Understanding Mathematics Classrooms Through the Synthesis of Multiple Analyses of a Common Data Set

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The increasing availability of substantial sets of complex data (particularly video data) makes imperative the identification of the precepts on which such syntheses of primary and secondary analyses can be conducted. In this paper Methodologically Inclusive Research Synthesis (MIRS) perspective, as conceived by Suri (1999), is used to explore the adaptability of the axioms and procedures of naturalistic inquiry to the process of the recently-published synthesis of the analyses conducted within the Classroom Learning Project (Clarke, 2001).

There has been a growing interest in the methods of bringing together findings of individual studies with a similar focus and several approaches to research synthesis have been suggested under different names. We contend that the systematic examination of transferability of primary research techniques to the process of research synthesis can contribute towards improving the methodologies of research synthesis. "Meta-analysis" (Glass, 1976), "meta-ethnography" (Noblit & Hare, 1988), and "exploratory-case-study oriented review" (Ogawa & Mallen, 1991) are examples of earlier efforts with a similar premise that have contributed towards advancing the methodologies of research synthesis.

Methodologically Inclusive Research Synthesis (MIRS) and Classroom Learning Project (CLP)

Methodologically Inclusive Research Synthesis (MIRS) is an approach to research synthesis that is methodologically inclusive at three levels. First, it is a broad framework that accommodates different methods of research synthesis oriented along diverse methodological, epistemological and theoretical viewpoints including all the examples listed above. Second, MIRS allows for the inclusion of primary research reports positioned in diverse methodologies. Third, it exploits the applicability of techniques from a range of primary research methodologies to the process of research synthesis.

MIRS is currently being developed through a process of multiple inquiries. First, the literatures on individual methods of research synthesis and overall methodological issues in a research synthesis process have been reviewed by constantly comparing and contrasting the information. An interpretive approach has been used to create shared spaces between these methods. (Non)transferability[1] of techniques across methods was examined. Second, interpretive efforts were made to inspect the adaptability, (non)applicability and (non)transferability, of various techniques employed in different primary research traditions, especially qualitative research traditions, to a research synthesis process. Thus a draft of guidelines for informed decision making at each step of a synthesis process was developed. Third, the applicability and feasibility of these guidelines are being tested and subsequently modified by using them to conduct a synthesis on an educational research topic. Fourth, attempts are being made to conceptualise diverse forms of published

[1] Use of brackets in this paper: (non)transferability is used as an abbreviation for transferability and/or non-transferability.

syntheses within the MIRS framework. All these approaches are applied in an iterative and parallel mode to inform and refine the development of the MIRS approach.

This paper illustrates an integrated attempt at the second and fourth forms of inquiry. In this paper we argue that the synthesis of diverse analyses of the same data-set can substantially advance understanding of a complex social setting like the mathematics classroom and optimise the effectiveness of the practices we find there. Our approach to the task of synthesis draws upon the framework of Methodologically Inclusive Research Synthesis (MIRS), as conceived by Suri (1999), to illustrate the characterisation of the recently-published synthesis of the analyses conducted within the Classroom Learning Project (Clarke, 2001) as the application of the methods of naturalistic inquiry to research synthesis.

CLP data collection involves a three camera approach (Teacher camera, Student camera, Whole Class camera) that includes the onsite mixing of the Teacher and Student camera images into a split-screen video record that is then used to stimulate participant reconstructive accounts of classroom events (Clarke, 1998 and 2001). The theoretical position underpinning the CLP can be summarised in this fashion: A study of learning in classroom settings would be incomplete without the simultaneous documentation of the social and cultural practices in which the learner participated, the instructional materials, physical configuration of the classroom, and other contextual features with which the learner interacted, the teacher actions that preceded and followed the learning under investigation, and the extent to which the practices of others were reflexively related to the learner's activities and the personal consequences of those activities. A mathematics classroom takes on a different aspect according to how we are positioned within it or in relation to it. With this logic, a multi-perspective research team was recruited to conduct multiple secondary analyses resulting in a variegated picture of mathematics classrooms that challenges a research tradition seeking a convergence on the truth.

MIRS Features Relevant to CLP

This section discusses the features of MIRS framework that are relevant to the context of CLP synthesis.

(In)compatibility with Diverse Epistemological Viewpoints

The epistemological standpoint underpinning an inquiry influences "what we study" and "how we study" it. Walker and Evers (1999, p. 41) identify three controversial epistemological viewpoints prevalent in educational research scenario: "oppositional diversity thesis", "complementarity diversity thesis" and "unity thesis". The former two theses postulate epistemologically distinct paradigms that are "incommensurable". Oppositional diversity thesis holds that these paradigms are "mutually incompatible, competitive ways of researching the same territory" (Walker & Evers, 1999, p. 41). Meta-analyses that claim to be the *only* form of rigorous research synthesis hold this viewpoint. This thesis is incompatible with the methodologically inclusive ideology of the MIRS approach. However, complementarity diversity thesis regards different paradigms to be "complementary, not competitive; equally appropriate ways of approaching different, overlapping, or perhaps even the same research problems" (Walker & Evers, 1999, p. 41). Slavin's (1986) best-evidence syntheses and some meta-analyses acknowledge that meta-analysis is one form of rigorous research synthesis and meta-analytic findings can be complemented by synthesis of qualitative findings on the same topic. Such meta-analyses

subscribe to complementarity diversity thesis which is also a standpoint compatible with the MIRS perspective.

Unity thesis denies the logic of epistemologically distinct paradigms and argues in favour of "holistic scientific naturalism". This standpoint "makes ready use of the best or most coherent theories of perception and cognition" (Walker & Evers, 1999, p. 53). In this paper we illustrate that CLP is an illustration of this viewpoint. CLP employs both qualitative and quantitative techniques for analysing the same set of classroom data. The purpose of the synthesis was to summarise these findings in the most succinct and coherent form. The MIRS framework is compatible with the unity thesis and the complementarity diversity thesis, but rejects the oppositional diversity thesis.

Celebrates Informed Subjectivity

Purists can criticise the MIRS approach for being eclectic in its methodology. However, the MIRS perspective holds that it is possible to learn constructively from diverse methodologies without entering into the paradigmatic debates[2]. The MIRS approach recognises that every research synthesis method has its domain of applicability. As no one method is superior to the rest for addressing all types of synthesis questions, the MIRS approach celebrates informed methodological subjectivity in research syntheses. It encourages synthesists to explore various options they have at every critical decision point in a synthesis process and make informed choices. The MIRS approach offers guidelines in the form of various options, and their implications, available to a research synthesist at every critical decision point in a synthesis process.

Conceptualising an integrative research review as a scientific inquiry involving five stages parallel to those of a primary research study, Cooper (1982, p. 291) describes "the functions, sources of variance, and potential threats to validity associated with each stage". *The Handbook of Research Synthesis* by the editors Harris Cooper and Larry V. Hedges (1994) draws from the experience of 43 major proponents of meta-analysis to discuss in detail the issues and methodological choices, associated with each of these stages, in the context of a meta-analytic integrative review. The MIRS approach extends this discussion by identifying the methodological choices, and their implications, at various phases[3] of a research synthesis process in the context of a research synthesis framework that is more inclusive of diverse methodologies.

Guidelines Rather Than a Rigid Set of Rules

The practical constraints of time, resources and access to information impact upon the methodological choices we make in a research synthesis just as they do in a primary research study. Accordingly, the MIRS approach does not offer a rigid set of standards, or prescriptive requirements, for rigour and quality against which syntheses should be judged. It offers a set of guidelines that encourage research synthesists to reflect upon, explicitly delineate, and substantiate the choices they make at critical decisions points in a research synthesis process. The transferability of the synthesis product is enhanced by emphasising transparency of the synthesis process. The guidelines help synthesists in being wary of common sources of biases and errors. Also, they provide a framework for the readers of

[2] Seale (1999) makes a similar assertion in the context of primary research methods.

[3] We have used the term "phases" in preference to "stages" to emphasise that these phases do not always have to be discrete and sequential. They can be simultaneous, overlapping or revisited iteratively. Also they have been adapted to reflect the methodologically inclusiveness of MIRS perspective.

research syntheses to actively evaluate and adapt the information they read to their own context.

Primary Research, Secondary Analysis, and Research Synthesis

The MIRS approach argues that primary research, secondary analyses, and research syntheses often have different purposes and ask different questions. While primary researchers collect their evidence from the field and secondary analysts also work with the primary data, research synthesists build their interpretations from the evidence found in the reports of these primary (and secondary) researchers. Research synthesis products are the interpretations of researchers' interpretations of primary data as reported by them. The purposes of primary research studies, secondary research studies, and research syntheses can be complementary, where each domain informs the other, with no implicit hierarchy.

There is also a reflexive relationship between the quality of primary research, secondary analyses and research syntheses. Advancing the methodologies of primary research or secondary analyses improves the quality of evidence used in research syntheses. Research syntheses play an important role in dissemination of knowledge and informing further research and practice by the knowledge gained through primary research and secondary analyses. Thus, improving the methodologies of research synthesis also improves the utility of primary research and secondary analyses. Also, research synthesists generally have a prior background of conducting primary research. Hence their thinking is informed by the methodologies employed in primary (and secondary) research.

MIRS, CLP, and Naturalistic Inquiry

According to the MIRS perspective, many primary research techniques and ideologies can be extrapolated to the process of research synthesis. As an illustration, this section compares the approach adopted in CLP synthesis with the Naturalistic Inquiry (NI) approach to primary research propounded by Lincoln and Guba (1985). Distinguishing the NI from rationalistic inquiry, Guba and Lincoln (1999, p. 141) identify the "axioms", "postures" and the criteria for trustworthiness associated with the NI. The table below examines the degree of transferability of these distinctive features of the NI to the CLP.

Table 1
Correspondence Between the Approach of Naturalistic Inquiry and the CLP Synthesis

	Naturalistic inquiry (Guba & Lincoln, 1999).	The CLP synthesis (Clarke, 2001)
	Axioms	
The nature of reality	"There exist multiple realities" that are constructed in people's minds and warrant a holistic inquiry. Naturalists are interested in the meaning that people give to "objects, events or processes" (p. 142).	CLP did not intend to "reveal what mathematics and science classrooms are 'really like'… A classroom takes on a different aspect according to how you are positioned within it or in relation to it. … As a consequence two or more analyses that discuss the same lessons, and even the same events, do not report the same findings, address the same issues, or draw the same conclusions" (p. vii).

Table 1 (cont.)

The inquirer-respondent relationship	In a NI, the "subject-object independence" is considered impossible and undesirable as the "interactivity" of "the human instrument" facilitates maximum "responsiveness, adaptability, and insight" (p. 142)	"Participants' voices must be heard both in terms of documenting the substance of social interaction and through the provision of the opportunity for participants to interpret and comment upon their own actions in order to provide data on the meanings that triggered, accompanied and arose from those actions" (p. 295).
The nature of truth statements	The aim of a NI is to "develop an idiographic body of knowledge" in the form of "working hypotheses" that most succinctly describe the individual case. "Naturalists aim for transferability of working hypotheses across contexts rather than generalisability of universal truths" (p. 143).	"Krummheuer (1995) invoked Goffman's (1959) notion of a 'working consensus' as the immediate goal of classroom argumentation. This conception of working consensus, the authority of which derives from its local and immediate viability, can be applied to describe the interpretive processes followed by many research teams engaged in interpretive research into complex social settings such as classrooms" (p. 22). In the case of the CLP the working consensus related to the local coherence and plausibility of each account rather than any convergence across accounts.
Causality	A NI infers "patterns of plausible influence" as complex interactions between various "factors, events, and processes" make assertions of causality in human relationships questionable (p. 143).	The CLP looked for plausible patterns of influence to facilitate a more complex and comprehensive understanding of the classroom and improve practice. For example, "The pervasiveness of uncertainty throughout this book is one of several structural patterns emerging from the synthesis of the various accounts offered in the different chapters" (p. 5).
Relation to values	Our values influence our choices of "problems, theories, instruments, and data analysis modes", "substantive theory", and "methodological paradigm". Likewise contextual values and the interactions among different values influence our accounts (pp. 143-144).	"Certainly, the various analyses draw our attention to differences in participants' interpretations of the same events. Differences in underlying values are one plausible reason for such differences in interpretation" (p. 298). In the CLP, the synthesist acknowledges the subjectivity of the synthesis process.

Table 1 (cont.)

	Postures	
Preferred methods	Qualitative methods are more amenable to the holistic emphasis of a NI (p. 144).	The multi-vocal method of data collection and the commitment to multiple analyses and their synthesis is indicative of CLP's inclusive and wholistic orientation.
Source of theory	Naturalists emphasise that the theory should be always grounded in data even if it does not emerge afresh in every inquiry (p. 145).	The CLP accommodates multiple theoretical positions and requires the authors of complementary analyses to specify their theoretical orientation. With regard to the process of synthesis, it is anticipated that within the constraints of the theoretical frame of the CLP as a whole, the synthesis process anticipates the emergence of theory grounded in the complementary analyses undergoing synthesis.
Knowledge types used	Naturalists "publicly admit dependency on their… tacit knowledge – insights, intuitions", and "apprehensions" (p. 145)	Each contributing researcher utilised a specific theoretical framework reflective of their particular area of expertise. The insights evident in the separate analyses reported in the CLP are a direct consequence of the project's utilisation of the tacit knowledge of experts.
Instruments	" humans as instruments" are preferred as they can have "greater insightfulness, flexibility, and responsiveness", "take a wholistic view", "utilize their tacit knowledge", and "simultaneously acquire and process information" (p. 145)	The CLP synthesis was the acknowledged enactment of one individual's subjectivity: "One aspect of this interpretive synthesis must be emphasised: It is ultimately one person's synthesis (mine)" (p. 292). Thus, the credibility of the synthesis process derives from the informed subjectivity of the synthesist as an individual rather than from the utilisation of a prescriptive technique or procedure.
Design	An emergent design is more amenable to a naturalistic inquiry	In the CLP, key themes and dimensions of variations emerged from the examination of individual analyses.
Setting	Naturalists prefer to study phenomena in their natural settings. This enhances transferability of their account to "other, similar contexts" (p. 146)	The CLP is committed to the portrayal and analysis of the practices and meanings of "natural" mathematics classrooms. Data collection is implemented on the premise of minimisation of distortion, within the practical constraints of inevitable intrusion into the settings and situations of interest.

Table 1 (cont.)

	Trustworthiness	
Credibility	Credibility is perceived as a "check on the isomorphism between" the inquirer's "data and interpretations and the multiple realities in the minds of the informants " (p. 147).	"We need to acknowledge the multiple potential meanings of the situations we are studying by deliberately giving voice to many of these meanings through accounts both from participants and from a variety of 'readers' of those situations. The implementation of this approach . . . accords the accounts complementary status, subject to the requirement that they be consistent with the data from which they are derived, but not necessarily consistent with each other, since no object or situation, when viewed from different perspectives, appears the same" (p. 1).
Transferability	Transferability can be enhanced by using "purposive sampling to maximize the range of information". Also, providing thick description can "facilitate judgements about the extent to which working hypotheses from that context might be transferable to a second, similar context" (p. 147)	The CLP position is that if the complexity and the expense of classroom videotape studies are to be (i) usefully realised, and (ii) justified, then not just secondary analyses, but also research syntheses must be anticipated and implemented. Specifically, it is particularly incumbent upon those of us employing videotape to study classroom phenomena, to ensure that our data collection anticipates and affords subsequent secondary analysis. This anticipation will also afford the transferability of our findings.
Dependability	Useful techniques to improve dependability include: "overlap methods", "stepwise replication", and a "dependability audit" (p. 148)	The use of a multi-disciplinary research team has the virtue of subjecting each team member's account to the critical scrutiny of several colleagues. Differences in the theoretical positions adopted by research team members constitute an important safeguard against methodological monism or myopia (p. 14)
Confirmability	Techniques to improve confirmability include "triangulation", maintaining a "reflexive journal", and a "confirmability audit" to demonstrate "that every entry can be supported with appropriate documentation" (p. 148).	In the CLP: Transparency of account provides some measure of confirmability. Every analysis is carefully situated in relation to the data and the analytic process carefully described. The process of synthesising complementary analyses is recounted in some detail with the intention of according the synthesis a similar degree of transparency. In part, the CLP argues for the trustworthiness of its findings on the basis of the critical reflexivity of the process whereby the separate analyses where firstly developed and secondly integrated into the synthesis.

Table 1 illustrates the adaptability of several axioms, postures, and criteria for trustworthiness of the NI approach to the context of the CLP synthesis. Such an illustration demonstrates how approaches to primary research, such as NI, can be useful departure points for informing the methodology of a research synthesis. We hope that such illustrations will encourage researchers to adapt the canons of methodological rigour that they commonly employ in primary research to the synthesis of separate individual analyses.

Conclusion

The premise on which MIRS is founded is that many primary research methods can be adapted to the process of a research synthesis. We have attempted to demonstrate the viability of this proposition specifically for the case of Naturalistic inquiry and CLP. In so doing, the authors are each asserting the major principles on which their research is currently predicated.

Clarke: The availability of high quality, fine-grained, video data, and suitable methods of primary and secondary analysis of such data, makes the synthesis of "complementary accounts" a powerful and appropriate tool for the study of complex social settings such as mathematics classrooms.

Suri: The rich diversity of perspectives and methods prevalent in contemporary primary educational research makes a methodologically inclusive perspective to research synthesis powerful and appropriate for understanding complex social settings such as mathematics classrooms.

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