Bibliography

Alexander, P. A., & Murphy, P. K. (1999). Nurturing the seeds of transfer: a domain-specifc perspective. *International Journal of Educational Research, 31*(7), 561-576.

Alexander, P. A., Schallert, D. L., & Hare, V. C. (1991). Coming to terms: How reasearchers in learning and literacy talk about knowledge. *Review of Educational Research, 61*(3), 315-343.

Ankiewicz, P., De Swart, E., & De Vries, M. J. (2006). Some implications of the philosophy of technology for science, technology and society (STS) studies. *International Journal of Technology and Design Education, 16*(2), 117-141.

Ary, D., Jacobs, L. C., & Razavieh, A. (2002). *Introduction to research in education*. Belmont: Wadsworth/Thomson learning.

Au, K. H. (1998). Social constructivism and the school literacy learning of students of diverse backgrounds. *Journal of Literacy Research, 30*(2), 297–319.

Audi, R. (2003). *Epistemology. A contemporary introduction to the theory of knowledge* (2 ed.). New York: Routledge.

Barlex, D. (1998). Design and technology – the Nuffield perspective in England and Wales. *International Journal of Technology and Design Education, 8*(2), 139–150.

Barlex, D. (2000). Perspectives on departmental organisation and children's learning through the Nuffield design and technology project. In J. Eggleston (Ed.), *Teaching and learning design and technology* (pp. 91-103). London: Continuum.

Barron, B. J. S., Schwartz, D. L., Vye, N. J., Moore, A., Petrosino, A., Zech, L., et al. (1998). Doing with understanding: Lessons from research on problem- and project-based learning. *The Journal of the Learning Sciences, 7*(3 & 4), 271-311.

Bayazit, N. (1993). Designing: Design knowledge: Design research: Related sciences. In M. J. De Vries, N. Cross & D. P. Grant (Eds.), *Design methodology and relationships with science* (pp. 121-136). Dordrecht: Kluwer.

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating project-based learning: Sustaining the doing, Supporting the learning. *Educational Psychologist, 26*(3 & 4), 369-398.

Bredo, E. (1994). Reconstructing educational psychology: Situated cognition an Deweyian pragmatism. *Educational Psychologist, 29*(1), 23-35.

Broens, R. C. J., & De Vries, M. J. (2003). Classifying technological knowledge for presentation to mechanical engineering designers. *Design Studies, 24*(5), 457-471.

Bzdak, D. (2008). On amnesia and knowing-how. *Techné: Research in Philosophy and Technology, 12*(1), 36-46.

Cohen, L., Manion, L., & Morrison, K. (2001). *Research methods in education.* London: Routledge Falmer.

Compton, V. (2004). *Technological knowledge: A developing framework for technology education in New Zealand* (Briefing paper prepared for the New Zealand Ministry of Education Curriculum Project).

Cooper, P. A. (1993). Paradigm shifts in designed instruction: From behaviorism to cognitivism to constructivism. *Educational Technology, 33*(2), 12-18.

Creswell, J. W. (2003). *Research design: qualitative, quantitative and mixed methods approaches*. California: Sage Publications.

Creswell, J. W. (2005). *Educational research: Planning, conducting and evaluating quantitative and qualitative research*. New Jersey: Pearson Prentice Hall.

Cross, N. (2002). The nature and nurture of design ability. In G. Owen-Jackson (Ed.), *Teaching design and technology in secondary schools: A reader* (pp. 124–139). London: Routledge Farmer.

De Corte, E. (1999). On the road to transfer: An introduction. *International Journal of Educational Research, 31*(7), 555-559.

De Vries, M. J. (1996). Technology education: Beyond the "technology is applied science" paradigm. *Journal of Technology Education, 8*(1), 7-15.

De Vries, M. J. (2003). The nature of technological knowledge: Extending empirically informed studies into what engineers know. *Techné: Research in Philosophy and Technology, 6*(3), 1-21.

De Vries, M. J. (2005a). The nature of technological knowledge: Philosophical reflections and educational consequences. *International Journal of Technology and Design Education, 15*(2), 149-154.

De Vries, M. J. (2005b). *Teaching about technology: An introduction to the philosophy of technology for non-philosophers*. Dordrecht: Springer.

De Vries, M. J., & Tamir, A. (1997). Shaping concepts of technology: What concepts and how to shape them. *International Journal of Technology and Design Education, 7*(1-2), 3-10.

Department of Education. (2002). *Revised National Curriculum Statement for Grades R-9 (Schools) for Technology*. Pretoria.

Department of Education. (2003). *Revised National Curriculum Statement Grades R-9 (Schools): Teacher's guide for the development of learning programmes - Technology*. Pretoria.

Dillenbourg, P. (1999). What do you mean by 'collaborative learning'? In P. Dillenbourg (Ed.), *Collaborative-learning: Cognitive and computational approaches* (pp. 1-19). Oxford: Elsevier.

Eisner, E. W. (1998). *The enlightened eye: Qualitative inquiry and the enhancement of educational practice*. Upper Saddle River, NJ: Merrill/Prentice-Hall.

Faulkner, W. (1994). Conceptualizing knowledge used in innovation: A second look at the science-technology distinction and industrial innovation. *Science, Technology, & Human Values, 19*(4), 425-458.

Ferguson, E. S. (1992). *Engineering and the mind's eye*. Cambridge: The MIT Press.

Frey, R. E. (1991). Another look at technology and science. *Journal of Technology Education, 3*(1), 1-12.

Gergen, K. J. (1985). The social constructionist movement in modern psychology. *American Psychologist, 40*(3), 266-275.

Gerring, J. (2004). What is a case study and what is it good for? *American Political Science Review, 98*(2), 341-354.

Gibson, K. (2008). Technology and technological knowledge: A challenge for school curricula. *Teachers and Teaching: Theory and Practice, 14*(1), 3-15.

Glaser, R. (1999). Expert knowledge and processes of thinking. In R. McCormick & C. Paechter (Eds.), *Learning & knowledge* (pp. 88-102). London: Paul Chapman.

Grob, B. (1986). *Direct and alternating current circuits*. New York: McGraw-Hill.

Harper, D. (2001a). Logos. *Online Etymological dictionary* Retrieved 15 October, 2008, from http://www.etymonline.com/index.php?term=logos

Harper, D. (2001b). Techno. *Online Etymological dictionary* Retrieved 15 October, 2008, from http://www.etymonline.com/index.php?term=techno-

Harper, D. (2001c). Technology. *Online Etymological dictionary* Retrieved 15 October, 2008, from http://www.etymonline.com/index.php?term=technology

Hatano, G., & Greeno, J. G. (1999). Commentary: Alternative perspectives on transfer and transfer studies. *International Journal of Educational Research, 31*(7), 645-654.

Herschbach, D. R. (1995). Technology as knowledge: Implications for instruction. *Journal of Technology Education, 7*(1), 31-42.

Hitt, M. A., Ireland, R. D., & Lee, H. (2000). Technological learning, knowledge management, firm growth and performance: An introductory essay. *Journal of Engineering and Technology Management, 17*, 231-246.

Ihde, D. (1997). The structure of technology knowledge. *International Journal of Technology and Design Education, 7*, 73-79.

Jackson, S. L. (2006). *Research methods and statistics: A critical thinking approach*. Singapore: Thomson Wadsworth.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33*(7), 14-26.

Jones, A. (2003). The development of a national curriculum in technology for New Zealand. *International Journal of Technology and Design Education, 13*(1), 83–99.

Layton, E. T. (1971). Mirror-image twins: The communities of science and technology in 19th-century America. *Technology and Culture, 12*(4), 562-580.

Layton, E. T. (1974). Technology as knowledge. *Technology and Culture, 15*(1), 31-41.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage.

Matthews, R. S. (1995). Collaborative learning: Creating knowledge with students. In R. H. Menges, M. Weimer & Associates (Eds.), *Teaching on solid ground: Using scholarship to improve practice*. San Francisco: Jossey-Bass.

Mawson, B. (2007). Factors affecting learning in technology in the early years at school. *International Journal of Technology and Design Education, 17*(3), 253-269.

McCormick, R. (1999). Practical knowledge: A view from the snooker table. In R. McCormick & C. Paechter (Eds.), *Learning and knowledge* (pp. 112-135). London: Paul Chapman.

McCormick, R. (2004). Issues of learning and knowledge in technology education. *International Journal of Technology and Design Education, 14*(1), 21-44.

McCormick, R. (2006). Technology and knowledge: Contributions from learning theories. In J. R. Dakers (Ed.), *Defining technological literacy: Towards an epistemological framework.* (pp. 31-47). New York: Palgrave Macmillan.

Mehan, H. (1981). Social constructivism in psychology and sociology. *The Quarterly Newsletter of the Laboratory of Comparative Human Cognition, 3*(4), 71–77.

Mitcham, C. (1994). *Thinking through technology.* Chicago: The University of Chicago Press.

Neuendorf, K. A. (2002). *The content analysis guidebook*. London: Sage.

Neuman, W. L. (2006). *Social research methods: Qualitative and quantitative approaches.* Boston: Pearson.

Olsen, R., & Kagan, S. (1992). About cooperative learning. In C. Kessler (Ed.), *Cooperative language learning: A teacher's resource book* (pp. 1-30). Englewood Cliffs, NJ: Prentice Hall Regents.

Pavlova, M. (2005). Knowledge and values in technology education. *International Journal of Technology and Design Education, 15*(2), 127–147.

Potgieter, C. (2004). The impact of the implementation of technology education on in-service teacher education in South Africa (impact of technology education in the RSA). *International Journal of Technology and Design Education, 14*(3), 205-218.

Press, M., & Cooper, R. (2003). *The design experience: The role of design and designers in the twenty-first century*. Aldershot: Ashgate.

Ropohl, G. (1997). Knowledge types in technology. *International Journal of Technology and Design Education, 7*(1-2), 65-72.

Rowell, P. M., Gustafson, B. J., & Guilbert, S. M. (1999). Characterization of technology within an elementary science program. *International Journal of Technology and Design Education, 9*(1), 37–55.

Ryle, G. (1960). *The concept of mind*. London: Hutchinson

Savin-Baden, M. (2003). *Facilitating problem-based learning*. Berkshire: Society for Research into Higher Education & Open University Press.

Savin-Baden, M., & Major, C. H. (2004). *Foundations of problem-based learning*. Berkshire: Society for Research into Higher Education & Open University press.

Scheffler, I. (1999). Epistemology and education. In R. McCormick & C. Paechter (Eds.), *Learning & knowledge* (pp. 1-5). London: Paul Chapman.

Simons, P. R. J. (1999). Transfer of learning: Paradoxes for learners. *International Journal of Educational Research, 31*(7), 577-589.

Slabbert, J. A., & Hattingh, A. (2006). 'Where is the post-modern truth we have lost in reductionist knowledge?' A curriculum's epitaph. *Curriculum Studies, 38*(6), 701-718.

Stark, R., Mandl, H., Gruber, H., & Renkl, A. (1999). Instructional means to overcome transfer problems in the domain of economics: Empirical studies. *International Journal of Educational Research, 31*(7), 591-609.

Stevenson, J. (2004). Developing technological knowledge. *International Journal of Technology and Design Education, 14*, 5–19.

Tulloch, S. (Ed.) (1995) The Oxford dictionary and thesaurus. Oxford: Oxford University Press.

Van Niekerk, E., Ankiewicz, P., & De Swart, E. (forthcoming). A process-based assessment framework for technology education: A case study. *International Journal of Technology and Design Education* Retrieved 12 March, 2008, from http://www.springerlink.com/content/bu7xl38637xl5282/fulltext.pdf

Van Putten, S. (2008). *Levels of thought in geometry of pre-service mathematics educators according to the Van Hiele model.* Unpublished MEd-dissertation, University of Pretoria, Pretoria.

Vincenti, W. G. (1990). *What engineers know and how they know it*. Baltimore/London: Johns Hopkins University Press.

Volet, S. (1999). Learning across cultures: Appropriateness of knowledge transfer. *International Journal of Educational Research, 31*(7), 625-643.

Questionnaire

Section A: Sources of technological knowledge

INDICATE YOUR ANSWER WITH AN **X** IN THE APPROPRIATE BLOCK.

1. To what extent did you make use of knowledge from theoretical science (e.g. transfer knowledge from science, reformulate or adapt) in the design and making of your artefact?

Transfer from science	Not at all	To a limited extent	To a fairly large extent	Extensively

An example of the kind of knowledge I transferred from theoretical science to *design* and *make* my artefact was …

2. To what extent did you discover (and use) "new" knowledge (e.g. operating principles) during the invention (designing and making process) of your artefact?

Invention	Not at all	To a limited extent	To a fairly large extent	Extensively

Concepts, such as the operating principles or best design/shape that best embody the operational principle, contrived (or come upon coincidentally), due to my invention include …

3. To what extent did you make use of theoretical research to acquire the necessary knowledge which enabled you to design and make your artefact?

Theoretical research	Not at all	To a limited extent	To a fairly large extent	Extensively

3.1 The main sources I used to do my theoretical research include (e.g. *Internet*, textbooks) …

3.2 The knowledge I produced via theoretical activity (research) is, for example …

4. To what extent did you make use of experimental research (e.g. testing of various products and materials), to acquire the necessary knowledge which enabled you to design and make your artefact?

Experimental research	Not at all	To a limited extent	To a fairly large extent	Extensively

4.1 I performed my experimental (evaluating/testing) research by means of (e.g. test facilities,

experimental techniques, measuring devices) …

4.2 The knowledge I gained through experimental research is, for example …

5. To what extent did you make use of knowledge from design practice (e.g. design process, design aspects, etc.)?

Design practice	Not at all	To a limited extent	To a fairly large extent	Extensively

Design practice reveals problems that call for research in order to solve these problems. An example of knowledge acquired in this way is …

6. The making (production) of your artefact can result in practical considerations which were not comprehended during theoretical research, design, etc. (e.g. material is too thin and too large, which can lead to cracking). To what extent did you make use of such practically discovered knowledge?

Production	Not at all	To a limited extent	To a fairly large extent	Extensively

Practical knowledge I gained during the production (making) of my artefact includes …

7. A *proof test* can be performed to determine whether a device (artefact) performs as intended. To what extent did you evaluate (test) your artefact in order to determine whether it does what it was designed to do?

Direct trial	Not at all	To a limited extent	To a fairly large extent	Extensively

7.1 During this direct trial I discovered that …

7.2 To what extent did you use the knowledge acquired about the artefact's shortcomings during the direct trail to improve the design or at least make suggestions to improve the design?

Direct trial	Not at all	To a limited extent	To a fairly large extent	Extensively

Section B: Categories of technological knowledge

1. Fundamental design concepts are part of a technologist's knowledge and have to be learned deliberately to form part of a technologist's essential knowledge. This knowledge includes:
   - operating principles of artefacts (i.e. how does it work); and
   - the general shape and arrangement of the artefact that are commonly agreed to best embody the operational principle.

In designing and making your artefact, indicate the extent to which you drew knowledge from fundamental concepts.

Fundamental design concepts	**Not at all**	**To a limited extent**	**To a fairly large extent**	**Extensively**

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2. To design a device, a designer must have specific requirements (e.g. a customer's needs and wants) in terms of the device. These qualitative (non-technical requirements/needs) goals/data from the customer must be translated to quantitative goals/data (concrete technical terms).

In designing and making your artefact, indicate the extent to which you:
- made use of criteria and specifications (such as the customer's needs and wants); and
- translated these qualitative criteria and specifications into technical terms.

Criteria and specifications	**Not at all**	**To a limited extent**	**To a fairly large extent**	**Extensively**

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3. Technologists make use of a wide range of theoretical tools to accomplish their design task. These include:
   - mathematical methods and theories for making design calculations - mathematical methods and theories may vary from elementary formulas for simple calculations to complex calculative schemes; and
   - intellectual concepts for thinking about design - intellectual concepts provide the language for articulating the thought in people's minds.

In designing and making your artefact, indicate the extent to which you made use of theoretical tools.

Theoretical tools	**Not at all**	**To a limited extent**	**To a fairly large extent**	**Extensively**

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4. Mathematical tools will be of little value without data for the physical properties or other quantities required in the formulas. Two types of knowledge/data can be distinguished, namely descriptive and prescriptive knowledge.

   Descriptive data includes data such as physical constants, properties of substances, strength of materials, etc. (i.e. how things are).

4.1 In designing and making your artefact, indicate the extent to which you made use of descriptive knowledge.

Quantitative data: *descriptive knowledge (how things are)*	**Not at all**	**To a limited extent**	**To a fairly large extent**	**Extensively**

Prescriptive knowledge, on the other hand, is knowledge of how things should be to in order to obtain the desired result (e.g. data or process specifications that manufacturers issue for guidance to assist designers and other workers).

4.2 In designing and making your artefact, indicate the extent to which you made use of prescriptive knowledge.

Quantitative data: prescriptive knowledge (how things should be)	**Not at all**	**To a limited extent**	**To a fairly large extent**	**Extensively**

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5. Some knowledge can be learned mostly in practice (e.g. learning from accidents, experience in practice, tricks of the trade) rather than through training or textbooks.

In designing and making your artefact, indicate the extent to which you made use of knowledge derived from practical experience.

Practical considerations	**Not at all**	**To a limited extent**	**To a fairly large extent**	**Extensively**

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6. In order to carry out a given task, you need to "know how" to carry out the task (e.g. follow the design process). The instrumentalities of the process include the procedures, ways of thinking and judgmental skills by which it is done.

In designing and making your artefact, indicate the extent to which you made use of this "know how" or procedural knowledge.

Design instrumentalities	**Not at all**	**To a limited extent**	**To a fairly large extent**	**Extensively**

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7. To what extent did you consider the interrelationship that exists between technical objects (e.g. your artefact), the natural environment (e.g. learning outcome 3: impact of technology) and social practice (e.g. learning outcome 3: biases created by technology) during the design and making process of your artefact?

Socio-technological understanding	**Not at all**	**To a limited extent**	**To a fairly large extent**	**Extensively**

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8. To what extent did you make use of knowledge acquired from other members in your group (if you were in a group)?

Collaborative design knowledge	**Not at all**	**To a limited extent**	**To a fairly large extent**	**Extensively**
