CDM reading list

Wenchao Ma
The University of Alabama

This is an extended reading list originally developed for the Cognitive Diagnosis Modeling class offered by Wenchao Ma at the University of Alabama. This list is by no means complete, but attempts to provide students with some general guidance so that they could better swim in the pool. If you'd like to add any references to the list, pull a request at `https://github.com/Wenchao-Ma/CDMreadinglist`.

Books, Reviews and General Introduction to CDMs

- Bolt, D. (2007). The present and future of IRT-based cognitive diagnostic models (ICDM) and related methods. *Journal of Educational Measurement*, *44*(4), 377–383. doi: 10.1111/j.1745-3984.2007.00045.x
- Carragher, N., Templin, J., Jones, P., Shulruf, B., & Velan, G. (2019). Digital module 04: Diagnostic measurement: Modeling checklists for practitioners https://ncme.elevate.commpartners.com. *Educational Measurement: Issues and Practice*, *38*(1), 89–91. doi: 10.1111/emip.12251
- de la Torre, J., & Minchen, N. (2014). Cognitively diagnostic assessments and the cognitive diagnosis model framework. *Psicología Educativa*, *20*(2), 89–97. doi: 10.1016/j.pse.2014.11.001
- DiBello, L. V., & Stout, W. (2007). Guest editors' introduction and overview: IRT-based cognitive diagnostic models and related methods. *Journal of Educational Measurement*, *44*(4), 285–291. doi: 10.1111/j.1745-3984.2007.00039.x
- Leighton, J. P., & Gierl, M. J. (2007). *Cognitive diagnostic assessment for education: Theory and applications*. Cambridge: Cambridge University Press.
- Ma, W., & de la Torre, J. (2019b). Digital module 05: Diagnostic measurement—the G-DINA framework https://ncme.elevate.commpartners.com. *Educational Measurement: Issues and Practice*, *38*(2), 114–115. doi: 10.1111/emip.12262
- Nichols, P. D. (1994). A framework for developing cognitively diagnostic assessments. *Review of Educational Research*, *64*(4), 575–603. doi: 10.3102/00346543064004575
- Nichols, P. D., Chipman, S. F., & Brennan, R. L. (Eds.). (1995). *Cognitively diagnostic assessment*. Hills-dale, NJ:Erlbaum.
- Rupp, A. A., & Leighton, J. P. (Eds.). (2016). *The handbook of cognition and assessment: Frameworks, methodologies, and applications*. Chichester UK and Hoboken NJ: Wiley Blackwell.
- Rupp, A. A., & Templin, J. L. (2008). Unique characteristics of diagnostic classification models: A comprehensive review of the current state-of-the-art. *Measurement: Interdisciplinary Research & Perspective*, *6*(4), 219–262. doi: 10.1080/15366360802490866
- Rupp, A. A., Templin, J., & Henson, R. A. (2010). *Diagnostic measurement: Theory, methods, and applications*. New York and London: Guilford.
- Seipel, B., Biancarosa, G., Carlson, S. E., & Davison, M. L. (2018). The need, use, and future of cognitive diagnostic assessments in classroom practice. In V. C. X. Wang (Ed.), *Handbook of research on program development and assessment methodologies in k-20 education* (Vol. 2, pp. 1–23). Hershey PA: Information Science Reference. doi: 10.4018/978-1-5225-3132-6.ch001
- Sessoms, J., & Henson, R. A. (2018). Applications of diagnostic classification models: A literature review and critical commentary. *Measurement: Interdisciplinary Research and Perspectives*, *16*(1), 1–17. doi: 10.1080/15366367.2018.1435104
- Stout, W. (2007). Skills diagnosis using IRT-based continuous latent trait models. *Journal of Educational Measurement*, *44*(4), 313–324. doi: 10.1111/j.1745-3984.2007.00041.x
- Tatsuoka, K. K. (2009). *Cognitive assessment: An introduction to the rule space method*. London: Routledge Academic.
- von Davier, M., & Lee, Y.-S. (Eds.). (2019). *Handbook of diagnostic classification models*. Cham: Springer International Publishing. doi: 10.1007/978-3-030-05584-4

Psychometric Models and Approaches for Cognitive Diagnosis

CDMs for dichotomous data

- Bradshaw, L., & Templin, J. (2014). Combining item response theory and diagnostic classification models: a psychometric model for scaling ability and diagnosing misconceptions. *Psychometrika*, *79*(3), 403–425. doi: 10.1007/s11336-013-9350-4
- Chen, Y., Li, X., Liu, J., & Ying, Z. (2016). Regularized latent class analysis with application in cognitive diagnosis. *Psychometrika*. doi: 10.1007/s11336-016-9545-6
- de la Torre, J. (2011). The generalized DINA model framework. *Psychometrika*, *76*(2), 179–199. doi: 10.1007/s11336-011-9207-7
- de la Torre, J., & Douglas, J. A. (2004). Higher-order latent trait models for cognitive diagnosis. *Psychometrika*, *69*(3), 333–353. doi: 10.1007/bf02295640
- DiBello, L. V., Stout, W. F., & Roussos, L. (1995). Unified cognitive/psychometric diagnostic assessment likelihood-based classification techniques. In P. D. Nichols, S. F. Chipman, & R. L. Brennan (Eds.), *Cognitively diagnostic assessment* (pp. 361–390). Hills-dale, NJ:Erlbaum.
- Haertel, E. H. (1989). Using restricted latent class models to map the skill structure of achievement items. *Journal of Educational Measurement*, *26*(4), 301–321. doi: 10.1111/j.1745-3984.1989.tb00336.x
- Hartz, S. (2002). *A bayesian framework for the unified model for assessing cognitive abilities: Blending theory with practicality* (Unpublished doctoral dissertation). University of Illinois at Urbana-Champaign.
- Hartz, S., & Roussos, L. (2008). The fusion model for skills diagnosis: Blending theory with practicality. *ETS Research Report Series*, *2008*(2), i-57. doi: 10.1002/j.2333-8504.2008.tb02157.x
- Henson, R. A., Templin, J. L., & Willse, J. T. (2009). Defining a family of cognitive diagnosis models using log-linear models with latent variables. *Psychometrika*, *74*(2), 191–210. doi: 10.1007/s11336-008-9089-5
- Hong, H., Wang, C., Lim, Y. S., & Douglas, J. (2015). Efficient models for cognitive diagnosis with continuous and mixed-type latent variables. *Applied Psychological Measurement*, *39*(1), 31–43. doi: 10.1177/0146621614524981
- Jiang, H. (1996). *Applications of computational statistics in cognitive diagnosis and IRT modeling* (Unpublished doctoral dissertation). University of Illinois at Urbana-Champaign.
- Junker, B. W., & Sijtsma, K. (2001). Cognitive assessment models with few assumptions, and connections with nonparametric item response theory. *Applied Psychological Measurement*, 258–272.
- Macready, G. B., & Dayton, C. M. (1977). The use of probabilistic models in the assessment of mastery. *Journal of Educational Statistics*, *2*(2), 99–120. doi: 10.3102/10769986002002099
- Maris, E. (1999). Estimating multiple classification latent class models. *Psychometrika*, *64*(2), 187–212. doi: 10.1007/bf02294535
- Park, Y. S., Xing, K., & Lee, Y.-S. (2018). Explanatory cognitive diagnostic models: Incorporating latent and observed predictors. *Applied Psychological Measurement*, *42*(5), 376–392. doi: 10.1177/0146621617738012
- Stout, W., Henson, R., DiBello, L., & Shear, B. (2019). The reparameterized unified model system: A diagnostic assessment modeling approach. In M. von Davier & Y.-S. Lee (Eds.), *Handbook of diagnostic classification models* (pp. 47–79). Cham: Springer International Publishing. doi: 10.1007/978-3-030-05584-4_3
- Templin, J. L., & Henson, R. A. (2006). Measurement of psychological disorders using cognitive diagnosis models. *Psychological methods*, *11*(3), 287–305. doi: 10.1037/1082-989X.11.3.287
- Templin, J., & Bradshaw, L. (2014). Hierarchical diagnostic classification models: a family of models for estimating and testing attribute hierarchies. *Psychometrika*, *79*(2), 317–339. doi: 10.1007/s11336-013-9362-0
- von Davier, M. (2008). A general diagnostic model applied to language testing data. *The British journal of mathematical and statistical psychology*, *61*(Pt 2), 287–307. doi: 10.1348/000711007X193957
- Yamamoto, K. (1982). Hybrid model of IRT and latent class models. *ETS Research Report Series*, *1982*(2), i-61. doi: 10.1002/j.2333-8504.1982.tb01326.x
- Yamamoto, K., & Everson, H. T. (1995). Modeling the mixture of IRT and pattern responses by a modified hybrid model1. *ETS Research Report Series*, *1995*(1), i-26. doi: 10.1002/j.2333-8504.1995.tb01651.x

- Zhan, P., Ma, W., Jiao, H., & DING, S. (2020). A sequential higher order latent structural model for hierarchical attributes in cognitive diagnostic assessments. *Applied Psychological Measurement*, *44*(1), 65–83. doi: 10.1177/0146621619832935

Other approaches for cognitive diagnosis

- Almond, R. G., & Zapata-Rivera, J.-D. (2019). Bayesian networks. In M. von Davier & Y.-S. Lee (Eds.), *Handbook of diagnostic classification models* (Vol. 51, pp. 81–106). Cham: Springer International Publishing. doi: 10.1007/978-3-030-05584-4_4

- Briggs, D. C., & Circi, R. (2017). Challenges to the use of artificial neural networks for diagnostic classifications with student test data. *International Journal of Testing*, *17*(4), 302–321. doi: 10.1080/15305058.2017.1297816

- Chiu, C.-Y., Douglas, J. A., & Li, X. (2009). Cluster analysis for cognitive diagnosis: Theory and applications. *Psychometrika*, *74*(4), 633–665. doi: 10.1007/s11336-009-9125-0

- Chiu, C.-Y., & Köhn, H.-F. (2019). Nonparametric methods in cognitively diagnostic assessment. In M. von Davier & Y.-S. Lee (Eds.), *Handbook of diagnostic classification models* (Vol. 46, pp. 107–132). Cham: Springer International Publishing. doi: 10.1007/978-3-030-05584-4_5

- Chiu, C.-Y., Sun, Y., & Bian, Y. (2018). Cognitive diagnosis for small educational programs: The general nonparametric classification method. *Psychometrika*, *83*(2), 355–375. doi: 10.1007/s11336-017-9595-4

- Falmagne, J.-C., Koppen, M., Villano, M., Doignon, J.-P., & al, e. (1990). Introduction to knowledge spaces: How to build, test, and search them. *Psychological review*, *97*(2), 201–224. doi: 10.1037//0033-295x.97.2.201

- Gierl, M. J., Leighton, J. P., & Hunka, S. M. (2000). An ncme instructional module on exploring the logic of tatsuoka's rule-space model for test development and analysis. *Educational Measurement: Issues and Practice*, *19*(3), 34–44. doi: 10.1111/j.1745-3992.2000.tb00036.x

- Liu, Q., Wu, R., Chen, E., Xu, G., Su, Y., Chen, Z., & Hu, G. (2018). Fuzzy cognitive diagnosis for modelling examinee performance. *ACM Transactions on Intelligent Systems and Technology*, *9*(4), 1–26. doi: 10.1145/3168361

- Leighton, J. P., Gierl, M. J., & Hunka, S. M. (2004). The attribute hierarchy method for cognitive assessment: A variation on tatsuoka's rule-space approach. *Journal of Educational Measurement*, *41*(3), 205–237. doi: 10.1111/j.1745-3984.2004.tb01163.x

- Tatsuoka, K. K. (1983). Rule space: An approach for dealing with misconceptions based on item response theory. *Journal of Educational Measurement*, *20*(4), 345–354. doi: 10.1111/j.1745-3984.1983.tb00212.x

CDMs for polytomous data

- Chen, J., & de la Torre, J. (2018). Introducing the general polytomous diagnosis modeling framework. *Frontiers in psychology*, *9*, 1474. doi: 10.3389/fpsyg.2018.01474

- Chen, J., & Zhou, H. (2017). Test designs and modeling under the general nominal diagnosis model framework. *PloS one*, *12*(6), e0180016. doi: 10.1371/journal.pone.0180016

- Culpepper, S. A. (2019). An exploratory diagnostic model for ordinal responses with binary attributes: Identifiability and estimation. *Psychometrika*, *84*(4), 921–940. doi: 10.1007/s11336-019-09683-4

- Ma, W. (2019a). A diagnostic tree model for polytomous responses with multiple strategies. *The British journal of mathematical and statistical psychology*, *72*(1), 61–82. doi: 10.1111/bmsp.12137

- Ma, W., & de la Torre, J. (2016). A sequential cognitive diagnosis model for polytomous responses. *The British journal of mathematical and statistical psychology*, *69*(3), 253–275. doi: 10.1111/bmsp.12070

- Liu, R., & Jiang, Z. (2018). Diagnostic classification models for ordinal item responses. *Frontiers in psychology*, *9*, 2512. doi: 10.3389/fpsyg.2018.02512

- Sun, J., Xin, T., Zhang, S., & de la Torre, J. (2013). A polytomous extension of the generalized distance discriminating method. *Applied Psychological Measurement*, *37*(7), 503–521. doi: 10.1177/0146621613487254

- Tu, D., Zheng, C., CAI, Y., Gao, X., & Wang, D. (2018). A polytomous model of cognitive diagnostic assessment for graded data. *International Journal of Testing*, *18*(3), 231–252. doi: 10.1080/15305058.2017.1396465

- von Davier, M. (2008). A general diagnostic model applied to language testing data. *The British journal of mathematical and statistical psychology*, *61*(Pt 2), 287–307. doi: 10.1348/000711007X193957

CDMs for polytomous attributes

- Chen, J., & de la Torre, J. (2013). A general cognitive diagnosis model for expert-defined polytomous attributes. *Applied Psychological Measurement*, *37*(6), 419–437. doi: 10.1177/0146621613479818
- von Davier, M. (2008). A general diagnostic model applied to language testing data. *The British journal of mathematical and statistical psychology*, *61*(Pt 2), 287–307. doi: 10.1348/000711007X193957
- Zhan, P., Wang, W.-C., & Li, X. (2019). A partial mastery, higher-order latent structural model for polytomous attributes in cognitive diagnostic assessments. *Journal of Classification*, *30*(2), 195. doi: 10.1007/s00357-019-09323-7

CDMs for multiple strategies

- de la Torre, J., & Douglas, J. A. (2008). Model evaluation and multiple strategies in cognitive diagnosis: An analysis of fraction subtraction data. *Psychometrika*, *73*(4), 595–624. doi: 10.1007/s11336-008-9063-2
- DiBello, L. V., Stout, W. F., & Roussos, L. (1995). Unified cognitive/psychometric diagnostic assessment likelihood-based classification techniques. In P. D. Nichols, S. F. Chipman, & R. L. Brennan (Eds.), *Cognitively diagnostic assessment* (pp. 361–390). Hills-dale, NJ:Erlbaum.
- Ma, W. (2019a). A diagnostic tree model for polytomous responses with multiple strategies. *The British journal of mathematical and statistical psychology*, *72*(1), 61–82. doi: 10.1111/bmsp.12137
- Ma, W., & Guo, W. (2019). Cognitive diagnosis models for multiple strategies. *The British journal of mathematical and statistical psychology*, *72*(2), 370–392. doi: 10.1111/bmsp.12155
- von Davier, M. (2010). Hierarchical mixtures of diagnostic models. *Psychological Test and Assessment Modeling*, *52*.

CDMs for options

- de la Torre, J. (2009a). A cognitive diagnosis model for cognitively based multiple-choice options. *Applied Psychological Measurement*, *33*(3), 163–183. doi: 10.1177/0146621608320523
- DiBello, L. V., Henson, R. A., & Stout, W. F. (2015). A family of generalized diagnostic classification models for multiple choice option-based scoring. *Applied Psychological Measurement*, *39*(1), 62–79. doi: 10.1177/0146621614561315

CDMs for longitudinal data

- Chen, Y., Culpepper, S. A., Wang, S., & Douglas, J. (2018). A hidden markov model for learning trajectories in cognitive diagnosis with application to spatial rotation skills. *Applied Psychological Measurement*, *42*(1), 5–23. doi: 10.1177/0146621617721250
- Madison, M. J., & Bradshaw, L. P. (2018). Assessing growth in a diagnostic classification model framework. *Psychometrika*, *83*(4), 963–990. doi: 10.1007/s11336-018-9638-5
- Wang, S., Yang, Y., Culpepper, S. A., & Douglas, J. A. (2018). Tracking skill acquisition with cognitive diagnosis models: A higher-order, hidden markov model with covariates. *Journal of Educational and Behavioral Statistics*, *43*(1), 57–87. doi: 10.3102/1076998617719727
- Zhan, P., Jiao, H., Liao, D., & Li, F. (2019). A longitudinal higher-order diagnostic classification model. *Journal of Educational and Behavioral Statistics*, *44*(3), 251–281. doi: 10.3102/1076998619827593

Model estimation and identifiability

- Chen, Y., Culpepper, S., & Liang, F. (2020). A sparse latent class model for cognitive diagnosis. *Psychometrika*. doi: 10.1007/s11336-019-09693-2
- da Silva, M. A., de Oliveira, E. S. B., von Davier, A. A., & Bazán, J. L. (2018). Estimating the DINA model parameters using the no-u-turn sampler. *Biometrical journal. Biometrische Zeitschrift*, *60*(2), 352–368. doi: 10.1002/bimj.201600225
- de la Torre, J. (2009b). DINA model and parameter estimation: A didactic. *Journal of Educational and Behavioral Statistics*, *34*(1), 115–130. doi: 10.3102/1076998607309474
- Fang, G., Liu, J., & Ying, Z. (2019). On the identifiability of diagnostic classification models. *Psychometrika*, *84*(1), 19–40. doi: 10.1007/s11336-018-09658-x
- Huebner, A., & Wang, C. (2011). A note on comparing examinee classification methods for cognitive diagnosis models. *Educational and Psychological Measurement*, *71*(2), 407–419. doi: 10.1177/0013164410388832
- Jiang, Z., & Carter, R. (2019). Using hamiltonian monte carlo to estimate the log-linear cognitive diagnosis model via stan. *Behavior research methods*, *51*(2), 651–662. doi: 10.3758/s13428-018-1069-9

- Jiang, Z., & Ma, W. (2018). Integrating differential evolution optimization to cognitive diagnostic model estimation. *Frontiers in Psychology*, *9*, 2142. doi: 10.3389/fpsyg.2018.02142

- Köhn, H.-F., & Chiu, C.-Y. (2017). A procedure for assessing the completeness of the Q-matrices of cognitively diagnostic tests. *Psychometrika*, *82*(1), 112–132. doi: 10.1007/s11336-016-9536-7

- Xu, G. (2017). Identifiability of restricted latent class models with binary responses. *The Annals of Statistics*, *45*(2), 675–707. doi: 10.1214/16-AOS1464

- Xu, G., & Zhang, S. (2016). Identifiability of diagnostic classification models. *Psychometrika*, *81*(3), 625–649. doi: 10.1007/s11336-015-9471-z

- Zhan, P., Jiao, H., Man, K., & Wang, L. (2019). Using JAGS for bayesian cognitive diagnosis modeling: A tutorial. *Journal of Educational and Behavioral Statistics*, *44*(4), 473–503. doi: 10.3102/1076998619826040

Reliability

- Chen, Y., Liu, Y., & Xu, S. (2018). Mutual information reliability for latent class analysis. *Applied Psychological Measurement*, *42*(6), 460–477. doi: 10.1177/0146621617748324

- Johnson, M. S., & Sinharay, S. (2018). Measures of agreement to assess attribute-level classification accuracy and consistency for cognitive diagnostic assessments. *Journal of Educational Measurement*, *55*(4), 635–664. doi: 10.1111/jedm.12196

- Wang, W., Song, L., Chen, P., Meng, Y., & DING, S. (2015). Attribute–level and pattern–level classification consistency and accuracy indices for cognitive diagnostic assessment. *Journal of Educational Measurement*, *52*(4), 457–476. doi: 10.1111/jedm.12096

- Templin, J., & Bradshaw, L. (2013). Measuring the reliability of diagnostic classification model examinee estimates. *Journal of Classification*, *30*(2), 251–275. doi: 10.1007/s00357-013-9129-4

Model fit and person fit evaluation

- Chen, F., Liu, Y., Xin, T., & Cui, Y. (2018). Applying the m_2 statistic to evaluate the fit of diagnostic classification models in the presence of attribute hierarchies. *Frontiers in psychology*, *9*, 1875. doi: 10.3389/fpsyg.2018.01875

- Chen, J., de la Torre, J., & Zhang, Z. (2013). Relative and absolute fit evaluation in cognitive diagnosis modeling. *Journal of Educational Measurement*, *50*(2), 123–140. doi: 10.1111/j.1745-3984.2012.00185.x

- Liu, Y., Douglas, J. A., & Henson, R. A. (2009). Testing person fit in cognitive diagnosis. *Applied Psychological Measurement*, *33*(8), 579–598. doi: 10.1177/0146621609331960

- Jiang, H. (1996). *Applications of computational statistics in cognitive diagnosis and IRT modeling* (Unpublished doctoral dissertation). University of Illinois at Urbana-Champaign.

- Hu, J., Miller, M. D., Huggins-Manley, A. C., & Chen, Y.-H. (2016). Evaluation of model fit in cognitive diagnosis models. *International Journal of Testing*, *16*(2), 119–141. doi: 10.1080/15305058.2015.1133627

- Liu, Y., Tian, W., & Xin, T. (2016). An application of m_2 statistic to evaluate the fit of cognitive diagnostic models. *Journal of Educational and Behavioral Statistics*, *41*(1), 3–26. doi: 10.3102/1076998615621293

- Ma, W. (2019b). Evaluating the fit of sequential G-DINA model using limited-information measures. *Applied Psychological Measurement*, 014662161984382. doi: 10.1177/0146621619843829

- Santos, K. C. P., de La Torre, J., & von Davier, M. (2019). Adjusting person fit index for skewness in cognitive diagnosis modeling. *Journal of Classification*, *62*, 191. doi: 10.1007/s00357-019-09325-5

- Sen, S., & Bradshaw, L. (2017). Comparison of relative fit indices for diagnostic model selection. *Applied Psychological Measurement*, *41*(6), 422–438. doi: 10.1177/0146621617695521

- Sorrel, M. A., Abad, F. J., Olea, J., de la Torre, J., & Barrada, J. R. (2017). Inferential item-fit evaluation in cognitive diagnosis modeling. *Applied Psychological Measurement*, *41*(8), 614–631. doi: 10.1177/0146621617707510

- Sinharay, S., & Almond, R. G. (2007). Assessing fit of cognitive diagnostic models a case study. *Educational and Psychological Measurement*, *67*(2), 239–257. doi: 10.1177/0013164406292025

- Wang, C., Shu, Z., Shang, Z., & Xu, G. (2015). Assessing item-level fit for the DINA model. *Applied Psychological Measurement*, *39*(7), 525–538. doi: 10.1177/0146621615583050

Inferential model comparisons

- de la Torre, J., & Lee, Y.-S. (2013). Evaluating the wald test for item-level comparison of saturated and reduced models in cognitive diagnosis. *Journal of Educational Measurement*, *50*(4), 355–373. doi: 10.1111/jedm.12022
- Ma, W., Iaconangelo, C., & de la Torre, J. (2016). Model similarity, model selection, and attribute classification. *Applied Psychological Measurement*, *40*(3), 200–217. doi: 10.1177/0146621615621717
- Ma, W., & de la Torre, J. (2019a). Category-level model selection for the sequential G-DINA model. *Journal of Educational and Behavioral Statistics*, *44*(1), 45–77. doi: 10.3102/1076998618792484
- Sorrel, M. A., de La Torre, J., Abad, F. J., & Olea, J. (2017). Two-step likelihood ratio test for item-level model comparison in cognitive diagnosis models. *Methodology*, *13*(Supplement 1), 39–47. doi: 10.1027/1614-2241/a000131
- Sorrel, M. A., Abad, F. J., Olea, J., de la Torre, J., & Barrada, J. R. (2017). Inferential item-fit evaluation in cognitive diagnosis modeling. *Applied Psychological Measurement*, *41*(8), 614–631. doi: 10.1177/0146621617707510

Methods for Q-matrix

- Chen, J. (2017). A residual-based approach to validate q-matrix specifications. *Applied Psychological Measurement*, *41*(4), 277–293. doi: 10.1177/0146621616686021
- Chiu, C.-Y. (2013). Statistical refinement of the Q-matrix in cognitive diagnosis. *Applied Psychological Measurement*, *37*(8), 598–618. doi: 10.1177/0146621613488436
- Culpepper, S. A., & Chen, Y. (2019). Development and application of an exploratory reduced reparameterized unified model. *Journal of Educational and Behavioral Statistics*, *44*(1), 3–24. doi: 10.3102/1076998618791306
- DeCarlo, L. T. (2012). Recognizing uncertainty in the Q-matrix via a bayesian extension of the DINA model. *Applied Psychological Measurement*, *36*(6), 447–468. doi: 10.1177/0146621612449069
- de la Torre, J. (2008). An empirically based method of Q-matrix validation for the DINA model: Development and applications. *Journal of Educational Measurement*, *45*(4), 343–362. doi: 10.1111/j.1745-3984.2008.00069.x
- de la Torre, J., & Chiu, C.-Y. (2016). A general method of empirical Q-matrix validation. *Psychometrika*, *81*(2), 253–273. doi: 10.1007/s11336-015-9467-8
- Liu, J., Xu, G., & Ying, Z. (2012). Data-driven learning of Q-matrix. *Applied Psychological Measurement*, *36*(7), 548–564. doi: 10.1177/0146621612456591
- Lim, Y. S., & Drasgow, F. (2017). Nonparametric calibration of item-by-attribute matrix in cognitive diagnosis. *Multivariate behavioral research*, *52*(5), 562–575. doi: 10.1080/00273171.2017.1341829
- Ma, W., & de La Torre, J. (2020). An empirical Q-matrix validation method for the sequential generalized DINA model. *The British journal of mathematical and statistical psychology*, *73*(1), 142–163. doi: 10.1111/bmsp.12156
- Nájera, P., Sorrel, M. A., & Abad, F. J. (2019). Reconsidering cutoff points in the general method of empirical Q-matrix validation. *Educational and Psychological Measurement*, *79*(4), 727–753. doi: 10.1177/0013164418822700
- Xu, G., & Shang, Z. (2018). Identifying latent structures in restricted latent class models. *Journal of the American Statistical Association*, *113*(523), 1284–1295. doi: 10.1080/01621459.2017.1340889

CD-CAT

- Cheng, Y. (2009). When cognitive diagnosis meets computerized adaptive testing: CD-CAT. *Psychometrika*, *74*(4), 619–632. doi: 10.1007/s11336-009-9123-2
- Chen, P., Xin, T., Wang, C., & Chang, H.-H. (2012). Online calibration methods for the DINA model with independent attributes in CD-CAT. *Psychometrika*, *77*(2), 201–222. doi: 10.1007/s11336-012-9255-7
- Kaplan, M., de La Torre, J., & Barrada, J. R. (2015). New item selection methods for cognitive diagnosis computerized adaptive testing. *Applied Psychological Measurement*, *39*(3), 167–188. doi: 10.1177/0146621614554650
- Wang, C., Chang, H.-H., & Douglas, J. (2012). Combining CAT with cognitive diagnosis: a weighted item selection approach. *Behavior research methods*, *44*(1), 95–109. doi: 10.3758/s13428-011-0143-3
- Wang, C., Zheng, C., & Chang, H.-H. (2014). An enhanced approach to combine item response theory with cognitive diagnosis in adaptive testing. *Journal*

of Educational Measurement, *51*(4), 358–380. doi: 10.1111/jedm.12057

- Xu, G., Wang, C., & Shang, Z. (2016). On initial item selection in cognitive diagnostic computerized adaptive testing. *The British journal of mathematical and statistical psychology*, *69*(3), 291–315. doi: 10.1111/bmsp.12072

- Yigit, H. D., Sorrel, M. A., & de La Torre, J. (2019). Computerized adaptive testing for cognitively based multiple-choice data. *Applied Psychological Measurement*, *43*(5), 388–401. doi: 10.1177/0146621618798665

- Zheng, C., & Wang, C. (2017). Application of binary searching for item exposure control in cognitive diagnostic computerized adaptive testing. *Applied Psychological Measurement*, *41*(7), 561–576. doi: 10.1177/0146621617707509

Applications

- Aryadoust, V. (2018). A cognitive diagnostic assessment study of the listening test of the singapore–cambridge general certificate of education o-level: Application of DINA, DINO, G-DINA, HO-DINA, and RRUM. *International Journal of Listening*, *63*(2), 1–24. doi: 10.1080/10904018.2018.1500915

- Bley, S. (2017). Developing and validating a technology-based diagnostic assessment using the evidence-centered game design approach: an example of intrapreneurship competence. *Empirical Research in Vocational Education and Training*, *9*(1), 281. doi: 10.1186/s40461-017-0049-0

- Bradshaw, L., Izsák, A., Templin, J., & Jacobson, E. (2014). Diagnosing teachers' understandings of rational numbers: Building a multidimensional test within the diagnostic classification framework. *Educational Measurement: Issues and Practice*, *33*(1), 2–14. doi: 10.1111/emip.12020

- de la Torre, J., van der Ark, L. A., & Rossi, G. (2018). Analysis of clinical data from a cognitive diagnosis modeling framework. *Measurement and Evaluation in Counseling and Development*, *51*(4), 281–296. doi: 10.1080/07481756.2017.1327286

- Gierl, M. J., Alves, C., & Majeau, R. T. (2010). Using the attribute hierarchy method to make diagnostic inferences about examinees' knowledge and skills in mathematics: An operational implementation of cognitive diagnostic assessment. *International Journal of Testing*, *10*(4), 318–341. doi: 10.1080/15305058.2010.509554

- Jurich, D. P., & Bradshaw, L. P. (2014). An illustration of diagnostic classification modeling in student learning outcomes assessment. *International Journal of Testing*, *14*(1), 49–72. doi: 10.1080/15305058.2013.835728

- Kabiri, M., Ghazi-Tabatabaei, M., Bazargan, A., Shokoohi-Yekta, M., & Kharrazi, K. (2017). Diagnosing competency mastery in science: An application of GDM to TIMSS 2011 data. *Applied Measurement in Education*, *30*(1), 27–38. doi: 10.1080/08957347.2016.1258407

- Kunina-Habenicht, O., Rupp, A. A., & Wilhelm, O. (2009). A practical illustration of multidimensional diagnostic skills profiling: Comparing results from confirmatory factor analysis and diagnostic classification models. *Studies in Educational Evaluation*, *35*(2-3), 64–70. doi: 10.1016/j.stueduc.2009.10.003

- Kunina-Habenicht, O., Rupp, A. A., & Wilhelm, O. (2017). Incremental validity of multidimensional proficiency scores from diagnostic classification models: An illustration for elementary school mathematics. *International Journal of Testing*, *17*(4), 277–301. doi: 10.1080/15305058.2017.1291517

- Lee, Y.-S., Park, Y. S., & Taylan, D. (2011). A cognitive diagnostic modeling of attribute mastery in Massachusetts, Minnesota, and the U.S. national sample using the TIMSS 2007. *International Journal of Testing*, *11*(2), 144–177. doi: 10.1080/15305058.2010.534571

- Lee, Y.-W., & Sawaki, Y. (2009b). Cognitive diagnosis approaches to language assessment: An overview. *Language Assessment Quarterly*, *6*(3), 172–189. doi: 10.1080/15434300902985108

- Lee, Y.-W., & Sawaki, Y. (2009a). Application of three cognitive diagnosis models to esl reading and listening assessments. *Language Assessment Quarterly*, *6*(3), 239–263. doi: 10.1080/15434300903079562

- Ma, X., & Meng, Y. (2014). Towards personalized english learning diagnosis cognitive diagnostic modelling for efl listening. *Asian Journal of Education and e-Learning*, *2*(5), 336–348.

- Sessoms, J., & Henson, R. A. (2018). Applications of diagnostic classification models: A literature review and critical commentary. *Measurement: Interdisciplinary Research and Perspectives*, *16*(1), 1–17. doi: 10.1080/15366367.2018.1435104

- Skaggs, G., Wilkins, J. L. M., & Hein, S. F. (2016). Grain size and parameter recovery with

timss and the general diagnostic model. *International Journal of Testing*, *16*(4), 310–330. doi: 10.1080/15305058.2016.1145683

- Sorrel, M. A., Olea, J., Abad, F. J., de La Torre, J., Aguado, D., & Lievens, F. (2016). Validity and reliability of situational judgement test scores. *Organizational Research Methods*, *19*(3), 506–532. doi: 10.1177/1094428116630065

- Tjoe, H., & de la Torre, J. (2014). The identification and validation process of proportional reasoning attributes: an application of a cognitive diagnosis modeling framework. *Mathematics Education Research Journal*, *26*(2), 237–255. doi: 10.1007/s13394-013-0090-7

- Tu, D., Gao, X., Wang, D., & CAI, Y. (2017). A new measurement of internet addiction using diagnostic classification models. *Frontiers in psychology*, *8*, 1768. doi: 10.3389/fpsyg.2017.01768

- Templin, J. L., & Henson, R. A. (2006). Measurement of psychological disorders using cognitive diagnosis models. *Psychological methods*, *11*(3), 287–305. doi: 10.1037/1082-989X.11.3.287