Skills-based learning within a constructivist curriculum: The case for rote learning to automaticity the multiplication facts for maths and alphabetic skills for reading

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ABSTRACT

Learning theories, and the many teaching practices based on them, abound throughout all education systems. Even though many of these theories and practices lack research-informed evidence and/or credibility, their presence persists in the instructional environment of the classroom. Over recent years, New Zealand primary schools have put a heavy emphasis on constructivist-based pedagogical instructions, and this has led to a de-emphasis of rote learning. This paper provides discussions around the roles of rote learning to automaticity the master of basic constrained skills in maths and reading. It argues that some skills, for instance, instant recall of basic number facts for mathematics, can be effectively developed through rote learning. As a learning method, rote learning can be used to address issue of students who develop early learning difficulties. Therefore, using rote learning to help address these issues should be considered to be harmless for no one, beneficial for all and vital for some.

Keywords: Constructivist curriculum, rote learning, multiplication fact, alphabetic skills.

INTRODUCTION

Learning theories, and the many teaching practices based on them, abound throughout all education systems. Even though many of these theories and practices lack research-informed evidence and/or credibility, their presence persists in the instructional environment of the classroom. For example in literacy, there are theories and practices promoting the use of coloured lenses as ways to help children with particular reading difficulties. There are also “learning styles” theories suggesting for example that some children have either visual, auditory or kinaesthetic preferences for learning that result in different curriculum deliver options for students, depending on their “personal learning styles”. However, Hattie and Yates (2014) argue that “there is not any recognised evidence suggesting that knowing or diagnosing learning styles will help teach students any better than not knowing their learning style” (p. 176).

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The theories and practices of whole language instruction in literacy education that are based on the unfounded premise that learning to read occurs as naturally as learning to speak, have been present in primary schools for several decades even though there is abundant research evidence demonstrating that this premise is incorrect .

Another practice that has found favour in New Zealand primary schools over more recent years involves a heavy emphasis on constructivist-based pedagogical instruction. Constructivism has several defining characteristics including a de-emphasis on the importance placed on rote learning to automaticity for learning certain sets of basic constrained skills. It is argued that the predominance of constructivism within the New Zealand mathematics and literacy curricula has been the main reason for the de-emphasising of rote learning of some constrained skills such as the basic number facts for maths and alphabetic skills for literacy.

CONSTRAINED AND UNCONSTRAINED SKILLS: THE CASE FOR MATHS AND READING

"Developing automaticity in cognitive processing represents a major goal for students as they progress through the reading and mathematics curricula in the junior primary years. Without such development, subsequent academic work becomes a matter of constantly using effortful and costly mental strategies" (Hattie & Yates, 2014, p. 61).

Skills-based learning can involve mastery of both unconstrained and constrained sets of skills. Unconstrained skills are those that continue to develop over one's lifetime and are therefore infinite in number. Examples of unconstrained skills include those involved with the development of comprehension strategies in reading and general vocabulary. As these skills are infinite in number, they continue to be developed and refined throughout one's entire lifetime (Paris, 2005). However, there are other sets of skills that are finite in number and therefore considered to be mastered by most students in a relatively short time span. The English alphabet for example has only 26 letters and, when learned as a group of single units (e.g., letter names) or in combination with other letters to represent the approximately 42 different sounds of the English written language (e.g., sh, oa, igh), provides the basis for both fluent reading and spelling skills. The English alphabetic and the orthographic representations of the speech sounds are both examples of constrained skill sets.

A similar case may be made for the basic number facts for maths (e.g., multiplication facts). Once they are mastered, constrained skills have been shown to play an important role in subsequent or higher levels of learning. There is an advantage in having instant recall of knowledge embedded within sets of constrained skills such as multiplication facts for maths and/or the alphabet for reading. Students who do have such knowledge are better able to focus their attention on the higher order cognitive processing task requirements including those involved in problem-based learning, than are those students who do not have instant recall. For example, having instant recall of particular letter-sound patterns' knowledge for quick and accurate decoding, allows the reader to allocate more cognitive energy to focus on the higher order comprehension strategies. Fluent reading is based on the ability to automatically recall words instantly and such automaticity of word recognition enables the reader to better focus on the wider understanding of the text. Students who are not fluent and need to spend more cognitive energy on identifying the words, will almost always have difficulty understanding what they read. Similarly, in maths, the instant recall of basic multiplication facts would allow the student to allocate more cognitive energy to the understanding and solving of the higher order problems. The corollary of this is that where the student has difficulty recalling basic facts as an integral step towards

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the solving of a mathematical problem, the likely outcome for the student is destined to be either confusion, and/or inevitable failure.

If constrained skills are not learned relatively early in school, they can also sometimes hinder later development. Constrained skills may therefore be viewed as a necessary (but not sufficient) prerequisite for later development. When discussing the importance of early mastery of number facts for mathematics Hattie and Yates (2014) argue that “students who display low levels of number facts at the junior primary level will proceed into the upper levels, but remain ‘at risk’, and are adversely affected by factors such as time pressure” (p. 58).

Because they are finite in number, it has been suggested that constrained skills are also relatively easy to learn for most children (Paris, 2005). However, some children require more explicit instruction and opportunities for them to master such skills. But such instruction and opportunities are seldom part of a constructivist learning environment. This is because it is believed that students will acquire the necessary skills merely by being part of a group in which skills and knowledge are “co-constructed” usually within group settings where the teacher is encouraged to “facilitate” the learning rather than to actively lead it.

However, with the added emphasis (in contemporary maths teaching) on the development of conceptual understanding and problem solving, there is even more reason why automaticity in the recall of basic facts is relevant. As Geary and Brown (1991) found, many students who have difficulties with early math concepts also have difficulty with retrieving math facts. In support of this view Westwood (2003) argues that “just as some students seem to need more direct teaching of basic literacy skills, it seems equally evident that certain students require more than just casual exposure to number relationships through problem solving discovery and discussion, if they are to reach mastery” (p. 13).

The problem with relying on problem-based methods of teaching in primary school, particularly with regard to the teaching of maths and literacy, is that young students are still developing number sense (for maths) and decoding skills (for reading comprehension) but without the automaticity required to attend to the higher level cognitive processes involved in the understanding of the wider problem. Westwood (2011) argues for example when discussing maths learning that ”most difficulties arise with a problem-based approach from the erroneous belief that all young students will acquire and master fundamental number skills simply by engaging every day with age-appropriate problems” (p. 9).

This is a similar concern with the whole language approach to teaching reading where the act of learning to read is considered to occur naturally like learning to speak where the child engages in age-appropriate speech experiences. This naturalistic learning-by-immersion view of speech development is considered to also be representative of the way reading skills develop. Because children learn to speak without necessarily receiving explicit teacher-led instruction, the constructivist view of reading similarly espouses the philosophy that there should be limited explicit teacher-led instruction in reading lessons. Rather, the focus should be on presenting the child with a ‘print-rich’ learning environment within which learning to read is believed to occur with minimal input from the teacher (see Moats, 2000). The teacher in both cases (i.e., reading and maths) is viewed more as a ‘facilitator of learning’ rather than an instructor. Furthermore, the learning of separate sub skills such as rote learning the alphabet or learning letter names or sounds outside of the context of regular reading or the rote learning of basic multiplication facts outside the context of ‘problem solving’ is not emphasised or even encouraged.

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SOCIO-CONSTRUCTIVISM FOR ALL?

While definitions of social constructivism vary, there are several common components that characterise the term. The socio-constructivist theory of learning suggests that every learner constructs their own meaning and knowledge from their personal experiences. Furthermore, it is believed that children develop and refine their thinking skills more effectively within social settings and groups where the learning becomes a shared process. Another characteristic of socio-constructivist learning is that the teachers' roles are viewed more as facilitators of learning rather than as instructors. Within the regular approach to teaching the teacher is viewed as someone who tells, but within a constructivist environment, the facilitator is viewed as someone who presents the learner with opportunities to develop their own intuitive thinking skills. Within this intuitive learning environment the learner is also given opportunities to develop guesswork strategies when presented with problems. Within the socio-constructivist learning environment, the learner and the facilitator are also considered to be equal partners in the learning process and the learner is more often encouraged to discover the main concepts. This is different from the regular teacher-student relationship where the teacher is viewed as the instructor who imparts knowledge to the students.

The main reason for the underplaying of the role of rote learning to automaticity for multiplication tables, appears to be based on a somewhat misguided theory of learning that maintains that all children will somehow better understand tables facts (only) if they first understand that the product can be represented in more than one way by manipulating the different factor combinations. As an example, where 5 x 6 = 30, the predominant learning strategy suggests that before a child is able to understand this equation they must first understand that the product (i.e., 30) may also be represented in other ways such as: by grouping three lots of ten (e.g., 3 x 10 = 30) or six lots of five (e.g., 6 x 5 = 30) or ten lots of three (e.g., 10 x 3 = 30). Knowing all the different factor/product combinations in such instances is a useful example of higher level thinking than mere recall of facts, but having this knowledge in the form of basic recall of the facts must surely also be relevant and helpful for the student.

It would be expected that the ability to quickly and seemingly unconsciously recall basic tables' facts must be a bonus for those students who are also able to recall such facts on an instantaneous basis during any maths-related problem solving situation. The main reason for this is that the instant recall of the facts allows the student to allocate more cognitive energy towards a wider understanding of the problem. In support of children being able to instantly recall basic facts as a way to avoid additional cognitive overload Woodward (2006) argues that "Information-processing theory supports the view that automaticity in math facts is fundamental to success in many areas of higher mathematics. Without the ability to retrieve facts directly or automatically, students are likely to experience a high cognitive load as they perform a range of complex tasks" (p. 269). In support of the role that automaticity plays as a means of freeing up cognitive space to allow for higher order thinking and processing abilities, Hattie and Yates (2014) further argue that "the notion of automaticity implies that when basic skills are automated, mental space becomes available for deeper levels of thinking and understanding through acquiring knowledge. Knowledge literally provides the mind with room to move, to develop and to change" (p. 58).

This is also a particular problem for those students who do not have an instant recall, of the basic facts. As Westwood (2003) claims, "to be competent in problem solving one needs to be able to draw easily on essential declarative and procedural knowledge. There is a possibility that activity-based methods and process maths have been stressing the development of concepts and strategic knowledge while underplaying the equal importance of automaticity in declarative knowledge and mastery of computational procedures" (p. 14).

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While the mere act of learning tables facts by memory to automaticity may appear to be rather meaningless, Christodoulou (2014) nevertheless sees such learning as the basis of understanding when he argues that while "just learning that 4 x 4 is 16 will be of limited use, learning the multiplication table and learning it so securely that we can hardly not think of the answer when the problem is presented, is the basis of mathematical understanding. [And so], if we want pupils to have good conceptual understanding, they need more facts, not fewer" (p. 32). In support of this view Hattie (as cited in Woulfe, 2014) states "I'm a great fan of teaching kids the times tables by rote. Why would you want to understand why six times nine is 54? It is, just accept it. Then you can use it" (p. 20).

When discussing the relative importance of learning constrained skills for literacy Paris (2005) is somewhat reluctant to acknowledge that some children may require more explicit instructional exposure than others before such skills are mastered. In support of this view Paris states for example that "Constrained skills are distributed at different mastery levels between people only during the brief period of acquisition. They are mastered by everyone eventually, whereas unconstrained skills are distributed between people on a norm-referenced continuum over a life-span" (p. 190). Furthermore, when discussing the learning of alphabet skills Paris also maintains that "most children learn the alphabet between 4-7 years of age (or during the first year of schooling) and the time for an individual child to master the alphabet is usually less than two years" (p.194). Fortunately many children do learn the alphabet early (i.e., prior to school entry) through such things as repeatedly singing the alphabet song and/or manipulating and playing with plastic fridge letters, or reading alphabet storybooks. Many young children even learn some of the sounds of the letters as well by playing language games and from listening to stories. However, there are also many young children who do not learn about the alphabet prior to school entry, and even after receiving six months of instruction at school Greaney and Arrow (2011) found that many children were still not able to even sing the alphabet song from memory or to correctly name all the letters of the alphabet and/or were unable to correctly identify many of the sounds. Unfortunately, Paris (2005) does not acknowledge that those children who do not learn these skills a short time frame will almost invariably have developed reading difficulties as a result of such a delay. Learning the alphabet by rote memory to automaticity is therefore a very valuable strategy for all children.

CONCLUSION

Hattie (cited in Woulfe, 2014) argues that "automaticity can be seen as a neurological gift to the human race" (p. 20) and he uses the learning of the times tables as a classic example of the value of learning to automaticity. In further support of learning the tables to automaticity Christoloudou (2014) states that "Just learning that 4x4 is 16 will be of limited use. But learning the multiplication table, and learning it so securely that we cannot think of the answer when the problem is presented, is the basis of mathematical understanding. If we want pupils to have good conceptual understanding, they need more facts, not fewer." (p. 32).

Furthermore, Westwood (2011) noted that The National Maths Advisory Panel (2008) claim that "Computational proficiency with whole number operations is dependent on sufficient and appropriate practice to develop automatic recall of addition and related subtraction facts, and of multiplication and related division facts" (p.xix)

Similarly when rote learning the letters of the alphabet it is easy to suggest that such learning may be viewed as a meaningless exercise. After all, many of the letters do not have easily understood sound equivalents. For example while some letters' names (like a, b, d, e, & k) lend themselves to some of the

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sounds that they represent in written words, but the names of other letters (such as f, h, l, & m) do not. Furthermore, while learning the alphabet by rote memory may appear meaningless because it is not necessary that a very young child needs to understand at the outset that a particular letter may represent many different sounds in different words such as the a sound in: at, ate, was, and saw, it is nevertheless, still useful foundational knowledge to know some of the sounds that the different letters may represent. Such knowledge also serves as a precursor to later literacy-related skills development including phonological awareness and the ability to decode unfamiliar words. This is therefore a call for the place of rote learning to automaticity for some constrained skills including the multiplication tables for maths and the alphabet knowledge for reading.

Opportunities to learn such skills can and should also be given and readily monitored and assessed to ensure that they are learned within the appropriate time-frame. Given the research evidence supporting the importance of early learning of alphabet skills for later literacy development (e.g., Adams, Foorman, Lundberg & Beeler 1998; Foulin, 2005; Tunmer, Chapman & Prochnow, 2006) and tables facts for maths development (Christodoulou, 2014; Hattie & Yates, 2014; Woulfe, 2014) it seems pointless to not support rote learning them to automaticity. The role of rote learning to automaticity for multiplication facts, the alphabet and some letter-sound spelling patterns, should also be considered as beneficial for all and harmless for none. The 'pay-off' for those who are able to quickly and effortlessly recall such basic skills is too important to ignore. Furthermore, for those students where such skills are not learned to automaticity within the appropriate time-frame will invariably result in lower rates of learning and even longer-term learning difficulties. A second reason for learning skills to automaticity in both literacy and maths is because many higher level cognitive skills are based on the ability to automatically recall the lower order skill sets. Efficient decoding, for example, is a determinant of reading fluency, and such fluency is dependent upon automatic retrieval of orthographic and phonological (letters and letter-sound patterns) knowledge. Similarly, the ability to develop maths fluency must also in many instances, be based on the recall to automaticity of the basic facts. The other positive aspect of rote learning of basic skills to automaticity usually means that once learned, such skills are both easily transferrable and, are seldom ever forgotten.

Placing a heavy focus on the development of conceptual understanding (as occurs in problem-based learning) while at the same neglecting to focus on the underpinning knowledge and skills required to fully understand the concepts, will only add confusion for many students. In support of this view Christodoulou (2014, p. 32) argues that "By neglecting to focus on knowledge accumulation, therefore, and assuming that you can just focus on developing conceptual understanding, today's common yet misguided educational practice ensures not only that pupils' knowledge will remain limited, but also that their conceptual understanding, notwithstanding all the apparent focus on it, will not develop either". This is the dilemma that faces both early literacy and maths curriculum planners and educationalists who work within a strong socio-constructivist environment in which the explicit teaching of skills are not given the relevant focus and attention that many learners demand, and in particular, those students who lack knowledge of the pre-requisite sub-skills that are necessary (but not sufficient) for higher level understanding. To address this issue Westwood (2011) would suggest that, in relation to learning basic mathematics' facts that teachers should "devote adequate instructional time to computational proficiency and automaticity with basic facts" (p. 14). Unfortunately, within any socio-constructivist paradigm of instruction there is a reluctance to include any focus on the rote learning to automaticity of isolated sets of skills. There are many students who make normal (or even superior) progress in maths and literacy within a constructivist learning environment. However, for those students who develop early learning difficulties, many of their problems would likely be more effectively addressed if the instruction included explicit opportunities for learning basic sets of skills to automatic

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recall. However, such a call is unlikely to be heeded in educational environments where discovery learning, problem-based learning and inquiry learning are the predominant methods of instruction for all students. Bair and Enomoto (2013) argue that "despite decades of research supporting the effectiveness of explicit, direct instruction for novice learners, teachers continue to engage in practices like discovery learning, problem-based learning, and inquiry learning for this academically vulnerable population" (p. 126).

In conclusion, learning a skill to automaticity, such as the instant recall of basic number facts for mathematics, should be considered to be harmless for no one, beneficial for all and vital for some. While there is a reluctance to include any emphasis on the learning of such skills and/or explicit instruction within a constructivist-based curriculum, many students with literacy and/or numeracy-related learning difficulties will continue to struggle.

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