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"There's a Reason for all the Numbers": Using a Literacy Framework in Enabling Education to Bridge the Gap Between Low Adult Numeracy Levels and Undergraduate Mathematics

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Abstract

If the Australian government is going to reach its target of 40% of 25–34-year-olds attaining a bachelor degree by 2025, it is critical that enabling courses are properly situated to bridge the gap between the alarmingly low numeracy of the adult population, and the mathematical or quantitative literacy (QL) required for undergraduate study. Yet, however, there is no single, widely accepted model for building the QL of adult learners. Data from students in one enabling course at a regional Australian university was analysed to identify potential congruence between students' understandings of their mathematics learning and the key elements of the four resources model (4RM), widely used to teach literacy in K-12 environments. Results showed that the 4RM can be mapped on to students' existing understandings, suggesting the model has strong potential for developing enabling curriculum and helping students prepare for undergraduate mathematics.

***Keywords**:* Enabling education; Adult numeracy; 4 resources model; Mathematics education.

Introduction

The Australian government has prioritised widening participation in higher education, aiming "to increase the bachelor degree attainment of 25-34-year-olds to 40% by 2025" (Gale, 2015, p. 258). Indeed, the benefits of improved education levels are widely reported (Brown, 2020). One significant barrier to this is the consistently low levels of literacy and numeracy of the post-school population. Of particular concern for this study is the low numeracy levels. A report on 2018 data showed that 46% of high school students did not meet the PISA Level 3 criterion for mathematics, a point at which students are considered "low performers" (Thomson et al., 2019, p. 23). Low adult numeracy is an issue in itself (Gal et al., 2020), but even more critically, if students are leaving school with numeracy deemed too low for everyday life and work, then there will also be a considerable gap between their existing levels and those required for university study (Vernon et al., 2019).

To fill this gap, enabling courses, sometimes called bridging or foundation courses, have been established at many educational institutions as an alternative pathway to bachelor level courses (Pitman & Trinidad, 2016). These also serve in part to bridge the gap between prior, usually school, knowledge, and that required for bachelor courses. Enabling courses, however, have more to deal with than simply a knowledge gap:

> Enabling education is an important first step back into learning for many disenchanted or previously 'unsuccessful' learners, and a key pathway for equity groups into Australian HE … and unpacking the discourses and cultural awareness to facilitate academic 'preparedness' is of crucial importance to students' success. (Baker & Irwin, 2016, p. 491)

Thus, the *way* of teaching, curriculum design, pedagogy, and consideration of students' backgrounds is critical.

Quite often, the blame for a lack of prior success has been misplaced onto the students (known as the "deficit model" (Kalantzis & Cope, 2016; Oughton, 2018)), especially those from backgrounds less traditionally seen in higher education, such as low socio economic status (SES), rural and remote, and first-in-family (Abbott-Chapman, 2011; Johns et al., 2016; Vernon et al., 2019). However, Pearce and Down (2011) argue "that universities and academics should pay closer attention to the particularities of students' social histories—language, culture, experience and interests—to create a more participatory and empowering education" (p. 485). A study by Willans and Seary (2018) revealed that enabling students often wanted more support to gain skills in *how* to learn. This is consistent with Motta and Bennett (2018) who found that, "content is less significant than skills [and thus] approaches and literacies within the context of the course and the experience/needs of the student" were vital for student success in any content area (p. 641). This shifts the focus for enabling students' success from what the students cannot do, to what the institution can do to promote students' understanding.

Context

The STEPS course has run at CQUniversity Australia since 1986 and is specifically designed to introduce students to the university environment (Pitman & Trinidad, 2016). As such, STEPS aims to provide context and content-specific learning and offers a low-cost pathway to bachelor level courses for those who "lack the essential knowledge and skills to successfully gain entry to a tertiary institution" and have been "hindered by both their past and present educational, social or cultural situations" (Seary & Willans, 2004, p. 310). The STEPS course consists of 12 units available for completion within a two-year time frame, including three mathematics units. Students are required to complete the core unit, Preparation Skills for University, plus a minimum of two other units. Each student's study plan is developed during an interview with an Access Coordinator who considers the student's situation, any prior studies and the requirements of the undergraduate course the student is hoping to enter. Each undergraduate course at CQUniversity has a set of enabling units as prerequisites, decided upon by the STEPS Head of Course in collaboration with the undergraduate Heads of Course, and most courses require one or more mathematics units to qualify for entry.

Choice of Framework

While the STEPS course was developed using adult learning principles, no explicit educational framework was used for teaching mathematics. This study draws from a Master of Education study examining the mathematics learning in the STEPS course where student interview data was collected with the aim of identifying pedagogies and frameworks that would align with the specific needs of the enabling cohort (Mann, 2018). In that study, different pedagogies and frameworks were analysed in relation to the data and one was chosen to examine in detail, the Four Resources Model (4RM) detailed below.

Research Questions

This study analysed enabling students' discourses around learning mathematics to identify whether students made use of the 4RM framework in their mathematics learning. The units the students were enrolled in did not use the framework explicitly and the framework was not introduced to the students during the study. The study was exploratory, and the research questions were:

- *When discussing their learning in the units, do the students mention behaviours that could be identifiable as one or more resources of the 4RM framework?*
- *If it is identified that these behaviours are aspects of the framework, does the type and number of resources used influence the level of quantitative literacy of the students?*
- *How could the 4RM be potentially integrated into the curriculum for teaching mathematics for quantitative literacy in an enabling course?*

This article describes the results and discusses the implications for enabling education.

Theoretical Framework

Quantitative Literacy

During the 1990s, the term "literacy" was expanded from its original application to words or texts to apply to many different areas of learning, including mathematics (Cope & Kalantzis, 1997). The concept of quantitative literacy extends and builds on the concept of numeracy, and, while they are similar, there are important distinctions between the two. Numeracy is focused on doing the mathematics, often in an abstract context, whereas quantitative literacy must have a real life context and "must not be seen merely as a set of generic mathematical skills and techniques" (Frith & Prince, 2016, p. 5). Importantly for enabling

students, there "are different quantitative literacy practices associated with different academic disciplines" (Frith & Prince, 2016, p. 5), so it is important that in enabling mathematics units, students can develop quantitative literacy for their differing future learning requirements.

The Four Resources Model (4RM) for Teaching Literacy

Freebody and Luke (1990) propose a framework for literacy in a sociocultural context that involves "four roles." These educationists are credited with developing the roles into the notion of "resources [as] necessary components of literacy" (p. 7). This development became known as the "Four Resources Model" (4RM). As Anstey and Bull (2003) explain, Freebody and Luke describe their model "as a framework to help teachers interpret the social critical theories of literacy… specifically for the teaching of reading" (p. 92). Anstey and Bull proposed that this framework would be useful across several practices including history, science and mathematics. As such it has become a feature of school literacy curricula (Ludwig, 2003; Quinnell, 2016; Serafini, 2012). The 4RM provides a theoretical framework to explain processes "that teach students to analyse tasks, problem-solve, identify resources and selfmonitor" (Anstey & Bull, 2003, p. 91).

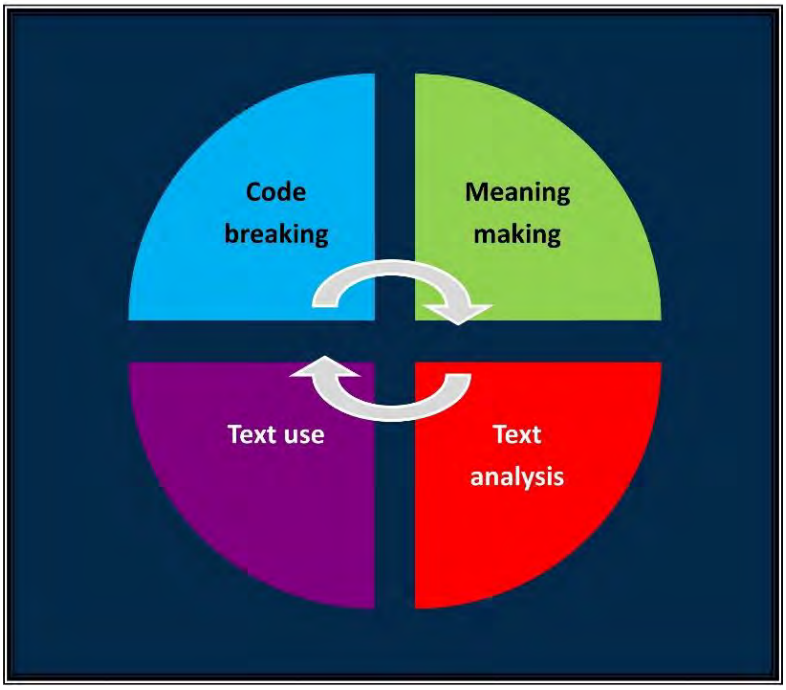
The four learning resources in the 4RM are interwoven and interrelated (Anstey & Bull, 2003; Freebody & Luke, 1990). They are:

- Code breaker: "make sense of the 'marks on the page'…to understand how these parts work individually and in combination" (Anstey & Bull, 2003, pp. 92-93).
- Meaning maker: "make literal and inferential meanings of text… Understanding the genres of the texts used in particular disciplines" (Anstey & Bull, 2003, pp. 94-95).
- Text analyst: "the critical analysis of texts in order to understand how texts construct and reconstruct our world, how we live in it and the power we exercise over it." (Anstey & Bull, 2003, p. 97).
- Text user: "use of text in different contexts and on different platforms [and] variation in its structure or layout" (Anstey & Bull, 2003, pp. 95-96).

These have been presented in the literature as non-hierarchical (see Figure 1).

Figure 1

The 4RM for literacy [Adapted from Serafini, 2012]



4RM and Mathematics

The 4RM has been adapted for use in mathematics literacy in the primary school context, and two examples of such adaptation are discussed here. Quinnell (2016) presented a mathematical representation of the 4RM in her doctoral thesis. They allocate specific mathematical symbols, terminology, meaning and analysis to each of the four resources:

- Code breaking: Mathematical symbols (e.g., π, ¼, ≥) and abbreviations (e.g., mm, NE, h); words and sentences; graphs, tables and visual images
- Meaning making: Word meanings (instructional, lexical, technical, everyday, prefixes, roots, origins, synonyms, conjunctions, obsolete words, words for abstract concepts, modified meanings)
- Critically analysing: Understanding that texts (with mathematical content) are written for set purposes and may influence readers in various ways
- Text using: Presenting and understanding text with various structures and features; including text containing multi-semiotic systems

Quinnell draws attention to aspects of mathematical text that may not be found in written text. For example, "directionality" is not necessarily a consideration in conversational language, but in mathematics, it is the order of operations, not the order of appearance that determines the meaning. Mathematics also has terminology that has specific mathematical implications.

A second study (Stack et al., 2010) related the 4RM more specifically to learning mathematics. This model is centred on questioning in order to help students develop deeper thinking around mathematical terminology and concepts:

- De-coding: What are the different ways numbers are used and represented? What is the terminology being used and what does it mean?
- Meaning-making: What is this text about? How can I use what I already know?
- Analysing: Are the mathematical concepts used appropriately in this text? What is the evidence? Does it have reasonable assumptions?
- Using: How would I use this text and what decisions would I make based on it?

Stack et al. (2010) found that teachers could successfully use the mathematical version of the 4RM such that students' "skills can be developed, gradually building on students' increasing familiarity with the contexts and the mathematical concepts" (p. 15).

These two models demonstrate that the 4RM can be used in a mathematics context to answer the question of how students develop quantitative literacy in learning mathematics. However, both studies are in a primary school context and focussed on teaching – that is, the teacher implemented pedagogies and curricula based on how they wanted the students to use the resources. For enabling students, however, it may be possible to take a more student-centred approach. This could involve using the principles of adult learning (Candy, 1991; Knowles, et al., 2005; Mann & Willans, 2020) to develop the 4RM as a way of "equipping students [and] providing knowledge that would become a basis upon which to build new literacies" (Anstey & Bull, 2003, p. 77). "Andragogy" (Knowles, 1981) holds that adults should be active participants in their own learning, as they have a tacit understanding of their own learning styles and preferences. While there have been criticisms of andragogy, the concept that adult learners are situated within the learning is still relevant for studies of enabling education, as pointed out by Mann & Willans (2020). One important aspect of andragogy, as emphasised by Street et al. (2006), is that educators "take into account the existing knowledge and practices of the adult learners" (p. 33). Part of engaging students in their own learning is making the link to their prior learning explicit. Burke (2002) stated that by disrupting the "teacher-as-expert and keeper of all truth [the] students/participants were thus positioned as contributing vital knowledge" (p. 118).

Methodology

As stated above, this study stemmed from a larger research project investigating how STEPS students learnt mathematics. In the original study, the researcher used constructivist grounded theory methodology (GTM) (Charmaz, 2014). GTM does not use a statistical sample and is not required to meet a certain demographic criterion: participants are recruited on the basis that they have had the relevant experiences (Morse, 2010). The participants in this study were 13 students who were enrolled in or had completed one or two of the STEPS mathematics units, Fundamental Mathematics for University (FMU) or Intermediate Mathematics for University (IMU). Participants chose their own pseudonyms. A list of participant attributes is given in Table 1.

Table 1

Participant Demographics

Pseudonym	Approximate age	Working	Studying	On campus	Course
Jane	Late 30s	Full	Part	Yes	Psychology
Michelle	Late 50s	No	Full	Yes	Education
Cathy	Mid 20s	No	Full	Yes	Engineering
Stevie	Late teens	Part	Part	No	Nursing
Mike	Early 20s	No	Full	Yes	Building design
Caroline	Mid 50s	Part	Full	Yes	Accounting
Charlie	Early 20s	Part	Full	Yes	Engineering
Kasey	Early 30s	Part	Full	Yes	Education
Kay	Early 20s	Part	Full	Yes	Oral Health
Ro	Late 20s	No	Part	Yes	Education
Cyndel	Early 30s	No	Part	Yes	IT
Thomas	Early 20s	No	Part	Yes	Engineering
Grace	Early 50s	Part	Full	Yes	Engineering

The original study also used GTM's common data generation process of conducting semi-structured, individual interviews (Charmaz, 2014). The interview protocol was developed keeping this methodology in mind. The questions were exploratory in nature with the primary goal of elucidating information about the participants' experiences and gathering details about their processes, actions, understandings, conceptualisations, and implications. The protocol was flexible enough to deal with unexpected information, and the style of the interview was open and interactive, encouraging a conversation. It is noted that it is usual in GTM, and in fact beneficial, for the researcher to act as interviewer as they know the situation and subject matter and are not required to be an objective observer (Charmaz, 2014). The participants were asked questions such as: How are you finding your maths units? What is helping you learn? How do you overcome struggles? Where do you use maths in your everyday life such as work or hobbies? What mathematics do you see yourself using in the future (study/work)? The answers the students gave were then discussed in more detail.

Once interviews were recorded and transcribed, an initial thematic analysis was completed. This again followed GTM principles by not following a prescriptive process, but rather allowing the codes to "emerge" from the data. Coding followed the process described by Saldaña (2016), where the researcher "breaks down qualitative data … examines them and compares them for similarities and differences" (p. 295). This was beneficial as it allowed for more thorough consideration using the GTM technique of "theoretical sensitivity", which led the researcher to the notion of the 4RM as a tool for literacy. The researcher subsequently re-analysed the interview data to determine if students' descriptions of their actions were indicative of the individual resources, or the model. For the researcher, the most salient aspect of the model as shown in Figure 1 was the way combinations of resources could be used in a non-hierarchical manner, and especially how all four interconnected. Therefore, the researcher chose to present the analysis as combinations of resources. The applicability of the model would depend on how many of the resources were identified as being useful to the students, as well as how the resource combinations were used. The analysis begins with the use of one resource and culminates in a description of how some students were able to use all four, thus building a picture of the applicability of the model for STEPS mathematics units.

Results and Discussion

In the interviews, the students described what they did in prior and current mathematical learning situations. These descriptions were then analysed to identify activities congruent with the four resources. The researcher could then encode the descriptions of the actions according to one of the resources. For this study, the four resources were labelled and described as follows:

- Breaking code [BC]: – Determining *what* was in the text, knowing the symbols, new knowledge, writing out, seeing steps.
- Making meaning [MM] – Understanding *how* the mathematics worked, relating to what was already known.

- Analysing text [AT] – Exploring *why* the mathematics worked, how it was relevant, its use in different contexts, and real world applications.
- Using text [UT] – Using the text to *do* the mathematics, employ process, follow rules, practice in doing, solve new problems.

The results showed that all of the students described the use of learning activities or processes consistent with at least one of the resources, and often more.

Using One Resource

Jane, Michelle and Cathy predominantly used only one resource – breaking code.

Jane gives examples of where she was breaking the code: "I can see the number line and I know that positive will go that way, and the negative goes this way." However, when it came to interpreting the meaning of the symbols, she struggled: "I think when it's written down, in the form that it is presented to you in class it doesn't make as much sense to me." Michelle also talked about breaking the code: "Like point seven five of a metre or point three, yeah, I can see all that." She found it difficult, however, to convert much of the content into meaning: "Trying to get it into my head. See integers and that, I'd never heard of them", and: "I can sit and do sums all day and it means nothing to me".

In line with what Quinnell (2016) described, some of the code breaking by Jane was visual: "I've found that some of the diagrams in the maths book, which are wonderful, and I can make sense of them when I look at them." Also in line with Quinnell's (2016) discussion is determining mathematical symbols, relationships and equations from worded problems. Jane found: "If you give that problem to me in words, in more a real life situation then I can figure it out" and Michelle said: "in these, you've got to write in a sentence. I don't have a problem with them." On the other hand Cathy found it quite difficult: "The, worded [questions], the sentences, they confuse me. I can't pull the sum that they want from the worded questions." These questions involving real-life situations are asking students to make the leap from breaking code to making meaning, but Cathy struggled to advance to that point.

Although the 4RM was not presented by Freebody and Luke (1990) as hierarchical, analysis here indicates that in mathematics there could be a need for students to break the code before they are able to make meaning, use it, or analyse it. It seems perhaps they had become 'stuck' at determining what the text says and were not able to move on to other resources.

Using Two Resources

There were five students who used two of the resources.

Stevie described a combination of breaking code and making meaning:

> I had some trouble with one of the percentage questions. I could not figure out the way it was worded. I knew how to do it I just couldn't figure out what it said. Then I messaged this girl and she's just like 'think about this'.

Hence Stevie was able to make meaning by thinking it through. She also used the online videos provided in the unit to make meaning of the work: "[The lecturer] kind of explained himself a bit better and I'm not sure how or why but it sunk in a little bit more."

In contrast, Mike predominantly described analysing and using text. One way Mike made meaning was through analysing different processes, hence analysing text and making meaning: "If you understand what a fraction is then everything else slots into place. That's why we're dividing, the way we can divide it, why we can do this with it. Understanding why and how can really improve maths comprehension." He was also quite confident in using the mathematics: "[I] was using the unit's method which I'd actually worked out myself."

Analysis of Stevie and Mike's data showed an interesting relationship. For Stevie, in breaking code and making meaning, she was able to understand how problems were done and could see the progression. She did not, however, make any comments that would indicate that she understood why the progression took place. This also meant there was a hurdle between seeing how others did it (in the videos etc.) and doing it herself. It is noted that she only used resources on the *upper* side of the model, and similar to those only using one resource, it seems she was also "stuck". On the other hand, Mike wanted to know why certain methods were used, and was very competent in using the processes without having to think about breaking the code or making meaning. Therefore, Mike was using resources on the *lower* side of the model.

Caroline also described two resources. First was breaking code: "Some of the terminology in it's been quite difficult." She talked about writing down what was in the question: "That's the first step to any mathematical problem is you've read it and you're writing it down and then writing the sum down." Second, she described doing the mathematics, which is using text: "If you write that percentage equals what you're looking for and you work it out on the scale, you just look up 30 percent." She seemed to miss out on the making meaning and analysing text aspects: "Maths has only got ten numbers. There's only ten numbers whichever way you look at it. It won't go any higher, won't go any lower, it's logic, it's straightforward, you don't have to think about it." This continues as she describes simply following a process to get a result: "There's rules that apply" and "the setting out, it's got to be the way [the lecturer] wants it."

Similarly, Charlie described following the rules to solve problems, that is, breaking code and using text: "It's just remembering the rules that go along with it. And then just applying them when seeing them written down in a different way." Remarkably, when he mentioned that he "like[s] reason behind something" and was questioned on the reasons, it did not involve making meaning or analysing text, it was simply: "It's a reason that this is happening, which is because of a rule. There's a reason that this is going from here to here, and it's because a rule."

Analysis of the data from both Caroline and Charlie showed they were breaking code and using text, and these are both resources on the *left* side of the model. The combination of breaking code and using text without making meaning or analysing the text is simply rote learning or copying a process. Difficulties arise when problem solving is needed that relies on a change to that process. If the student does not understand why it is done that way, they may not be able to be flexible in approaching new problems. It is also important that when students look for "reasons" when analysing text, they are identifying mathematical, inherent, or real-world reasons, rather than, as in Charlie's case, blindly following a rule (using text without analysing text). Also, it seems evident that students cannot engage in using text without first breaking code. It may have seemed that way with Mike, but he had done a lot of maths before and it could be inferred that he had previously broken the codes on that content.

Kasey's approach was the opposite of Caroline and Charlie's. She described mostly wanting to make meaning and analyse the text:

> I think it's better to have the understanding, but to get the whole picture. It was actually finding that there is the real world aspect to it, but not just that, it's that there is a reason to do it and that is probably the best thing.

She described a strong need for reasoning, because of real life and not simply because of rules: "There's always a reason for all the numbers in the world, but actually being able to show that there is a reason why we're doing this, it's not just so we get the maths in our head." She added that there is a benefit to reasoning: "if people had that extension on things, there's a reason why we do [it, it would] actually get people not to be scared of it." Kasey did not, however, talk about actually doing the maths, whether by interpreting text and breaking code, or putting the meaning into practice and using text. She could find the meaning and know why, but it is not clear whether she could translate that into solving new problems. She was demonstrating making meaning and analysing text and these fall on the *right* side of the model.

All students who used two resources used ones that were adjacent in the model, rather than diagonally opposing resources. It is noteworthy with Mike and Kasey that neither described breaking code, a resource described above as potentially necessary before the other resources. This may be because they both had advanced prior learning and had already broken the code: Mike did well in school and Kasey had been given an exemption from FMU.

Using Three Resources

Three students used three resources. All of these students described using breaking code, making meaning and using text. The common resource they were missing was analysing text.

Kay described breaking the code: "the big line down the middle is actually a divide", and making meaning: "I interpret it my way", and was then capable of using it: "one of the methods was a FOIL method, [the lecturer] said I tend to use that a lot and she said it's good because it gives you a whole picture." Similarly, Ro was able to break the code: "our lecturer's taught us just to pull out all the maths facts", make meaning: "and try and link up what mathematic operation we need for it", and use the text along with the new-found meaning to solve problems: "when I thought I understood it, they would give me an example, and then I would do it and if I got it right, they were like, ok cool, you've got it." Cyndel also described the same three resources of breaking code: "drawing the applications, drawing the picture, trying to work out how", making meaning: "then

see where the angle is that they're wanting us to find", and using text: "I have to do it on paper." Cyndel shows the use of all of these resources: "I got to copy, and then I got to learn like that by doing it, with different exercises till it sinks in."

Even without the fourth resource, analysing text, students were still quite competent at doing the mathematics. They could understand what was happening, how to solve the problems, and do problems for themselves. Perhaps the reason they were missing the analysing text resource was that it was not seen as essential or else it took extra time. They may not have even realised they were missing it. It may only be later when they must apply the mathematical concepts to their context-specific learning in their undergraduate degrees that they are disadvantaged by not having a full grasp of analysing text.

Using Four Resources

Thomas and Grace described using all four resources.

Thomas discussed all resources many times, and succinctly described them in one statement:

> Before it was just numbers on a page, but now I actually want to remember what I learn. I probably have a deeper appreciation for its role in the world. Working from design plans … you pick up the importance of a lot of theories … but the core mathematics involved with that, it has such an important role. I feel like I really want to understand how it all works and remember how it actually works.

From breaking the code of "numbers on a page", through making meaning in terms of "understand[ing] how it all works", to analysing text from the real world, to then being able to use the text himself, Thomas demonstrated a thorough use of the entire model.

Grace also showed that she used all four resources in the model. She described breaking the code by breaking down the problem: "I have to work through the examples to figure out how they worked it. It's not broken down [it is] just a complete, full package there." Grace gave an example of making meaning in terms of relating the concepts to previous learning:

> That's what I found good about Fundamentals is that we started building up. You built on this, you built on that. I think we should be reminded to do that, recall what you've covered so far, you can apply it.

Grace also really liked the worded questions to analyse the text: "I see value in them. I mean, you must be a fool then if you don't think it has a practical application." Even when she talked of understanding, making meaning and analysing the text, she was clear that it was also important to apply that and use the text for herself: "At some stage though, you're going to have to have a go yourself."

It is noteworthy that the two students who used all four resources were also the most experienced with mathematics. Thomas had done Mathematics B and C in high school, "[so FMU was] more of a refresher course for me", and had also worked in an industry with strong mathematical application. Grace also had a strong school background ("I did to grade ten and that was very good and then … I did grade eleven and twelve") and had also done a Certificate 3 in Laboratory Skills. In addition, she had done Accounting at school and "loved Accounting. Maths and the Accounting." This was interesting because the less mathematically experienced students had not only missed learning the mathematics concepts, but also missed aspects of how to become more quantitatively literate according to the 4RM.

Summary

The 4RM is a very powerful tool in helping students develop literacy and has great potential for developing quantitative literacy in enabling students. For students, it means understanding at a core level what they need to achieve in four steps. How they can achieve those steps is outlined in each resource. For teachers, it theorises and breaks down the cognitive steps of learning so that they can teach in a way that will have the most impact. In their discourse about learning mathematics, students discuss many actions that can be attributed to the various resources in the 4RM, demonstrating that this model would be applicable in teaching enabling mathematics units, if all of the resources are used.

The resource that seems to have been the simplest for the students to use was breaking code because the abstract "form that is presented to you in class doesn't make much sense." This is a logical first step in learning mathematics, as it is necessary for students to be able to interpret the symbols to understand their meaning and use them. With adult learners in a tertiary environment, it can be easy for teachers to forget this as a fundamental principle, as they may assume prior knowledge. The

students have clearly articulated that this is a necessary step. Having a model that includes code breaking is therefore important in an enabling course.

When it came to using several resources, there were different outcomes depending on how many resources were used and particularly which resources were combined. This resulted in being able to see why the content made sense, but not being able to replicate it, or being able to do it in a repetitive way by simply "remembering the rules", but not being able to understand why or transfer it to other situations. Being able to replicate and transfer the knowledge to new situations is one of the aims of any enabling course and is thus necessary for students to learn the complete set of skills. The students who used three resources seemed to be quite capable of learning and even doing the mathematics, but without the sound understanding that comes from analysing text, there is still core information missing that would help students to apply this knowledge to more complicated content in the future. It is clear that any model for developing quantitative literacy needs to be more than any combination of two or three resources.

The applicability of the 4RM over other models can really be seen in the final analysis of the students who had used all four resources. These students were not only the most successful, but also the most engaged with the subject matter. The power of the 4RM comes from combining all of the resources in a non-hierarchical, iterative way, in a context in which both the students and the teachers understand the full process. In an enabling course, this would help students learn the skills they need to take into an undergraduate course.

This analysis suggests that the 4RM could be an effective tool to help lecturers construct curricula in enabling mathematics units to ensure students are exposed to all four resources, in terms of both content and promoting a more complete understanding. It might also help lecturers examine what is lacking in a student's approach to learning, and provide activities or material to decrease those gaps. In practical terms, it could be used by teachers to provide worksheets on breaking the code of symbols, incorporating discovery activities that link the new work to existing knowledge, or encouraging text use through gamification where 'failure' is simply part of improving.

It could even be more powerful in the enabling education context, where students are adults and are encouraged to be self-directed learners, than in the school context. As students move through mathematics units, they develop ability in the four resources, and confidence to use these resources for themselves. In the enabling environment in particular, this shifts the power balance from the *knowing* teacher working with *unknowing* students to literate students who can use the resources for themselves, while the teacher acts as a guide who can tailor practices depending on student need. Again, in practical terms for teaching and learning, that means the students could refer to the model when asking for help with direct instruction to help break the code, making their own meaning through examples that relate to their own prior knowledge or specific situation, or normalising trial and error in using text. Students and teachers would then be able to use all of the resources to achieve quantitative literacy.

Conclusion

A low level of numeracy poses a barrier for adults to enter higher education, and specifically bachelor degrees. Enabling courses have been shown to be successful in preparing students for this transition (Willans & Seary, 2018) and are ideally situated to widen the participation in university courses for students from non-traditional backgrounds. It is important that as part of their preparation, students are not only taught numeracy, but also taught skills on *learning how to learn*, becoming quantitatively literate to maximise their success in higher level courses. This means that prior learning must be recognised and incorporated into learning strategies, and students positioned as active participants in negotiating their own learning journeys. The evidence presented here clearly shows that students are already using learning behaviours that are identifiable with the resources in the 4RM. It is also clear that there is a correlation between a level of quantitative literacy and the use all four of the resources. This suggests that using the 4RM in a way that draws on andragogical perspectives may provide further opportunity to increase the quantitative literacy of enabling students. It could also be relevant to all adult education environments, and could perhaps help to ensure the government target of bachelor degree attainment is achievable.

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