Uncertainty in Mathematics Curriculum Structures for the Third and Fourth Grades

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ABSTRACT

This study mainly focuses on the following issues: (1) How to define the uncertainty in math curriculum structure by the notion of the Shannon entropy? (2) Does the uncertainty in math curriculum structure contain any statistically significant trends? (3) What is the relation among student achievement in math, the difference of practical and predetermined teaching hours for teachers and the Shannon entropy derived from the corresponding math curriculum structure ? The former two issues may be achieved by the machinery of graph theory, the notions of Novak concept maps and so-called C statistics. For the requirement of the last issue, 523 graduates and 18 teachers of some primary school in Changhua County were selected as the subjects of our study. The main results of this study are as follows: (1) The uncertainty in math curriculum structures is increasing significantly. (2) The relation of uncertainty in math curriculum structures and math achievement is significantly and negatively correlated. (3) The difference of practical and predetermined teaching hours is insignificantly correlated with the uncertainty of the corresponding curriculum structure and math achievement, respectively.

Keywords : uncertainty、curriculum structure、math achievement、Shannon entropy

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REFERENCES

參考文獻 一、中文部份 吳心怡(2002)。教科書。國民教育，43(2)，79-84。 李慶祥、李應華、吳秀玲、林長壽、林淑君、翁秉仁、陳俊瑜、張麟偉、鄭人豪、盧銘法(2009-2011)。國民小學數學教師手冊(1至8冊)。台北市，國家教育研究院。 周玉秀 (2006)。從PISA看數學素養與中小學數學教育。科學教育，293，2-21。 林碧珍、蔡文煥(2005)。探討TIMSS 2003臺灣國小四年級學生的數學成就及其相關因素之探討。科學教育月刊，285，2-38。 洪中鈞（2012）。國小學生的數學成就與數學課程的關聯研究(未出版之碩士論文)。大葉大學，彰化縣。 洪中鈞、陳進財、蕭鴻貴(2011)。國小低年級學生數學成就與課程結構的關係。第八屆「課程、教學與評量」理論與實務研討會。大葉大學，彰化縣。 洪碧霞、蕭嘉偉、林素微 (2010)。PISA數學素養認知成份分析對補救教學的意涵。課程與教學，13(1)，47-66。 徐偉民(2011)。三位六年級教師數學課程實施之比較。教育研究集刊，57(2)，85-120。 許秀蕊(2006)。基於試題反應理論與模糊理論探討國小三四五年級學童面積概念之發展(未出版之碩士論文)。國立台北師範學院，台北市。 教育部(2003)。國民中小學九年一貫課程綱要。台北:教育部。 教育部(2008)。國民中小學九年一貫課程綱要。台北:教育部。 張宇樑、洪巽盈(2009)。運用概念構圖教學策略提升六年級數學低成就學生學習效之個案研究。台灣數學教師電子期刊，18，50-65。 張英傑、張素宜(2008)。小寶貝，我把數學變簡單了！—從情境學習理論談數學課程設計。科學教育月刊，313，9-17。 張春興(1996)。教育心理學。東華書局。 黃立期(2009)。臺灣四十年來國編版國小數學教科書分數乘法教材之分析比較。國立臺北教育大學。台北市。 黃惠卿、林啟超(2005)。國中生數學之成就目標導向對自我效能和不適應學習行為之關係。教育科學期刊，5(2)，27-51。 黃德祥(1990)。國中與國小學生數學焦慮與數學態度之分析研究。輔導學報，13，1-52。 陳美如(2007)。課程與教學。五南。 陳義汶(2009)。國中生學校數學成績與數學補習及數學態度之相關研究。國民教育學報，6，131-161。 陳義汶、呂佳陵(2010)。國中生數學成績與性別之相關研究。第七屆「課程、教學與評量」理論與實務研討會。大葉大學，彰化縣。 陳錦雲、施皓耀(1999)。利用局部概念圖重現學生的認知結構之研究—針對一元二次方程式之研究。科學教育，10，87-110。 鄭秀娟(1997)。國小學童的學習適應、焦慮人格特質及其相關背景變向之研究。國立嘉義師範學院學報，11，119-156。 潘黃家齊(2006)。使用GHMM與IRT結合模式校正順序理論與試題關聯結構分析法之猜測效應(未出版之碩士論文)。亞洲大學，台中縣。 蔡文標(2002)。影響國小數學低成就學生數學成就的相關因素及直接教學效果之研究。國立彰化師範大學，彰化縣。 蔡秉燁(2007)。促進理解的認知學習:國小數學學習地圖。高等教育，台北市。 劉韋成(2010)。以試題反應理論探討學童分數加減解題能力之研究(未出版之碩士論文)。國立新竹教育大學，新竹市。 盧雪梅、毛國楠（2008）。國中基本學力測驗數學科之性別差異和差別試題功能（DIF）分析。教育實踐與研究，21(2)，95-126。 鍾 靜(2005)。論數學課程近十年之變革。教育研究月刊，133，124-134。 魏麗敏(1989)。國小學生數學焦慮、數學態度與數學成就之關係。測驗年刊，36，47-60。 魏麗敏(1997)。影響國小兒童數學成就之自我調節學習與情感因素分析之研究。臺中師院學報，11，37-63。 嚴正意(1992)。學生怕數學嗎？數學焦慮之探討。國教之友，44(2)，43-48。 二、英文部分: Aiken (1970). Attitudes toward mathematics, Review of Educational Research, 40(4), 551-596. Anderson, J. R., & Bower, G. (1983). Human associative memory. Washington, DC: Winston. Anderson, J. R. (1995). Learning and memory: An integrated approach. New York: Wiley. Anderson, R. C. (1977). The notion of schemata and the educational enterprise: General discussion of the conference. In Anderson, R. C., Spiro, and Montague 1984. Apple, M. (1992). The text and cultural politics. Educational Researcher, 21(7), 4 – 11. Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its component processes. In K. Spence & J. Spence (Eds.), The psychology of learning and motivation, Vol. 2. New York: Academic Press. Ausubel, D. (1963). The psychology of meaningful verbal learning. New York: Grune & Stratton. Ausubel, D. P., Novak, J. D., Hanesian, H. (1978). Educational psychology: a cognitive view, holt, rinehart and winston, New York. Baxter, G. P., & Glaser, R. (1998). Investigating the cognitive complexity of science assessments. Educational measurement: issues and practice, 17, 37-45. Biggs, N., Lloyd, E., & Wilson, R. (1986), Graph Theory, Oxford University Press. Bloom, B. S., Englehart, M. B., Furst, E.J., Hill, W. H., & Krathwohl, O. R. (1956). Taxonomy of educational objectives: The classification of educational goals. Handbook 1: The cognitive domain. New York: Longman. Bransford, J. D. (1979). Human cognition: Learning, understanding, and remembering. Belmont, CA: Wadsworth. Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. Education Researcher , 18(1),32-42. Bruner, J. S. (1977). The process of education. Cambridge, MA: Harvard University Press. Byrnes, J. P., & Fox, N. A. (1998). The educational relevance of research in cognitive neuroscience. Educational Psychology Review, 10(3), 297-342. Chiang, H. K., Chiou, C. C., Chou, Y. Y., Huang, C. Y., & Lai, S. H. (2012). Effects of multidimensional concept Huang, H. S., maps on fourth graders ’ learning in web-based computer course. Computers & Education. 58, 863 – 873. Clark, C. M., & Peterson, P. L. (1986). Teachers' thought processes. In M. C. Wittrock (Ed.) Handbook of Research on Teaching, 3rd ed, 255-296. New York: Macmillan. Cohen, P., Cohen, S. G., West, L. S. (2003). Aiken, applied multiple regression/correlation analysis for the behavioral sciences, 3rd ed., Lawrence Erlbaum Associates, Mahwah, N.J. Covington, M. V., & Mueller, K. J. (2001). Intrinsic versus extrinsic motivation: An approach/avoidance reformulation. Educational Psychology Review, 13, 157-176. Doerr, H., & Browers, J. (1999). Revealing

pre-service teachers ’ thinking about functions through concept mapping. Proceedings of the Twenty-first annual meeting of the PME-NA, 364-369. Cuernavaca, Morelos, Mexico. Eccles, N., Wigfield, A., Harold, R. D., & Blumenfeld, P. (2003). Age and gender differences in children ’ s self and task perceptions during elementary school. Child Developments, 64, 830-847. Ericsson, K. A., & Kintsch, W. (1995). Long-term working memory. Psychological Review, 102, 211-245. Fennema, E., & Sherman, J. (1976). Fennema-Sherman mathematics attitudes scales. JSAS Catalogue of selected Documents in Psychology, 6, 31. Fennema, E., & Frank, M. L. (1992). Teachers ’ knowledge and its impact. Handbook of research on mathematics teaching and learning, National Council of Teachers of mathematics. Macmillan Publishing Company, New York, 147-164. Gagne, R. M. (1973). Learning and instructional sequence. In F. N. Kerlinger (Ed.) Review of Research in Education. Itasca, IL:Peacock. Gail, J., & Vesilind, E. (1993). Changes in the structure of pedagogical knowledge in mathematics and science pre-service teachers. Proceedings of the Third International Seminar on Misconception and Educational Strategies in Science and Mathematics, Misconceptions Trust: Ithaca, New York. Gallagher, A., Bridgeman, B., & Cahalan, C. (2000). The effect of computer-based tess on racial/ethnic, gender and language groups, NJ: Educational Testing Service. Georgiou, I. (2009). A graph-theoretic perspective on the links-to-concepts ratio expected in cognitive maps. European Journal of Operational Research, 197, 834 – 836. Grouws, D., Smith, M., & Sztajn, P. (2004). The preparation and teaching practice of U.S. mathematics teachers: Grades 4 and 8. In P. Kloosterman & F. Lester (Eds.). The 1990 through 2000 mathematics assessments of the national assessment of educational progress: Results and interpretations (pp.221-269). Reston, VA: NCTM. Han, J., Kamber, M. (2000). Data mining: concepts and techniques. Academic Press, Orlando, FL. Hao, J. X., Kwok R. C. W., Lau, R. Y. K., & Yu, A. Y. (2010). Predicting problem-solving performance with concept maps : An information-theoretic approach, Decision Support Systems, 48, 613 – 621. Hasemann, K., & Mansfield, H. (1995). Concept mapping in research on mathematical knowledge development: background, methods, findings and conclusions. Educational Studies in Mathematics, 29, 45-72. Hembree, R. (1990). The nature, effect, and relief of mathematics anxiety. Journal for Research in Mathematics Education, 21(1), 33-46. Huerta, M. P. (1995). Using concept maps to analyze students' relationships between quadrilaterals. Proceedings of the 19th International Conference for the Psychology of the Mathematics Education, 1, 242 , Recife, Brazil. Huerta, M. P., Galan, E., & Granell, R. (2010). Concept maps in mathematics education : a possible framework for student ’ assessment. Journal of Research in Science Teaching, 31(1), 91-101. Joshua S. R., Jennifer W., Keith W. T., & Thomas D. G. (2012).Concept mapping improves metacomprehension accuracy among 7th graders, Learning and Instruction, 22, 262-270. Khalifa, M., & Kwok, R. C. W. (1999). Remote learning technologies: effectiveness of hypertext and GSS, Decision Support Systems, 26 (3), 195-207. Kwok, R. C. W., Ma, J., & Vogel, D. (2002). Effects of group support systems and content facilitation on knowledge acquisition. Journal of Management Information Systems, 19 (3), 185-229. Kuhn, T. S. (1962). The Structure of Scientific. The University of Chicago Press, Chicago. Illinois. U.S.A. Lloyd, G. M. (2008). Curriculum use while learning to teach: One student teacher ’ s appropriation of mathematics curriculum materials. Journal for Research in Mathematics Education,39(1), 63-94. Massaro, D. W., & Cowan, N. (1993). Information processing models: Microscopes of the mind. Annual Review of Psychology, 44, 383-425. McClure, J., Sonak, B., Suen, H. (1999). Concept map assessment of classroom learning: reliability, validity and logistical practicality, Journal of Research in Science Teaching, 36, 475 – 492. Merrill, M. D. (1987). The New Component Design Theory: Instructional design for courseware authoring. Instructional Science, 16, 19-24. Mullis, I. V. S., Martin, M. O., Gonzalez, E. J., & Chrostowski, S. J. (2004). TIMSS 2003 International Mathematics Report: Findings from IEA ’ s Trends in International Mathematics and Science Study at the Fourth and Eighth Grades. Chestnut Hill, MA: Boston College. Newell, A., & Simon, H. (1972). Human problem solving, Prentice Hall, Englewood Cliffs, NY. Nicol, C. C., & Crespo, S. M. (2006). Learning to teach with mathematics textbooks : how preservice teachers interpret and use curriculum materials. Educational Studies in Mathematics, 62(3), 331-355. Novak, J. D. (1998). Learning, creating, and using knowledge: concept maps as facilitative tools in schools and corporations. Mahwah, NJ: Lawrence Erlbaum Associates. Novak, J. D., & Canas, A. J. (2008). The theory underlying concept maps and how to construct and use them. Florida Institute for Human and Machine Cognition, Technical report IHMC CmapTools 2006-01 Rev 01-2008. OECD (2002). Programme for International Student Assessment. Orpwood, G. & Garden, R. A. (1998). Assessing Mathematics and Science Literacy (TIMSS monograph No.4). Vancouver: Pacific Educational Press. Piaget, J., Inhelder, B. & Szeminska, A. (1960). The Child ’ s Concept of Geometry. New York: Basic Book. PISA (2003). www.pisa.oecd.org. Postrel, S. (2002). Islands of shared knowledge: specialization and mutual understanding in problem-solving teams, Organization Science, 13(3), 303-320. Quillian, M. R.(1968). Semantic memory, in: M. Minsky (Ed.), Semantic Information Processing, MIT Press, Cambridge, MA. Raymond, A. (1997). The use of concept mapping in qualitative research: a multiple case study in mathematics education. Focus on Learning Problems in Mathematics, 19(3), 1-28. Reigeluth, C. M., Merrill, M. D. & Bunderson, C. V. (1978). The structure of subject matter content and its instructional design implications. Instructional Science, 7(2), 107-126. Remillard, J. (2005). Examining key concepts in research on teachers ’ use of mathematics curricular. Review of Educational Research, 75(2), 211-246. Ruiz-Primo, M., & Shavelson, R. J. (1996). Problems and issues in the use of concept maps in science assessment. Journal of Research in Science Teaching, 33 (6), 569-600. Ruiz-Primo, M., Shavelson, R. J., Li, M., & Shchultz, S. E. (2001). On the validity of cognitive interpretations of scores from alternative concept-mapping techniques. Educational Assessment , 7(2), 99-141. Rumelhart, D. E., & McClelland, J. L. (Eds.). (1986). Parallel distributed processing: Explorations in the microstructure of cognition. Cambridge, Ma: MIT Press. Shannon, C. E. (1948). A mathematical theory of communication. Bell System Technical Journal, 27, 379-423 & 623-656, July & October, 1948. Shavelson, R. J. (1987). Teachers ’ judgments. In M.J. Dunkin (Ed.), The international encyclopedia of teaching and teacher education (pp. 486-490). New York: Pergamon. Shavelson, R. J., & Ruiz-Primo, M. A. (2000). On the psychometrics of assessing science understanding, in: J.J. Mintzes, J. Wandersee, J.D. Novak (Eds.), Assessing Science Understanding, Academic Press, San Diego, pp. 304-341. Solso, R. L. (2001). Cognitive Psychology (6th ed.).

Boston: Allyn & Bacon. Stein, M. K., Remillard, J., & Smith, M. S. (2007). How curriculum influences student learning. In F. K. Lester, Jr. (Ed.), Second handbook of research on mathematics teaching and learning (pp. 319-369). Charlotte, NC: Information Age. Tarr, J. E., Reys, R. E., Reys, B. J., Chavez, O., Shih, J., & Osterlind, S. J. (2008). The impact of middle-grades mathematics curricula and the classroom learning environment on student achievement. Journal for Research in Mathematics Education, 39(3),247-280. Thornson, S., Cresswell, J., & De Bortoli, L. (2004). Facing the Future: A Focus on Mathematical Literacy among Australian 15-year-old in PISA 2003. www.pisa.oecd.org. Venezky R. L. (1992):Textbooks in school and society，in Jackson Philip W. (eds)《Handbook of research on curriculum》，New York，Macmillan Publishing Company，436-461。Williams, C. (1998). Using concept maps to assess conceptual knowledge of function. Journal for Research in Mathematics Education, 29(4), 414-421. Yin, Y., Vanides, J., Ruiz-Primo, M. A., Ayala, C. C., Shavelson, R. J. (2005). Comparison of two concept-mapping techniques: implications for scoring, interpretation, and use. Journal of Research in Science Teaching, 42(2), 166-148.