Guided Inquiry as a Model for Curriculum Resources in Mathematics

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Research and the Australian Curriculum both indicate the importance of teaching students to apply their mathematical knowledge to real world problems. When developing curriculum resources for Queensland state school teachers from Prep to Year 9, the Department's mathematics team identified the significance of embedding the inquiry process in these materials. The aim of this paper is to describe the model that evolved and the adaptations of inquiry method, necessary to produce materials suitable for state-wide use.

The ACARA F–10 Australian Curriculum for mathematics emphasises the importance of teaching students to apply their mathematical understanding to real-world problems, especially when describing the proficiency strands of problem solving and reasoning (ACARA, 2013). Inquiry methodology has been identified as promoting high order thinking, using real life contexts and maximising student engagement and responsibility for their own learning. It became apparent that the inquiry approach would provide ideal methodology for embedding these skills when developing curriculum resources.

In Queensland, the Curriculum into the Classroom (C2C) project has developed a set of online planning resources in mathematics to help teachers implement the Australian Curriculum in state schools. The C2C materials provide a starting point for curriculum planning and teachers may adopt or adapt them to meet student needs. The intent of the C2C is to support the interpretation of the Australian Curriculum and model best practice based on a sound knowledge of mathematics and the development of mathematical understanding. The planning documents are presented in a set format. The package consists of year level plans, lesson plans, supporting learning resources, independent learning materials and assessment materials. It addresses the core knowledge, understanding and skills as well as the general capabilities and cross curriculum priorities identified as important for all Australian students (ACARA, 2013).

Initial professional development consisted of briefings with the research team, discussions with current practitioners and perusal of existing materials based on inquiry learning. Interacting with teachers from the research project who enthusiastically shared their stories, the good and the bad, provided a positive and practical basis for this project. Communication was vital during these initial stages and face-to-face contact became an important aspect of the project. Reflective and collaborative practice was a strong feature in the process of developing the Guided Inquiry materials.

Adapting Inquiry for State-Wide Use

The original intent was to embed the inquiry method into the resource materials developed. However, the flexibility, ambiguity and openness of inquiry method were hard to capture within the structured format established for the lesson plans and supporting learning resources. When it became apparent that this level of openness was not practical, it became necessary to partially modify the approach. It was also identified that the audience for this resource consisted of teachers in a variety of classroom contexts and from

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varied experiential backgrounds. Therefore, it was decided that the supporting learning resource (SLR) materials would best be presented with more scaffolding than had been the case in the research project, where teachers had received extensive professional development to support them in learning to teach with an inquiry approach.

The term *Guided Inquiry* evolved from this dilemma. The research project and teacher resource materials published by teachers in the project (Allmond, Wells, & Makar, 2010) had successfully used the five phases of Inquiry (Discover, Devise, Develop, Defend and Diverge) when developing their research. The inquiry model from the research project was adapted for C2C as a Guided Inquiry model (Figure 1, left), supported with a graphic representing the 5D model. A second model to foreground the importance of evidence in inquiry from the research project (Fielding-Wells & Makar, 2012) was also developed into a graphic appropriate for classroom use (Figure 1, r ight). Information sheets were also created to link to every "Guided Inquiry" series of lessons.

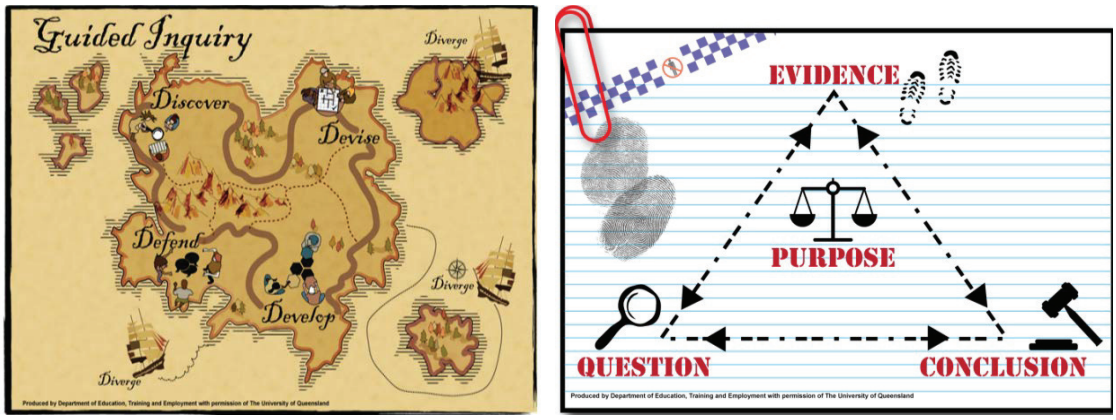

Figure 1: C2C Graphics showing phases in mathematical Guided Inquiry (left) and Evidence model (right)

Establishing Guided Inquiry Questions

The driving inquiry questions became the initial hurdle for the writers. It is often a concern for educators that the problems that students solve in mathematics may rarely reflect the skills needed to address the complex problems encountered in real life. The Guided Inquiry questions were to provide an opportunity to immerse students in authentic problems that embraced the ambiguities and complexities of everyday issues. They had to have clear links to the mathematics being taught and they needed to be transferable to all the diverse learning contexts within the state including students who worked with independent learning materials. The engagement of students, accessibility to resources and the diverse needs of students were major considerations. Some of the topics had been trialled in classrooms but others evolved over many discussions and modifications during the writing process. Some examples include:

- *Where can a lizard go on a holiday?*
- *Who stepped in the mud?*
- *How many chairs can fit into the school hall?*
- *How could we best utilise rainwater in our school?*

Developing the Support Materials

While the Guided Inquiry was only briefly outlined within the year level and lesson plans, the Support Learning Resource (SLR) became a more detailed and scaffolded guide for teachers. The structure of the SLR evolved as writers become more confident in developing this new style of resource. The Guided Inquiry Model phases *Discover*, *Devise*, *Develop*, *Defend*, and *Diverge* provided a clear structure. In most cases these resources were used to develop a series or suite of lessons and not restricted to a single lesson. At the beginning of the SLR, teachers are provided with an overview of the mathematics in the Guided Inquiry. For example:

> The guided inquiry is intended to direct students to explore the mathematics of location and transformation. They will explore the language and tools used to provide information about location. The tools include the use of mapping grids. Students will then apply their knowledge of simple mapping to represent familiar board games, social, outdoor or sporting games. (Year 3 Unit 4)

As some teachers and students may be unfamiliar with Guided Inquiry, it was felt to be necessary to prompt teachers how to orientate students to the unit. For example:

> Orientate students to the Guided Inquiry by explaining briefly the nature of a Guided Inquiry and the process involved.
>
> When you complete a Guided Inquiry you will usually answer a question that can have many different answers or pathways to an answer.
>
> When completing a Guided Inquiry you think about the question and make a plan to explore the topic before choosing your best answer.
>
> Once you have your answer, it is important that you can defend your answer with evidence or examples that support our answer.

As a key feature of inquiry method was questioning, the SLR for a Guided Inquiry modelled the use of questioning to scaffold the inquiry, draw attention to the mathematics of the topic and facilitate constant reflection. Students are encouraged to develop questions to support the structure of the Guided inquiry especially when addressing the topic question in the Discover phase. They are also encouraged to use questioning to reflect on their learning and the development of the Guided Inquiry. When identifying new directions for their topic in the Diverge phase, students pose further questions for later consideration. As with all SLR's in the C2C materials, teachers are provided with Focus questions to ensure understanding of the mathematics studied. For example:

> **Focus questions:**
> *What words were used to describe pathways?*
> *Which words were more helpful than others? Why?*
> *What other words could have been used?*

Also included in these materials were work samples and resources that were meant to act as suggestions for teachers (Figure 2).

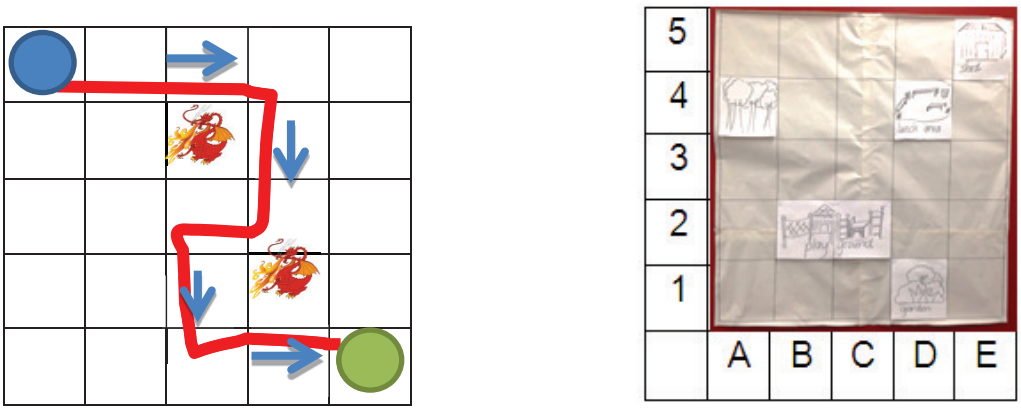

Figure 2: Sample responses to help teachers visualise possible outcomes

Assessment is an important part of the C2C materials. It is promoted through ongoing monitoring and summative assessment tasks. By nature, Guided Inquiry has provided many opportunities to collect valuable data about student learning and performance. Some Guided Inquiries have included summative assessment tasks while all provide rich monitoring opportunities. These may include opportunities for focus questioning, observation and the collection of work samples. In many cases, the Guided Inquiry allows students to demonstrate the depth and breadth of their understandings. Because the Guided Inquiry relies on students applying their knowledge in real life situations, if misconceptions are present they are quickly exposed. As the writing of Guided Inquiries continued, more and more assessment opportunities were identified by the writers.

Conclusion

It is anticipated that success with this resource will impact on daily pedagogy across the state and prompt practitioners into exploring the possibility of developing the more open pedagogy of Inquiry. We have hopefully launched a platform for more dialogue and reflective practice in the area of real world problem solving which in turn will improve student performance. As these resources are implemented in classrooms in 2013 and teachers become more familiar with the methodology, it will be important to address their feedback. The journey for the writers has just concluded and C2C Guided Inquiry is now on its maiden voyage.

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