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EDUCATIONAL RESEARCH FOR THE FAINTHEARTED


What we are sharing is not a typical symposium on research methods in the sense that it provides general formulae, complex rules or prescriptions for audiences to follow like a recipe book when they want to do educational research. This is really not possible nor desirable in our opinion as people who actually do educational research as part of our everyday jobs. Rather, what the four of us wanted to do was to introduce educational research in a very direct, jargon-free way as seen through our own past experiences as graduate students. In this way, readers can better understand research from first-hand accounts of our struggles, frustrations, dead-ends, and occasional moments of happiness. Unpacking some of the theories and concepts behind educational research will certainly not be forgotten and will be interwoven throughout these experiences of ours. Just like beginners learning to swim, one cannot swim by merely reading a book nor by immediately jumping into the water without some notions of how to breathe, tread water and so forth. Both swimming theory and practical experience of being in the water are requisite although at any moment one aspect might be more advanced than the other. It is our sincere wish that anybody contemplating a new research project or who is presently encountering some obstacle in one would derive many benefits from this symposium.

Some participants might immediately challenge this line of approach: “How can lived experience with all its trial-and-error modes of learning surpass theoretical wisdom? Isn’t it a true saying that there is nothing more practical than a good theory?” Others might prefer moving completely towards the other end of the learning spectrum and wish to understand how an investigation was successful completed in real, concrete terms. What is expected now are the many human interest stories and snippets of good advice, something like what a wise mentor might reserve for the special training of a young apprentice. Nothing airy-fairy here, only ideas that have been proven in the real world—“what works” assumes primary importance and interest. As usual, the appropriate and realistic answers always seem to lie somewhere in the fuzzy in-between regions. Theory certainly has to be applicable in the hustle and bustle of classroom life just as our educational research practices demand a sound conceptual backbone. This is a hard balancing act to achieve and yet it is vitally needed for anybody to succeed in their investigations. Stuart Hall, a noted commentator of culture, once said that theory and experience being forever at odds with each other is not that bad a situation after all for their constant bickering and interplay actually pushes knowledge forward. We similarly agree but there remains the painful dilemma of how to concretely implement educational research? Should beginning researchers go forth into schools trusting that things will eventually fall into place somehow or should we prepare ourselves as best as we can before we even contemplate stepping into the field?

It is hoped that the way this symposium is structured will go some way in resolving this impossible chicken-and-egg question of how to begin for we tackle research theory and lived experience together. Neither is prior nor complete without the other. Despite the apparent soundness of this advice, we actually found this secret out the hard way after we had completed our studies, and not before. If we had earlier known that “we cannot understand explanations of research (methods, methodology) until we have already developed an understanding of research” (Roth, 2006, ¶6), we would have avoided a number of heartaches and sleepless nights. Yet, many texts on educational research methodologies in the market are prescriptive in nature and are very intimidating for the beginner. Because these books often present difficult concepts in the absence of practical know-how and appropriate contexts, they then become time-bombs waiting to explode when picked up by the newcomer wanting to learn something useful. The book gets left aside, or the project possibly fails to achieve the necessary rigor due to wrongly applied theories lifted from somewhere. This unsatisfactory state of affairs has in fact prompted Wolff-Michael Roth to suggest placing a warning label on every research methods book (see Figure 1 below) and moved this educator to write a groundbreaking methods book that was the inspiration for this very symposium (Roth, 2005).
Figure 1. “A sticker like this ought to feature on every book pretending to be a hands-on guide to research by presenting different methodologies and approaches” (Roth, 2006, ¶6)

In what follows, the four authors will individually present a brief outline of their graduate experience. From this common format, the audience will gain an idea of how theory and practical experience should inform each other, how these two are inseparable during the process of research. The symposium will also showcase a couple of common research approaches to find out a) what students know (TSC & DT), b) what teachers know (LYJ), and c) what happens during classroom instruction (TAL). At the end of each presentation, some of us will engage the presenter in a dialog, highlighting how we would have done it differently, how it could have been modified and other critique. This affords a valuable forum for sharing with each other and audiences alternatives that we might never have considered.


**Tan Seng Chee**

**Research question(s):** Does the use of concept mapping with Computer-assisted instruction (CAI) affect student’s learning outcomes in terms of achievement test and concept mapping ability?

**Main research method:** Quantitative comparison study of 3 groups of students using different extent of concept mapping with Computer-assisted instruction (CAI). Group A: Partial map interface + concept mapping; Group B: Complete map interface + note-taking; Group C: menu-selection + note-taking.

**Sample:** Convenience sampling of 91 Sec 4 students in a local SAP school, random assignment of students into 3 treatments.

**Key findings:** Students given partial map as interface and construct their own concept maps performed significantly better for higher-order questions better than the other two groups of students. They also performed significantly better in concept mapping task, particularly in labeling relationships among concepts.

**Implications:** Implications on interface design of computer-assisted instruction and accompanying activity for CAI. Generative activity like concept mapping is more effective than note-taking. Using complete concept map as an interface has no significant effect compared with traditional menu design.

**Research limitations:** Only quantitative data was collected. There was no record on the qualitative process which might provide further explanation on the results. A combination of treatment was used: Partial map interface + concept mapping; Complete map interface + note-taking; menu-selection + note-taking. Can’t isolate the effect of interface and accompanying activity.
AL: What were the parameters used in measurement? Were all the three groups given the same ‘test’ and their results compared? Given that they were subjected to different ‘treatments’, will assessing them using the same method be limiting?

SC: This is a typical comparison study, with random assignment of subjects into various groups. Attempts were made to control the extraneous variables, including time on task. The subjects were given the same tests – one on chemistry achievement test (as typically used in school and “O” level), another one is concept mapping ability test (subjects were given a passage and asked to construct concept maps based on that). In such experimental study (which tries to emulate scientific research), it is important to assess the subjects based on the same instruments, thus, the same tests. It doesn’t make sense to compare them based on different tests (how do we reach a conclusion in Ms World contest if we use IQ as a criterion for Ms Czech and appearance for Ms Australia?!

YJ: I find it difficult to believe that the effects of concept mapping can be reflected so quickly into actual achievement scores among the students. Perhaps the practice of concept mapping mimicked the type and nature of the higher order questions just as it allowed students to gain familiarity with labeling relationship exercise?

SC: I think the effect came from the generative activity (or some people call it constructivist activity). I argue that the three treatments vary in terms of degree of cognitive engagement. Students having to generate concept maps need to think harder (cognitive effort and engagement) than those just using the map and taking note. Labelling relationship requires some critical thinking, which I think why concept mapping is superior to mind mapping (Tony Buzan) in terms of learning concepts.

Daniel Tan KC

Research question(s):

Identify the concepts and propositional knowledge necessary for secondary chemistry students to understand the topic of qualitative analysis. Develop a two-tier multiple choice diagnostic instrument consistent with the identified concepts, propositional knowledge and known student alternative conceptions related to qualitative analysis. Measure secondary chemistry students’ understanding of the concepts and propositional knowledge related to qualitative analysis through the use of the two-tier multiple choice diagnostic instrument developed.

Main research method:

Content framework of qualitative analysis was defined by a list of propositional knowledge statements and a concept map. The literature was reviewed to determine students’ knowledge and alternative conceptions in topics related to qualitative analysis. Semi-structured interviews of Grade 10 students (15 to 17 years old) were conducted to explore their understanding of qualitative analysis. Free response tests were administered to collect additional data on students’ difficulties and alternative conceptions. Identified student conceptual difficulties and alternative conceptions from the interviews and free response tests were used to develop the two-tier multiple choice diagnostic instrument, the ‘Qualitative Analysis Diagnostic Instrument’ (QADI). Alternative conceptions are considered significant if they existed in at least 10% of the student sample as a higher minimum value, say 25%, would possibly eliminate some valid alternative conceptions from the results.

Sample:

The QADI was administered to 915 Grade 10 students from 11 local secondary schools.

Key findings:

The study showed that the Grade 10 students had difficulty understanding the reactions involved in the identification of cations and anions, for example, double decomposition reactions, the formation and reaction of complex salts, and thermal decomposition.
Implications: The results showed that students found qualitative analysis difficult to understand and are unable to relate what they do in the practical sessions to what they learned in class. It is proposed that their difficulties may arise from not knowing explicitly what is required in qualitative analysis, the content of qualitative analysis, the lack of motivation to understand qualitative analysis, cognitive overloading, and the lack of mastery of the required process skills.

Research limitations: Problems associated with the pencil-and-paper tests; students may not understand or may misinterpret the questions and options, and they have little recourse for clarification.

YJ: Daniel, what kind of free responses did the students supply? Did they lend support to some of the commonly heard criticisms of pencil-and-paper tests?

DT: It does help to probe students' reasoning behind their answers and does give an indication of students guessing the answers.

AL: You mentioned that semi-structured interviews were used to explore the students' understanding. Did the interviews show any correlation with what you found using Qualitative Analysis Diagnostic Instrument? How many of 915 students were interviewed and how were they chosen for the interview?

DT: 51 students were interviewed - the teachers assisting the study chose the students. The data from the interviews led to the development of the instrument - they were asked a subset of similar questions as those in the diagnostic instrument.


Research question(s): What do local high school and junior college (JC) teachers understand about biological evolution and ecology?

Main research method: Quantitative Rasch item analysis of multiple choice questions answered by teachers. Surveyed background demographics through the questionnaire and familiarity with syllabus content, emphasis and coverage of the topic.

Sample: Stratified random sample of schools, 40 local secondary and 12 junior college biology teachers coming from 38 secondary and 7 colleges.

Key findings: Mean total scores in the achievement test were significantly higher in favour of JC teachers. Similarly, JC teacher scores over the sub-section of evolution was significantly higher than secondary teachers but not so with respect to ecology items.

Implications: Analysis of test scores from a sample of 24 pre-service student teachers supported the possibility that teaching and learning on-the-job as biology specialists in the academically demanding college environment had contributed to higher scores in the achievement test for JC teachers. There were specific instances of misconceptions or alternative conceptions, especially among secondary school teachers, which are discussed in detail in this study.

Research limitations: All the problems associated with mailed surveys plus dealing with a highly complex and controversial topic from a paper-and-pencil test. I did not have face to face interviews with any teachers as well.
AL: Teachers' level of comprehension of biological evolution is complex. Besides the 'official' knowledge that they acquire from school and science books, their personal belief systems of biological evolution will also shape their comprehension of what evolution is. Teachers' comprehension of biological evolution can hence occur at the scientific level; the personal level, the school science level or even the social level. As such, how does the Rasch item analysis account for these complexities?

YJ: I think we only managed to capture one level or perhaps aspect is a better word that the test was originally constructed for—scientific knowledge. But even though this was the only information that we obtained from the test, I believe those interested in measurement and evaluation are assured that Rasch models do their job pretty well (see Boone & Scantlebury, 2005). Basically, this family of item response models will rank people and items on the same measuring stick so to speak. In this way, we know who demonstrates ability on this particular test and similar ones as well. And it allows test makers to use the same test to compare cohorts of test takers reliably. I had one particular not quite scientific question in my study that asked teachers to indicate whether they believed in the theory of evolution; nearly half did not because they felt that information about the past was unreliable or that evolution was not based on “hard” facts. This to me was very interesting as well as perplexing.

AL: There is a relationship (whether co-relational or inversely related) between teachers' comprehension, beliefs and theories as compared with their actual practices in the classrooms. Classrooms are places when the teachers' comprehension, beliefs and theories are reshaped by their interaction with the students and the diversity of experiences which the students bring to class. How would classroom observation data be used to enhance the findings you have with Rasch item analysis?

YJ: You have raised an important weakness of my study in that I tested how people performed during a pencil-and-paper test, not how teachers actually taught the topic. Because there are many discrepancies between thought and deed, I had no way of knowing if teachers who performed well on my test actually could have mitigated biological evolution as scientific “truth” by simply mentioning to their pupils at some point, evolution is just a theory. I was told of many occasions where these things have happened. And, I had no way of finding out how students reacted during the actual teaching or whether the teacher encouraged questions or if the lesson was breezed through without elaboration.

SC: What was the intention/motivation of this study? What problems were you trying to solve? What was/were the intended contribution(s) to theory/practice?

YJ: It is commonly known around the world that biological evolution poses great difficulties for teachers for a variety of reasons but this has never been determined before in Singapore. Hence, once we knew what teachers knew, I figured it would inform the teaching of this topic in schools and universities.

SC: Could there be a biased in favour of the JC teachers, given that they probably would be teaching the topic to greater depth compared to secondary teachers? How were the items constructed?

YJ: The items were obtained from the GCE A and O Level biology past examinations, spread about equally from both. What was interesting is that the secondary and JC biology teachers were alike in terms of background variables like age, gender, teaching experience, number of years since graduation, religious affiliation, membership of professional organizations, academic qualifications, and past educational experience in evolution and ecology. In terms of background training, they were rather similar and I thus attribute the differences mainly to the demands of the JC curriculum(exams) that required a certain level of competency from the teachers!


**Research question(s):** Comparing interaction features in the biology laboratories and classrooms for the topics of *Ecology* and *Reproduction in Plants.*
Main research method: Qualitative analysis of audio transcripts of lessons and teacher interviews using conversation analysis and certain principles of discourse analysis.

Sample: Convenience sampling of two secondary school biology teachers and two classes of students within one school.

Key findings: Classroom instructions and laboratory sessions in a topic perceived by teachers as “highly structured” show very strong teacher control. Teacher control is comparatively less “structured” in topics teachers perceived as more open-ended. Regardless of topics and setting, the knowledge that is presented by teachers appears to be controlled by the examination requirements and syllabus documents.

Implications: Two key forces appear to influence the power to determine the kinds of classroom interaction in biology. The first is the highly rigid way in which scientific knowledge is presented to teachers and the students and secondly the highly prescriptive examination requirements and syllabus documents. How these influences impact classroom interaction is discussed in detailed in the study. The realization of the grip these forces have on instruction in critical for practitioners. The implication of this study is important for the field of disciplinarity as it examines “intra-disciplinary” differences rather than assuming that knowledge is homogenous within a single discipline.

Research limitations: Amateur interview techniques leading to poor quality of interview data source. Students’ artifacts were not included as part of the data base.

YJ: So Aik Ling, do you think by having your two teachers undergo a pencil-and-paper test of their competency (and hence confidence in teaching) we might discover that plant reproduction is a hard to understand topic for them? I mean if the reason why they taught it this way was because the teachers found the topic difficult and hence wanted greater control over instruction?

AL: I have a couple of issues with using a paper and pencil test to assess the biology competency of the teachers. Even is the test can reveal that the teachers find the topic easy (that is they are well versed in the knowledge presented in this topics) it does not show that they find it easy to teach. ‘Teaching’ and ‘knowing’ the topic could be two rather separate issues. I agree that the level of difficulty of a subject could possibly dictate how the teachers will teach in class. In the study, teachers revealed that the reason why they maintain tight control over the topic of plant reproduction was because they thought the students will find the topic difficult. It appears that it is the students’ competencies rather than the teachers’ competencies that determine the interaction in the classroom.

DT: Generalising that classroom & lab sessions are highly structured because of the difficulty of the topic/teacher or student competencies based on observations of 2 teachers may not be valid – a follow-up study/survey will give more credence to the hypothesis.

AL: My results of my study were not intended for generalization. It is focused on a phenomenon or an way of thought that could possibly exist in the minds of teachers at that point in time. As Erickson (1986) aptly reminded us about the assumptions of the uniformity and hence predictability of one person compared with the next and of one phenomenon compared with the next, I am careful about generalizing my findings beyond the classroom and the teachers I have studied. My study focuses on ‘particularity’ rather than ‘universality’ (Erickson, 1986). This study was not set out to prove or disprove a hypothesis but rather to show and possibly suggest a reason for the teachers behaving the way they did.

YJ: Are you saying that at least in secondary Biology, how the syllabus and examination formats are configured largely determine what and how subject matter is learned? Surely what happens in classrooms is more variable and contingent than that? I have also heard that interviewing participants is not as neutral and value-free as we might make it out to be. For example, using certain words or
asking certain questions immediately “loads” the interviewee to answer in a particular way so how could you have avoided these research pitfalls?

DT: Did you ask the teachers why they behave the way they did? I don’t think you can avoid leading the interviewees but to minimise it.

AL: Yes, the syllabus and examination formats play a part in shaping the kinds of interaction and discourse in the classrooms and laboratories. Of course, there are other factors in shaping the interactions and these include the teachers’ and students perception of their roles and of each other. Their ideas of how and what constitute knowledge in biology also shape the interaction. Despite the criticisms of using interviews as a means of data collection, I think that it is probably still an important means to understand what goes on in the heads of teachers’ and students. There are a couple of assumptions made when using interviews. Firstly, when using interviews, we assume that the participants already have some knowledge, beliefs, theories and ideas about the reality which we try to understand during the interview. Hence, the interviewee answers will count as data (Baker & Johnson, 1998). A problem arises in the analysis when what the interviewee is saying is taken out of the context and analysed on its own. To overcome this, analysis of interviews can be done in context, that is interviews can be seen as a special event of talk-in-interaction, that is what the interviewee says in response to the context of the interview.

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