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The Impact on Final Year Pre-Service Secondary Teachers of a Unit in Teaching Literacy and Numeracy across the Curriculum

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Abstract: Addressing literacy and numeracy as social practices in different teaching content areas create challenges for teachers and teacher education. Literacy and numeracy skills and understandings are generally addressed incidentally in teacher education courses and often overlooked by teachers in secondary schools. This paper reports on a study which examined the impact of a unit called 'Curriculum Literacies' in the final year of a Secondary Bachelor of Teaching/ Bachelor of Arts course. The unit developed students' personal skills and understanding of literacy and numeracy and their application to teaching in particular discipline areas. Findings show the unit had positive effects on most students' personal knowledge and pedagogy. However, these effects varied depending on content area and literacy was generally found to be more relevant and more easily integrated than numeracy. The results of this study confirm the value of such units in teaching degrees.

Introduction

The notion that each discipline area involves a body of knowledge as well as social practices and discourses which are expressed through its texts and technical language has given rise to the terms 'content literacy' (Christie, 1998; Brozo & Simpson 2006) or 'curriculum literacies' (Deakin University, 2001). The increasing complexity of content knowledge combined with the demands of using new media require teachers to pay attention to and explicitly teach students to effectively acquire and critically respond to literacy and numeracy specific content in all disciplines.

The practice of explicit teaching of literacy which includes such strategies as the scaffolding and explanation of the linguistic and grammatical features of various text types or the demonstration of reading strategies for different media is well established in the discourses of English pedagogy (Ludwig, 2000; Sim, 2006). Fang and Schleppegrell (2010) argue that if learners recognise typical language patterns, they have access to important ways in which knowledge is constructed. Such awareness of the role of literacy is not so apparent in content areas other than English. There is even less recognition that numeracy has a place in the pedagogy of any content areas other than those with a specifically mathematical focus. Watson (2009), in outlining a model for critical numeracy, states that:

For some time now it has been recognised that literacy is a responsibility of teachers from all areas across the curriculum. But perhaps because of underlying uncertainties about mathematics in the past, it has been more

difficult to convince teachers that numeracy is also their responsibility across the curriculum. (p. 1)

Gough (2007) observes that the number of non-mathematics subjects and the great range of possible scenarios that require mathematics to be applied is too great for a mathematics specialist to be able to cover them all. Groves (2001) conducted a six week unit for final year secondary pre-service teachers entitled *Numeracy across the Curriculum*. She identified a number of challenges in teaching the unit. One was the fact that in secondary schools there is not a general recognition that all teachers are responsible for students' numeracy learning. Another is the unevenness of numeracy demands in different teaching areas. For example, Groves cites the challenge for Dance and Drama students to find authentic examples of numeracy demands when on their teaching practice though they could in theory when in university classes.

Lesley and Matthews (2009) and Milton, Rohl and House (2007) affirm the need for graduating teachers to have adequate understandings of literacy and numeracy and recognise that teachers need to foster such skills embedded in every content area. They conducted a nation-wide survey which explored how new teachers (first and second year teachers in both primary and secondary) perceived their readiness to teach literacy and numeracy. The survey focused on personal competence in numeracy and literacy and how well the teachers felt prepared to teach specific aspects. Of 303 respondents fewer respondents saw themselves as teachers of numeracy than literacy and felt less prepared to teach numeracy. Milton et al concluded that most non-Mathematics teachers felt that they did not need high levels of numeracy to teach their own subject. However, a considerable number indicated that they would have liked university courses to include units on teaching literacy and numeracy across the curriculum.

Hattie's (2009) synthesis of over 800 meta-analyses relating to achievement concluded that teaching requires deliberate interventions to ensure that there is cognitive change in the student and that "It is critical that the teaching and learning are visible" (Hattie, 2009, page 25). Such visibility is supported by the key recommendations of The Middle Years Literacy Research Project (Deakin University, 2001) which involved developing teacher knowledge about literacy and learning in all key learning areas in order to meet the needs of adolescent students as they encounter increasingly complex texts. Secondary teacher education courses have for a long time provided in-depth teaching about individual content areas but even though there has been some attention to literacy and numeracy within these subjects there has not been much of a systematic focus on developing students' personal skills and teaching strategies for literacy and numeracy across the curriculum. The purpose of this study was to evaluate the impact of such a unit.

Background

The recognition that all practicing teachers should have well developed personal literacy and numeracy skills as a foundation for explicit teaching whatever their content area led to the development of a 36 hour unit (12 weeks at 3 hours per week) called Curriculum Literacies. This unit is placed in the fourth and final year of a Bachelor of Teaching/Bachelor of Arts degree. It has a dual purpose: to consolidate personal skills and introduce specific teaching strategies which can be integrated with

content delivery. For many students, the Curriculum Literacies unit is challenging because it departs from their usual comfort zones: English and History majors have to engage with concepts involving number and measurement skills, statistics, probability and chance while Economics/Technology/ Mathematics majors need to learn about text types and sentence structures.

Based on a needs analysis of relevant literacy and numeracy for teaching, the unit was broken up into two related parts: four weeks input on numeracy and eight weeks on literacy. Assessment tasks included tests of personal skills as well an explanation of how literacy and numeracy is constructed in students' discipline area through a teaching portfolio of strategies to deliver content in subject specific areas. It should be noted that Mathematics and English majors study a second teaching subject and their portfolio had to be for that subject. Topics covered within the unit included an introduction to aspects of functional grammar such as text types; the nature and uses of mathematical concepts in number, measurement, statistics and probability; theories of literacy and numeracy as social practice; the learning needs of learners from diverse cultural and linguistic backgrounds as well as the introduction, modelling and practice of a variety of generic teaching strategies such as three level reading guides, writing scaffolds, the construction of graphs and time-lines and strategies to teach numeracy set in contexts.

This case study reports on the impact of the 2009 Curriculum Literacies unit on a cohort of 105 students and examines their perceptions of the knowledge and teaching practice they gained. It also examines the extent to which students applied their learning from the unit in their own classrooms when on a 10 week teaching internship.

Specific Research Questions

1. How did final year secondary students perceive the usefulness of the unit Curriculum Literacies?
2. What evidence is there that the unit impacted on their teaching practice when on a 10 week internship?

Methodology

Three forms of data were collected.

1. All students enrolled in Curriculum Literacies were surveyed through an anonymous paper questionnaire at the end of the twelve week unit. They were asked both closed and open questions about the usefulness and value of the content in the unit to their own knowledge and to teaching strategies. The questionnaire was supplemented by focus group interviews with loosely arranged groupings according to humanities/non- humanities disciplines.
2. A questionnaire with similar questions but only about teaching strategies actually used was conducted again immediately after students had completed their 10 week internship.
3. University supervisors of students on internship were invited to record instances when the specific teaching strategies identified in the questionnaire were used during supervised lessons. Participation was voluntary as supervisors had to perform their normal supervisory functions. Ten were approached but in the end only two supervisors actually returned their

comments for analysis. Mentor teachers were not included as the internship is high stake assessment for the student teachers and it was decided not to add extra tension to the mentor – student relationship.

The results were collated and key themes extracted for analysis

Results and Discussion

The results are reported separately for the questionnaire and focus group discussions at the end of the unit, questionnaire after the internship and the two supervisors' comments.

Questionnaire and Focus Group Discussion before the Internship

The questionnaire posed four statements measured on a 4 - point Likert scale; Strongly Agree, Agree, Disagree and Strongly Disagree. The questionnaire also included the opportunity for open – ended responses about personal knowledge development and usefulness for teaching. The questionnaire was followed up in the final tutorial with some focus group reflection led by the authors. The four statements were:

1. My knowledge about literacy has increased from the unit.
2. My knowledge about numeracy has increased from the unit.
3. I learnt strategies from the literacy content which I will be able to use in my teaching.
4. I learnt strategies from the numeracy content which I will be able to use in my teaching.

Table 1 shows the percentage of students that aggregated data showed strongly agreed or agreed to each of the four statements. There were a total of 105 responses to the questionnaire.

	Literacy	Numeracy
Personal knowledge	89	64
Teaching strategies	91	52

Table 1: Percentage of Students who Strongly Agreed or Agreed to the Four Statements

The aggregated data show that students believed they acquired personal knowledge and skills in literacy which could be translated into useful strategies to teach literacy within their own content areas. While still more than half, considerably fewer students agreed that they acquired personal knowledge in numeracy and some of these students did not agree that they could use this knowledge to teach numeracy in their own subject area.

As teachers in this unit, the authors often encountered students in subjects like English and Visual Arts being resistant to learning numeracy skills and strategies with similar reactions of Mathematics students to literacy. Further, it may have been that Mathematics students already knew the content presented for numeracy and English students for literacy, though the data suggest this was more likely for the Mathematics students than the English students. Some more fine grained analysis is indicated, in particular the need for some subject specific Key Learning Area (KLA). Responses. Table 2 shows the data in Table 1 according to the teaching area (KLA) of the student. Most students except for Technology (25 students) study two teaching areas and

chose to report on both their subjects but some opted for only one. So the total number of students responding in Table 2 is still 105 but reports on 157. Table 2 shows the percentage who strongly agreed/agreed for each of the four statements. The number shown with the subject area is the total number of students enrolled for that area – so 26 English students, 38 History students etc.

Subject Area	Literacy knowledge	Literacy strategies	Numeracy knowledge	Numeracy strategies
English (26)	100	92	62	50
History (38)	69	91	56	72
Geography (10)	100	90	80	70
Visual Arts (12)	83	92	58	75
Religion (25)	92	36	56	56
Economics (8)	88	88	63	100
Mathematics (13)	92	85	54	92
Technology (25)	100	92	72	80

Table 2: Percentage of Students who Strongly Agreed or Agreed to each of the Four Statements by Teaching Subject Area

Not surprisingly, Mathematics students acquired more personal knowledge of literacy than numeracy and learnt teaching strategies about equally for both. As well, the high level of learnt numeracy strategies by the Mathematics students may seem surprising given they had studied two specialised curriculum units. The result may be attributed to the fact that Numeracy looked back at fundamental mathematical concepts rather than higher level ones addressed in the curriculum units. The following are three Mathematics students' comments.

- *I enjoyed Literacy more because I never got taught grammar.*
- *...it was good to refresh basics. Was shown why maths is done, not just formulas*
- *Students can't do word problems in maths so literacy skills (text participant/ code breaker) will help.*

One particular strategy to scaffold contextual questions involving some numeracy called Newman's analysis (Newman, 1983) emerged as popular with the mathematics students (6 of the 13 mentioned it). For example:

- *More focus on Newman ... it was really good. I have used it in tutoring – it was new. I like it*

English students reported low development of personal skills in numeracy or usable numeracy strategies. One reason for the low levels may be the perceived relevance of numeracy to English teaching and their own dislike of mathematics. The following are three English students' comments.

- *... as someone who is not mathematical ...I found it hard to understand*
- *The literacy will be very useful ... because it is such an integral part of both subjects. I still find it hard to integrate numeracy into English ...I'm also still not confident with all the concepts of numeracy.*

Not all English students found integrating numeracy so problematic.

- *Started sceptical - why numeracy? But now opened our eyes to uses in English*

Visual Arts data are similar to English in terms of numeracy skills but differ in the higher level of reported use of numeracy teaching strategies. We can only surmise that the Visual Arts students had not considered using numeracy strategies at all and now did to some degree. Their comments also echoed many of the sentiments of the English students. For example:

- *I found applying numeracy highly difficult especially considering my poor level of maths*

- *I would have found it more useful if knowledge of basic numeracy and literacy was not assumed. I do see the value in skills and how they would be useful in my KLA ... but I don't feel I understand the basics to effectively implement them...*
- *I liked the numeracy part*

History students reported more learning in both literacy and numeracy teaching strategies than acquisition of personal knowledge and skills. Economics did likewise for numeracy. We suspect the reason is that we put forward for Visual Arts – not having really considered integrating numeracy and literacy in their own subject area.

- *History syllabus says literacy and numeracy skills but I've never looked at them before. This unit made me have a look and they are there.*
- *Realised how important literacy and numeracy is across all KLA's*

Technology students were very positive about the literacy component and less so for numeracy. Opposite to Visual Arts, it may be that they knew quite a bit of mathematics and had it as part of their Technology subjects but had been exposed to literacy far less. For example:

- *learning the different types of texts was very helpful- I can use (them) for many tech classes and adapt them to different technology content.*
- *in technology we've never been told to put literacy and numeracy. We cover content...*

In summary, the unit was useful and brought awareness about literacy and numeracy that had not been thought of before. In literacy, students made particular mention of meta language relating to the grammar of text types, though some were overwhelmed by the grammar. New learning in numeracy was mentioned less often than literacy and many of those who learned new skills in numeracy were challenged by them.

There was substantial evidence for students being able to see how they might use literacy strategies in classroom teaching and considerable evidence for numeracy strategies. However, whereas a few students found they could not see how to use literacy strategies, nearly three times as many thought they would have difficulty in applying numeracy either because they perceived numeracy was irrelevant to their subject area or because they felt they didn't have adequate personal skills. Overall, students were more comfortable with literacy and felt better equipped to apply literacy strategies in the classroom than numeracy. Then there was the student who thanked the authors profusely for the numeracy work. She was an English major doing some casual work and had been assigned a Year 7 Mathematics class.

Post Internship Questionnaire

This was administered after students had completed their 10 week internship. The focus was teaching. It provided a list of teaching strategies taught in the unit and asked students to identify ones or any others they had actually used when teaching on their internship. The final section asked them to comment on the value of the unit for teaching their subject. Students were not limited to the number of comments they could make and many made more than one. The total number of responses about useful literacy strategies was 256 and for numeracy 134. Consistent with the pre internship data, literacy strategies were more readily identified as being useful than were numeracy ones. Table 3 shows the breakdown of responses by subject area (KLA). Raw data rather than percentages are used because the multiple responses by some students does not allow for percentage part whole comparisons. The second statistic in parenthesis is the number in that subject area who strongly agreed/agreed on the usefulness of the unit for teaching before the internship. For example, the 7 for

Economics represent 7 responses out of the 8 students enrolled (showing as 88% in Table 2)

Subject	Literacy Strategies	Numeracy Strategies
Economics	15 (7)	5 (8)
English	44 (24)	12(13)
Geography	11 (9)	8 (7)
History	55(29)	30(13)
Mathematics	14(11)	29 (12)
Religion	8 (24)	0 (14)
Technology	70(23)	38(23)
Visual Arts	39(11)	12 (9)

Table 3: Number of Students who made Comment about the Usefulness of the Unit during their internship by Teaching Subject Area

For literacy, all students except those studying Mathematics, Geography and Religion provided a response rate in excess of or close to twice that for the pre internship questionnaire. Strategies were classified as introducing topics/clarify learning outcomes (28 of the responses); vocabulary (33); reading (16); writing (23). Teaching vocabulary and introductory strategies were the most commonly reported. History and Technology students had about one third of their strategies devoted to vocabulary; Mathematics students one half. All students except those teaching Geography (3 for reading and 2 for writing) used fewer strategies to develop reading than writing and no one mentioned using more sophisticated strategies involving sequencing activities or the three-level guide for reading even though these were modelled extensively in tutorials.

With numeracy, Mathematics, Technology and History students had a higher level of response rate than students from the other teaching areas. The questionnaire asked strategies to be classified as computation (13 of the responses half of which were in mathematics lessons); number skills (28 of the responses); statistics (27); measurement (22); metalanguage (11). All the mathematics students' numeracy examples were in mathematics lessons and specific to syllabus content. One third of the Technology students reported strategies involving measurement; English and Geography students one third on number skills and one third on statistics; Visual Arts students one third on number skills and one third on measurement; History students one third on number skills and one third on statistics. Two Mathematics and two English students reported using Newman's analysis for contextual questions involving numeracy.

In summary, the number who identified the use of literacy (256) and/or numeracy (134) strategies substantially exceeds the total number of students (105). Hence, it appears the unit had some impact on the students' teaching of literacy and numeracy in their various teaching areas. Literacy strategies were seen as far more useful across the range of subjects except for Mathematics, even though more sophisticated approaches were not cited. English, Technology and History in particular reported higher literacy usage. History also reported finding the numeracy content highly applicable. Vocabulary strategies figured prominently in literacy and while the spread of different strategies was more even in numeracy. Newman's analysis was seen as useful for unpacking numeracy question set in a context.

Supervisors' Observations

The two responding university supervisors at two different schools completed the same questionnaire as the students' post internship one based on what they observed in lessons. A total of 10 students from the cohort of 105 were observed.

The first supervisor observed four students from the cohort teaching twelve lessons and observed one of student teachers using explicit teaching of literacy in nine of these lessons (Visual Arts 4, History 2 and Religion 3). Teaching vocabulary was noted on eight occasions through glossaries and explanations of technical terms. Reading strategies such as students reading aloud and paraphrasing sentences was observed in four lessons. Writing strategies involving scaffolding were also observed in four lessons. The supervisor observed the explicit teaching of numeracy in five of the twelve lessons (Visual Arts 2, History 3). There were four lessons where number skills were specifically addressed and in two others graphs and measurement were a focus. This supervisor stated that though he observed instances of explicit teaching, they were brief and a normal part of lessons. Not much careful explicit teaching of skills was identified; rather the skills were demonstrated, revised or highlighted in response to student questions.

The second supervisor observed six students from the cohort teaching fifteen lessons (Mathematics 6, History 3, English 3, Geography 2 and Religion 1). She observed the explicit teaching of literacy in two non English lessons only: one Geography lesson and one History lesson where for both the observed strategy involved the use of glossaries and students reading aloud. Apart from the Mathematics lessons, she observed explicit teaching of numeracy in two Geography lessons (compass bearings and reading graphs) and one history lesson (discussing centuries). She stated that these five lessons were the only non English, non mathematics ones where she observed the explicit teaching of literacy and numeracy.

In summary, there were few strategies taught in Curriculum Literacies observed by the two supervisors and the ones that were tended to be content specific (e.g., compass bearings) or vocabulary or based on students reading aloud.

Conclusions

Curriculum Literacies clearly had some positive effects on the majority of the students' personal knowledge and pedagogy in both literacy and numeracy. There was clearly more reported in literacy - in particular by the Technology students.

The greater acknowledgment of the usefulness of literacy and the evidence here that a considerable number of humanities and visual arts students have difficulties with Mathematics and prefer not to engage with it points to the fact that embedding numeracy in more subject areas is clearly a challenge. The findings are consistent with Milton et al (2007) observations about fewer teachers seeing themselves responsible for numeracy than literacy and Watson's (2009) assertion that it is more difficult to convince teachers that numeracy is also their responsibility across the curriculum. The results also show we have some way to go to achieve Gough's (2007) position that non-mathematics specialists teachers must take responsibility for covering most of the mathematical applications that arise in their own non-mathematics subjects. Positively, the data suggest that history may not fit this picture

as many student teachers found explicit numeracy teaching supported the history content.

The supervisors' observations suggest the actual amount of explicit teaching of both literacy and numeracy was not as high as the student post internship comments suggest. The frequency may be true across the board but the observations (10 students) out of the 105 doing the internship make it only a small snap shot. Any follow up study would do well to increase the observation data and could even look to engaging supervisors and teachers more to promote the practices sought in the students on internship. The students' comments at least show that they are aware of the need for the explicit teaching of literacy and to a lesser extent numeracy. However, while both student reporting and supervisor observations suggest the types of strategies being adopted in literacy are reasonably low order and in numeracy very content specific, the widening of strategies remains a challenge. One positive aspect for numeracy teaching was the responses of the students to Newman's analysis (1983) as a tool for dealing with contextual problems. Such a tool lends itself to the types of Mathematics questions asked in national testing.

The results reinforce the need for units in teaching degrees which focus on explicit teaching of literacy and numeracy across the curriculum and fits the national teaching standards being developed. The quantity of data allows for general conclusion similar to other studies but also provides a more in depth analysis of students' responses from the different teaching areas. The following student comment epitomises the potential benefits of the unit.

I work in a school a couple of days a week and they are looking at literacy across the curriculum and the literacy needs of teachers. As a new teacher I feel I have an advantage as I have had it refreshed. I have implemented some things I have learnt in my year 7 class.

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