Pechenizkiy, A. Tsymbal, & D.-J. Lee (Eds.), *Proceedings of the 21st IEEE International Symposium on Computer-Based Medical Systems* (pp. 397–402). Los Alamitos, CA: IEEE Computer Society.

Zualkerman, I., Pasquier, M., Jibreel, M. M., Zakaria, R. S., & Tayem, R. M. (2010). An adaptive learning RPG game–engine based on knowledge spaces. In *Proceedings of the 2nd International Conference on Education Technology and Computer* (pp. V2–223–V2–227). IEEE.