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TOWARDS REFLECTION IN TEACHER EDUCATION

What Counts as Evidence?

by

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Currently there are increasing demands that teachers and other professionals become more reflective of both their practice and what it is that informs such practice. While such exhortations are many, there have been few studies of practical strategies to facilitate such reflection and even fewer investigations of the impact of various strategies upon the development of reflective practices. More important, there appears to be little, if any, evidence from the published literature that assisting professional workers to become reflective necessarily makes their practice more effective.

This paper, after briefly reviewing some of the literature dealing with the definition and nature of reflection discusses some issues related to the question of 'What constitutes evidence of reflection?'. This question and the issues discussed have arisen within the context of a research programme being undertaken by the authors at the University of Sydney. The research programme is being supported by a Small Grant from the Australian Research Council. The research is an evaluation of the impact of strategies being used to promote reflective student teachers in a Bachelor of Education (Secondary) degree in the Faculty of Education (Smith, 1991 (a), (b)).

On the definition and nature of reflection

While the concept of reflection in education is not new and much of the writing about reflection employs the work of Dewey (1933) as a reference point (eg., Adler, 1991, 1990; Calderhead, 1989; Gilson, 1989; Farrah, 1988), the problematic nature of the concept and its definition, raised within Dewey's writing has not been resolved. An analysis of the literature reveals a plethora of words associated with the concept of reflection, each of which, as Adler (1990, 1991) suggests is embedded in, and reflects a different discourse. A full analysis of these terms has been undertaken elsewhere (Smith and Hatton, 1992) and will not be repeated

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here.
The most important point, however, for the issues of this paper, is that whatever answers are dervied for the question 'What constitutes evidence for reflection?' are inherently linked to the definition of reflection employed in any research and the assumptions on which the definition is based. Thus, if one employs a Deweyian notion of reflection evidence would be based upon some form of searching/inquiring to resolve some state of doubt or perplexity (Farrah, 1988). In addition such searching would be confined to thinking and the thinking would be of a structural, logical and sequential nature (Farrah, 1988). Thus, if a researcher was to employ such a definition of reflection not only is the nature of evidence already construed by the definition but so is the nature of the task or problem by which the evidence is gathered.
The thinking and problem-centred view of reflection as characterised by Dewey and supported by others (eg., Wildman, et al, 1990; Calderhead, 1989; Cutler, Cook and Young, 1989; Gilson, 1989) may be contrasted, for example, with a view of reflectgion that emphasises either the framing and reframing of beliefs and perceptions to generate alternative ways of viewing a situation or experience (Noordhoff and Kleinfeld, 1988; Boud, Keogh and Walker, 1985) or one that suggests that reflection may consist of more than thinking and constitute thinking only as part of wider reflective action (Noffke and Brennan, 1988; Grant and Zeichner, 1984).
As Zeichner and Liston (1990) have argued any concept or definition of reflection is embedded in a particular ideology and epistemology. These can then be said to form a theoretical framework in which any research program and its activities are embedded. Thus, each phase of the research, from the manner in which research questions and hypotheses are framed, through the manner in which data gathering and analysis techniques are established, to the decisions regarding what constitutes evidence and the conclusions drawn, will all be rramed and directed by the definition of 'reflection' employed. A further complicating factor in the definition of the concept is the type or nature of reflection being researched.
Various authors and researchers have identified different levels of reflection (Ross, 1990; 1989) and different forms or types of reflection. Principal among the latter is Schon's work (1983, 1987) raising the time dimension for reflection and arguing for the basis of professional practice to be in knowing-, and knowledge-in-action rather than knowledge which

derives from reflection-on-action. Again, if research is based in Schon's concept of reflection-in-action the contexts in which data is gathered and the types of data gathered will be very different to research which sees reflection as something that occurs after the action has taken place.
A further important distinction is that related to the focus of the relfection, the nature of the material that forms the reluctance of the reflection, and the purpose intended by those establishing the contexts in which the reflection takes place. These issues are central to questions of the concepts of 'technical' reflection, 'hermeneutic' and 'critical' reflection which have been discussed at length elsewhere (eg., Smith and Hatton, 1992; Smith and Lovat, 1991; Gore and Zeichner, 1991; Adler, 1990;

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Noffke and Brennan, 1988; Gore, 1987; Van Manen, 1977), and will not be didscussed in detail here. Suffice it to say, that again, what constitutes evidence of reflection may be heavily influenced by the types of reflection that are established by researchers within their broader definition of the concept of reflection itself.

While many of the issues raised above may appear self evident, their importance becomes very significant when one begins a research programme whose purpose is to identify evidence of reflection. Indeed, what may have appeared to be difficult theoretical issues in the discourse about reflection before the research began, become much more complex and significant when decisions about actual data are being made. These comeplexities have certainly arisen in the research program currently underway by the two authors. The remainder of the paper takes up several of the more pertinent issues.

The Study

Five broad approaches to stimulate reflection in professionals either in training and/or in service have been identified (Smith and Hatton, 1992). These include:

- action research (Gore and Zeichner, 1991; Smith and Lovat, 1991; Sparks-Langer and Colton, 1991; Ross, 1989; Noffke and Brennan, 1988; Kemmis and McTaggart, 1988);
- case studies of students, teachers, classrooms and schools (Sparks, 1991; Ross, 1989; Zeichner, 1986);
- field experiences and practicums (Sparks-Langer and Colton, 1991; Zeichner, 1968);
- microteaching (Cruickshank, 1985); and,
- tasks, including the development of curriculum units and their implementation (Smith, 1991 (a), (b); Zeichner, 1986; Beyer, 1984; Ben Peretz, 1984).

Since 1985, in the 'Teaching and Learning' component of the third and fourth years of the Bachelor of Education (Secondary) degree at the University of Sydney a number of strategies have been employed in an attempt to facilitate reflection in student teachers. These strategies include, in the third year, microteaching linked to practicum experience with several written tasks designed to elicit reflection concerning the development of the students ion a range of teaching skills that are the basis of the microteaching. In the fourth year the student teachers engage in a continuing reflective process focused around the planning, developmen t and implementation of a unit of work for one class and in one teaching area and the ractors, perceptions and beliefs information this. This process involves interviewing in critical friend dyads anmd associated written reports. The tasks have been described in detail elsewhere (eg., Smith 1991 (a), (b); Smith and Lovat, 1991).

The research programme currently underway seeks to evaluate the effectiveness of the strategies outoined above in facilitating reflection in the student teachers. The data for the project comes from the cohort of 45 students currently in y ear four. Data sources are varied exploring different forms, and ways of gathering evidence of reflection and providing the potential for triangulation of evidence (Smith and Hope, 1992). The data comprise:

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- two written reports by each student (6000 words in total);
- two self evaluation forms, one after year three practicum and one after year four practicum;
- two 20 minute videos of teaching, one during third year practicum and one during fourth year practicum of thirteen volunteer 'case study' students; and
- a 20 minute interview with each student teacher undertaken by the research assistant at the end of year comprising questions asking for student evaluation of the strategies, as well as a vignette of a practicum context in which the student teacher is asked to identify and comment upon the issues involved.

Initially, a literature review of some seventy books, articles and papers from U.S.A., U.K., Europe, N.Z. and Australia was undertaken. This review was used as the basis for the development of a set of criteria to be used to evaluate the impact of the strategies used. It was during the process of establishing these criteria and the application of the criteria to the first set of written reports that the issues discussed below were raised.

While it might be supposed that the logical step in establishing a set of strategies to facilitate relfection should be the initial identification of a clear definition of reflection and the criteria to underpin this, it does not necessarily follow that this occurs. Indeed, a number of problems have been recognised associated with the development of reflection in teacher education. These include; reflection not normally being associated with teaching (Elbiaz, 1988) and therefore alienating and useless to teachers and student teachers (Zeichner, 1990); a lack of time (Noffke and Brennan, 1988) to develop the metacognitive skills necessary (McNamara, 1990); feelings of vulnerability by student teachers and therefore reluctance to engage in reflective activity (Wildman and Niles, 1987); and, very importantly, the fact that traditional ideologies of teacher education programs do not provide conditions or attitudes conducive to effective reflection (Zeichner, 1990; Calderhead, 1989).

What should be remembered is that the strategies employed at the University of Sydney began in 1985, well before much of the now available literature was written. With the benefit of this literature and the experience of the research, significant changes in the strategies employed have already been planned for introduction in 1993.

What constitutes evidence of reflection?

The issues discussed below began to emerge as the research team struggled to identify the framework and the criteria to be used in analysing the data and then beginning to apply these. Many of the questions arose when the applied criteria failed to produce much evidence of reflection, even though the intuition of the researchers suggested that reflections was evident in both students practicum work and in-class discussion. The intention in the remainder of the paper is not to provide an excuse for the failure of the strategies being employed; indeed this may well be the finding after all the data have been analysed. Rather it is to raise issues that seem to us to be pertinent to any programme of research dealing with reflection.

The research began, not by applying an a priori set of criteria but by

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beginning to read the written report data, and with the review of literature as a framework, attempting to identify the types of writing and reflective writing in the data. This approach, we believe illustrates the essential dynamic relationship between data and theory that is characteristic of research of this nature.

This process resulted in the identification of four types of writing, three of which were characterised as different types, but not necessarily hierarchical levels, of reflection. The criteria for each dof these types are included as Appendix 1. This is still a working document, but, at the moment, identifies four types of writing, namely, descriptive, descriptive reflection, dialogic reflection, and critical reflection. Many of the criteria identified for each of these types are similar to those identified in other literature (eg., Gore and Zeichner, 1991; Adler, 1990; Ross, 1990,. 1989; Kemmis and McTaggart, 1988). It was in the application of these to the data, however, that much more fundamental matters concerning the nature of the evidence for reflection arose. Principally these matters refer to the nature of written evidence and the possibility of a genre of reflection that is underpinned by specific metacognitive skills.

While as outlined above, the definition of reflection employed in any research programme is of paramount significance, it can be argued that, at least for a number of concepts of reflection, written data may in fact be the least appropriate form of evidence. This assertion is interesting given the emphasis upon writing as a styrategy to promote, and provide

evidence of reflection (eg., Freidus, 1991; Sparks-Langer and Colton, 1991; Andrews and Wheeler, 1990; Ross, 1990; Cutler, Cook and Young, 1989; Wedman, Mahlios and Whitefield, 1989). While it is asserted that different types of writing may be more or less effective in promoting, and providing evidence of reflection (Holly, 1989), this assertion is as yet unresearched. The current conclusion, however, of the research team at Sydney is that written evidence may not be the most effective form, and certainly is highly restricted in the types of evidence of reflection it provides.

It would seem that the most useful way of thinking about reflection within the context of professional education is in its relationship to action. Much of the rationale for reflection lies in its relation to action and in its potential to improve professional practice (Smith and Lovat, 1991; Smyth, 1989; Boud, Keogh and Walker, 1985). If Schon's (1983) framework for the relationship of reflection and action is accepted there are two broad time frames for reflection. The first of these is reflection-on, or after, -action. This is a meaning of reflection that is commonly accepted in the literature (eg., Buchmann, 1990; Pugach, 1990; Hewson et al, 1989; Boud, Keogh and Walker, 1984). Using this concept of reflection, there are particular forms of written evidence that may be appropriate, although these are still problematic, as will be discussed below. More important, however, is the second concept of reflection that occurs while action is occurring, which Schon (1983) argues, is the type of reflection that should characterise professional practice. Unless the written evidence is gathered and considered during the time of the action while the reflection

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is occurring, then written forms can only provide evidence of the remembered reflection that transpired during the action reconstructed after the action has taken place; by definition, reflection-on-action. More appropriate evidence of reflection-in-action may be that which is collected in observation of action or in some form of dialogue between the researcher and the actor at the time at which the action is taking place. Thus it can be argued that the usual written forms can only provide evidence of reflection-on-action.

A second issue is that written forms, by definition, can constgitute only evidence of thinking and only inferred evidence at that. It has already been suggested that reflective activity may well constitute more than thinking. It is not easy to conceive of the criteria which might constitute evidence of such activity, however, such criteria must, by definition include more than written forms.

If the arguments above are accepted, then written forms are limited in terms of the types of reflection for which they can constitute evidence. Given this, there are still further issues of the degree to which various written forms can constitute evidence of reflection-on-action. Some of these are related to the nature of the task set that produces the written forms.

Journal writing is commonly used to attempt to facilitate reflection (eg., Holly, 1989). Such writing is by its definition and structure reflective-on-action and is more likely to exhibit characteristics of the genre of reflection (see below). There are still issues, however, related to the audience for the writing and the degree to which it is private or public, which also confound its usefulness as evidence for reflection.

The type of written evidence in the current project is of the style of a report in which students are asked to reflect on the process of their planning, development and implementation. Because of the nature and style of report writing much of the reflection and the mulling over of events and deliberating on the circumstances of the events undertaken by the student, either as reflection-in-action, as the processes were taking place, or as reflection-on-action, occurring immediately or soon arfter the action has happened, are portrayed in the report as a description of past events. Thus, examples of descriptive writing that originated in reflective activity are very difficult to separate from descriptive writing that did not originate from reflective activity, but which are constructed in the report in a similar fashion.

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In the first analysis of the written report data, therefore, a very large proportion of text has been identified as descriptive writing, even though

there is a feeling by the researchers when analysing the text that some of what is now constructed as descriptive writing, actually stems from events that would have constituted reflective activity if that had been captured at the time it was occurring. this matter of text construction raises the final issue to be discussed, that of the notion of a genre of reflective writing.

Probably, by virtue of the way the different types of reflective writing

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have been described, and their criteria identified, by the researchers, a particular construction of text has been mandated as necessary before certain types of reflective writing can be recognised. This is particularly the case with text that is being identified as comprising 'dialogic reflection' rather than 'descriptive reflection'. Of course, in any categorising system the criteria are established as the means to either include or exclude examples. what is being argued here, however, is that there is another artifact that is implicitly embedded in the criteria, particularly for 'dialogic reflection' that acts very powerfully in accepting or rejecting examples of text into this category.

There are a number of writers who suggest that one of the essential characteristics of reflection is the 'stepping back from', the mulling over, the exploration of, the action or the event (eg., Buchman, 1990; Gilson, 1989; Farrah, 1988; Boud, Keogh and Walker, 1985). This idea is clearly captured in the criteria for dialogic reflection (see Appendix 1), as used in the current research. what the researchers have found, howver, is that certain constructions of language are likely to produce decisions to code pieces of report text as belonging to 'dialogic reflection'. For example, constructions such as,

DAVID, SOMETHING MISSING HERE!!

almost automatically mean that the piece of text is coded as constituting dialogic reflection. What seems to be occurring is that for text to satisfy the criteria for 'dialogic reflection' it mustr nearly always be constructed in a particular form; that the criteria themselves actually suggest, maybe even impose a particular construction of text if it is to constitute evidence of reflection. Such a genre of reflective writing may be unproblematic for that text classified as evidence that has been constructed within the genre of reflective writing but which validly represents refelctive activity. what is much more problematic is whether first, writing, because it is written in a manner that conforms to the genre is being classified as reflective writing when in fact it isn't, or second, and more important, whether writing which is actually evidence of reflective activity is not being recognised within the criteria framework because it does not conform to a reflective writing genre.

In conclusion, while, as in any research, which by its nature is socially constructed and reflexive, the definitions of constructs, embedded in their own theories will influence all stages of the research and its findings, there appear to be some specific issues that need to be considered in research that aims to investigate evidence of reflective activity. Given that the research currently underway and described in this paper is still in its early stages of data analysis, it appears to the researchers that these are some broader issues related to any research into reflection. Principal of these is the question 'What constitutes evidence for reflection?' In attempting to answer this question in their own research, the researchers have suggested that:

a) difference concepts of reflection will demand very different types of evidence and data gathered in different contexts and forms;

b) for maybe the most important concepts of reflection written forms may

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not be very useful as evidence; and,
c) maybe any written forms of evidence are contaminated by a genre of reflective writing that, while in itself may be unproblematic, may serve to disguise evidence of authentic reflective writing that is not constructed according to the genre, which in turn will underestimate the amount of reflection actually recognised in any set of research data.
As can be seen from its construction, this paper is exploratory and evolving, attempting to raise issues and questions rather than providing solutions. If its claims are valid, however, there are some important

implications both for developing more effective strategies to promote reflection in teacher educatioln and for those researching the evidence for such reflection. Both of these aspects require further investigation.
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BIBLIOGRAPHY

Adler, S. (1991) The Reflective Practitioner and the Curriculum of Teacher Education. Journal of Education for Teaching 17(2), 139-150
Adler, S. (1990). 'The Reflective Practitioner and the Curriculum of Teacher Education'. Paper presented at the Annual Meeting of the Association of Teacher Educators, Las Vegas, February.
Andrews, S. & Wheeler, P. (1990). 'Tracing the Effects of Reflective Classroom Practice'. Paper presented at the Annual Meeting of the National Reading Conference, Florida, November.
Ben-Peretz, M. (1984). Curriculum theory and practice in teacher education, in L. Kastz & J. Raths (eds), Advances in Teacher Education, 1. New Jersey: Ablex.
Beyer, L. (1984). Field experience, ideology, and the development of critical reflectivity. Journal of Teacher Education, 35(3), 36-41.
Boud, D., Keogh, M., and Walker, D. (1985). Reflection: Turning Experience into Learning. London: Kogan Page
Buchmann, M. (1990). Beyond the Lonely, Choosing Will: Professional Development in Teacher Thinking. Teachers College Record, 91(4), 482-508.
Calderhead, J. (1989). Reflective Teaching and Teacher Education. Teaching and Teacher Education, 5(1), 43-51.
Clift, R., Houston, R. and Pugach, M. (eds) (1990). Encouraging Reflective Practice in Education, An Analysis of Issues and Programs. New York: Teachers College Press.
Cruickshank, D. (1985). Uses and Benefits of Reflective Teaching. Phi Delta Kappan, June, 7046.
Cutler, B., Cook, P. & Young, J. (1989). 'The Empowerment of Preservice Teachers Through Reflective Teaching'. Paper presented at the Annual Meeting of the Association of Teacher Educators, St Louis, February.
Dewey, J. (1933). How We Think: A restatement of the relation of reflective thinking to the educative process. Boston: D.C. Heath.
Elbaz, F. (1988). Critical Reflection on Teaching: insights from Freire. Journal of Education for Teaching, 14(2), 171-181.
Farrah, H. (1988). The Reflective Thought Process: John Dewey Re-Visited. Journal of Creative Behaviour, 22(1), 1-8.
Freidus, H. (1991). 'Critical Issues in the Curriculum of Teacher

Paper Presented at the Joint AARE/
NZARE Conference, Geelong, 1992
Australian Association
for Research in Education

Education Programs'. Paper presented at the Annual Meeting of the AERA, Chicago, April.
Gilson, J. (1989). Reconstructive Reflective Teaching: A Review of The Literature. ED 327 481.
Gore, J. (1987). Reflecting on Reflective Teaching. Journal of Teacher Education, March-April, 33-39.
Gore, J. & Zeichner, K. (1991). Action Research and Reflective Teaching in Preservice Teacher Education: A Case Study from the United States. Teaching and Teacher Education, 7(2), 119-136.
Grant, C. & Zeichner, K. (1984). On Becoming a Reflective Teacher in C. Grant (ed,.) Preparing for Reflective Teaching, Boston: Allyn & Bacon.
Hewson, G., Hewson, P and Jensen, N. (1989). The Role of Reflection in Professional Medical Education: A Conceptual Change Interpretation. Paper Presented at the Annual Meeting of the American Educational Research Association, San Francisco.
Holly, M. (1989). Reflective Writing and the Spirit of Inquiry. Cambridge Journal of Education, 19(1), 71-80.
Kemmis, S. and McTaggart. (1988).
McNamara, D. (1990). Research on Teachers' Thinking: its contribution to educating student teachers to think critically. Journal of Education for Teaching. 16(2), 147-160.
Noffke, S. & Brennan, M. (1988). 'The Dimensions of Reflection: A Conceptual and Contextual Analysis'. Paper presented at the Annual Meeting of the AERA, New Orleans, April 5-9.
Noordhoff, K & Kleinfeld, J. (1988). Rethinking the Rhetoric of 'Reflective Inquiry' in Teacher Education Programs, in H. Waxman et.al., (eds), Images of Reflection in Teacher Education, Virginia: ATE, 27-30.

Pugach, M. (1990). Self-Study: 'The Genesis of Reflection in Novice Teachers'. Paper presented at the Annual Meeting of the AERA, Boston, April,
Ross, D. (1989). First steps in developing a reflective approach. Journal of Teacher Education, 40, 22-30.
Ross, D. (1990). Pragrammatic Structures for the Preparation of Reflective Teachers. In R. Clift, et al (eds), op cit, 97-118.
Schon, D. (1983). The Reflective Practitioner: How Professionals Think in Action. New York: Basic Books.
Schon, D. (1987). Educating the reflective practitioner: Toward a new design for Teaching and Learning in the Professions. San Francisco: Jossey Bass.
Smith, D. (1991 (a)). Educating the Reflective Curriculum Practitioner. Education Action, 2(1), 2837.
Smith, D. (1991 (b)). Educating the Reflective Practitioner in Curriculum. Curriculum 12 (2), 115124.
Smith, D. (assisted by Hope, J.) (1992). The Health Professional as Researcher. Wentworth Falls: Social Science Press.
Smith, D. and Hatton, H. (1992). Towards Critical Reflection in Teacher Education. Paper presented to the Annual Conference of the Australian Teacher Education Association, Ballina, July.

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NZARE Conference, Geelong, 1992
Australian Association
for Research in Education

Smith, D. & Lovatt, T. (1991). Curriculum: Action on Reflection. Wentworth Falls: Social Science Press (2nd edition).
Smyth, J. (1989). Developing and Sustaining Critical Reflection in Teacher Education. Journal of Teacher Education March-April, 2-9.
Sparkes, A. (1991). The Culture of Teaching, Critical Relfection and Change: Possibilities and Problems. Educational Management and Administration, 19(1), 4-19.
Sparks-Langer, G. & Colton, A. (1991). Synthesis of Research on Teachers' Reflective Thinking. Educational Leadership, March 37-44.
Surbeck, E., Park Han, E. & Moyer, J. (1991). Assessing Reflective Responses in Journals. Educational Leadership, March, 25-27.
Van Manen, M. (1977). Linking ways of knowing with ways of being practical. Curriculum Inquiry, 6, 205-28.
Wedman, J., Mahlios, M. & Whitefield, J. (1989). Perceptual Differences Regarding the Implementation of An Inquiry-Oriented Student Teaching Curriculum. Journal of Research and Development in Education, 22(4,, 29-35.
Wildman, T. & Niles, J. (1987). Reflective Teachers: Tensions between Abstractions and Realities. Journal of Teacher Education. July-August,. 25-31.
Wildman, T., Niles, J., Magliaro, S. and McLaughlin, R. Promoting Reflective Practice among Beginning and Experienced Teachers. In R. Clift, et al (eds), op cit, 1990, 139-161.
Zeichner, K. (1986). Preparing Reflective Teachers: An Overview of Instructional Strategies which have been employed in Preservice Teacher Education. International Journal of Educational Research, II (5), 565-75.
Zeichner, K. & Liston, D. (1987). Teaching Student Teachers to Reflect. Harvard Educational Review, 57(1), 23-48.
Zeichner, K. (1990). Changing Directions in the Practicum: looking ahead to the 1990's. Journal of Education for Teaching, 16(2), 105-131.
Zeichner, K. & Liston, D. (1990). Traditions of Reform and Reflective Teaching in US Teacher Education, Michigan: National Centre for Research in Teacher Education, Michigan State University.

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