

# SUBJECT LITERACY

## INQUIRY DIGEST

ISSUE 5, 2020





# FOREWORD

As part of the support ELIS provides teachers who wish to deepen their learning in the use of language support strategies and classroom talk, we are pleased to present *Subject Literacy Inquiry Digest, Issue 5*.

The importance of engaging students in classroom talk to promote learning has long been recognised by scholars and practitioners. Classroom interactions need to be skilfully planned and conducted in order for productive talk to take place. In this issue, we feature the work of three inquiry teams who explored ways to improve student learning and engagement through the strategic use of classroom talk and literacy support strategies. We hope that the richness of learning that ensued will inspire you to embark on your own inquiry into the use of talk to improve teaching and learning.

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# Helping Upper Secondary Students Write Better Explanations in Social Studies

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## INQUIRY FOCUS

Three Upper Secondary Social Studies teachers observed that their students struggled to write answers for source-based case study questions in Social Studies. With support from ELIS and the Master Teacher for Social Studies, they explored ways to scaffold student writing using the Gradual Release of Responsibility instructional framework.

## BACKGROUND

The Source-Based Case Study (SBCS) in Social Studies contains an assessment item (sub-question (e)) that typically asks students how far they would agree with an issue statement. This question requires students to “interpret and evaluate a collection of sources based on a societal issue”, “consolidate perspectives from multiple sources of information to respond to the issue”, “draw conclusions based on reasoned consideration of evidence and arguments” (MOE, 2016, p. 21-22), select source evidence to support their stand, and present their response in a coherent write-up. This complex task involves disciplinary ways of thinking, reading and writing which are not always obvious and do not come naturally to many

students. Scholars recommend that teachers make these subject-specific literacy practices visible and gradually mentor their students to become competent at them (Lent, 2016; Schleppegrell, 2009; Shanahan & Shanahan, 2008). One approach to doing this is the Gradual Release of Responsibility (GRR) model which has been documented as an effective method for improving literacy achievement (Fisher & Frey, 2008). Using carefully constructed scaffolding and classroom talk, this instructional approach gradually shifts the responsibility for performing a task from the teacher to the students through a process of teacher modelling, guided instruction and collaborative tasks before engaging students in independent work.

## PROCEDURE

Wanting to explore the use of literacy strategies and the GRR approach to help their students write better, the teachers began their inquiry with the question: *What impact do literacy strategies have on Secondary 3 students' ability to write responses for Source-Based Case Study questions in Social Studies?*

Working closely with a Master Teacher for Social Studies and an English Language Specialist from ELIS, they devised a range of scaffolding strategies to guide students' thinking and writing to be used within an eight-lesson unit for a Secondary 3 Express class (see Figure 1) which one of them taught.

### Unit Plan: Writing Responses for Source-Based Case Study Questions

| Lesson | Activity   |
|--------|--|
| 1      | <b>Pre-Intervention Task</b>   |
| 2-3    | <b>Teacher Modelling</b> <ul style="list-style-type: none"><li>• Modelling thinking aloud using the thinking frame, text structure and sentence stems</li></ul>              |
| 4      | <b>Guided Practice</b> <ul style="list-style-type: none"><li>• Teacher and students co-construct answers to a practice question</li></ul>                                    |
| 5-7    | <b>Collaborative Tasks</b> <ul style="list-style-type: none"><li>• Pinning sentences to the frame</li><li>• Group writing</li><li>• Peer critique of group answers</li></ul> |
| 8      | <b>Independent Practice</b> <ul style="list-style-type: none"><li>• Post-intervention task</li></ul>   |

Figure 1. Sequence of lessons.

#### Pre-intervention Task

Prior to intervention, the teacher gave her students a SBCS writing task to complete independently. The SBCS focused on the issue of foreign talent in Singapore (see Figure 2). This assignment served as a diagnostic assessment so that

teachers could determine areas of need and calibrate their teaching accordingly. It also provided a baseline with which the students' writing could be compared after the intervention.

(e) "Foreign talent should be welcomed into Singapore."

Using sources in this case study, explain how far you would agree with this statement.

Figure 2. Pre- and post-intervention task: Sub-question (e) of a Source-Based Case Study on the policy of welcoming foreign talent into Singapore.

The teachers observed that while students were generally able to identify sources that were for or against the statement in the question, they did not know how to use sources as evidence to support their stand. Students tended to rephrase or describe source content rather than build an argument to reach a reasoned conclusion. Many of them

lacked the language to express the connections they were trying to make between the evidence and their claims. They also could not relate their observations to the larger issue of diversity and the social tensions it can produce (see Figure 3 for such an example of student writing).

e) I agree with a large extent that "Foreign talent should be welcomed into Singapore.

Source A do not welcome foreign talents. It is said in the source that 'foreign talent used Singapore as a stepping stone to other countries.' What I can infer from this source is that Singaporeans feel used as foreign talents enter Singapore mainly to get recognised. However, the source also said 'the country has benefitted from the presence of foreign talent'. What I can infer is that even though foreign talents are helpful and beneficial to society, Singaporeans do not see that and assume that they just steal jobs.

Figure 3. Student A's response to the pre-intervention SBCS question.

In this example, the teachers noted that the student indicated a stand in the first sentence but proceeded to contradict it in the next. Instead of using a source as evidence to support his stand, the student proceeded to discuss the source as if he were responding to a question

that asked what could be inferred from the source. The teachers noted that students regularly used the expression 'What I can infer from this source' because they did not know other ways to talk about sources and lacked the language to do so even if they did.

### Teacher Modelling (I do) and Guided Practice (We do)

Recognising that their students struggled with the literacy demands of the task, the teachers designed resources that would help to structure their students' thinking and writing. Among these were the What-How-Why thinking and paragraph writing frame (see Figure 4), the text structure of a response graphic organiser (see Figure 5) and a list

of sentence stems and connectors for expository writing (see Figure 6). These resources revealed the thinking work behind the construction of a response and provided the language support students needed to complete the SBCS task.

| Thinking Frame |   |
|----------------|---|
| <b>What?</b>   | What is your stand?<br>Do you agree or disagree with the statement in the question? |
| <b>How?</b>    | How do you know?<br>Provide supporting evidence using a selected source.            |
| <b>Why?</b>    | Explain (provide reasons) why you think the evidence supports your stand.           |

Figure 4. The What-How-Why thinking and paragraph writing frame.

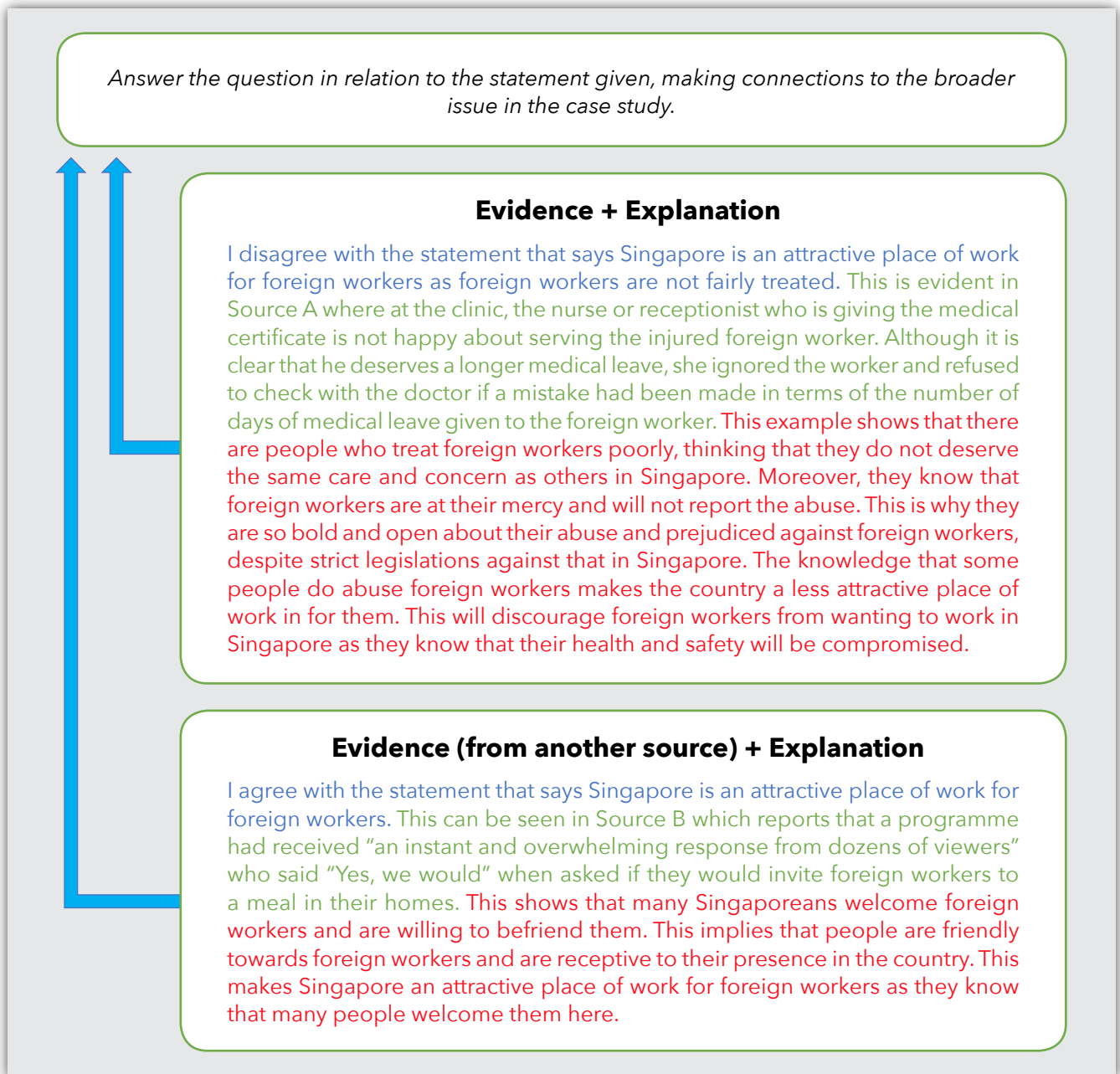


Figure 5. A graphic organiser for the text structure of a response that has been filled in during guided practice. Sentences were colour-coded both during teacher modelling and guided practice to make explicit their function within each paragraph.

| I am trying to                                      | Sentence stems and connectors that I can use  |
|---|---|
| Quote from an evidence                              | <ul style="list-style-type: none"> <li>• This is evident in Source A which states that ...</li> <li>• For example, Source A states that ...</li> <li>• For example, in Source A, ...</li> </ul> |
| Explain what is meant by the evidence in the source | <ul style="list-style-type: none"> <li>• This means / shows that ...</li> </ul>   |
| Show cause and effect                               | <ul style="list-style-type: none"> <li>• As a result, ...</li> <li>• ... led to ...</li> </ul>  |
| Link back to the argument                           | <ul style="list-style-type: none"> <li>• This suggests/shows/illustrates/demonstrates that ...</li> <li>• This means that ...</li> <li>• This implies that ...</li> </ul>                       |
| Show a contrast in views                            | <ul style="list-style-type: none"> <li>• However, ...</li> <li>• ... but ...</li> <li>• While ...</li> </ul>  |

Figure 6. A list of sentence stems and connectors to help students in their writing.

At the start of the unit, the teacher taught the students explicitly how to respond to an evaluation question of the SBCS. They introduced the use of the resources and modelled thinking aloud to demonstrate to the class how to construct a written response. For example, they modelled how they would use the What-How-Why thinking frame to organise their ideas and supporting evidence for their response. They then demonstrated how they would translate those ideas into sentences and paragraphs using the text-structure graphic organiser as scaffolding. As they did this, they also highlighted their use of selected sentence stems and explained the rationale for their choice of words. In so doing, the teachers made visible the cognitive processes that students need to engage in when writing an answer and identified the elements of a response.

During the guided practice phase of the unit, the students were given another SBCS question to work on, closely guided by the teacher. Through a whole class discussion facilitated by the use of talk moves (Michaels & O'Connor, 2012), the teacher and students co-constructed a response to the question using the resources (see Figure 4). This allowed students to explore and apply what they had just learned within a safe and structured setting.

## FINDINGS

The teacher assessed the students' writing and discussions throughout the unit, checking for understanding and areas of need. Over the course of the lessons, she noted gradual improvements in her students' ability to craft responses to SBCS questions. With practice, the students grew more adept and confident at using the resources and made an effort to apply what they had learnt during the group and individual tasks. For example, when the teacher analysed the students' critique of their peers' work towards the end of the unit, she found that they were adept at identifying and correcting problems in the writing (see Figure 7). They had not demonstrated such awareness and attention to coherence before.

The teachers also noted improvements in the students' individual written work when they assessed their responses to the post-intervention task. The students demonstrated more control over their writing and a better understanding of the demands of the question. For example, the same

## Collaborative Tasks (You do together)

In order to give students more opportunities for practice and engage them in deeper learning, several group tasks were incorporated into the unit. One task required students to organise a mixed-up set of sentences into a coherent write-up, using the writing frame as a guide. Another activity invited students to jointly construct a response with their group members, which required them to negotiate meaning, clarify understanding and apply learning in the context of a new SBCS question. After completing the collaborative writing task, the groups exchanged their write-ups and proceeded to critique one another's write-ups, using sticky notes to indicate areas of strengths and weaknesses, as well as suggestions for improvement. This peer review assignment aimed to promote metacognitive awareness and self-regulation as students learned to be critical of the choices that writers make and the effects of these choices on readers.

## Independent Practice (You do alone)

At the end of the unit, the same SBCS question used as the pre-intervention task was given to students again to complete independently. The teachers then analysed the responses to assess student learning and the effects of their intervention.

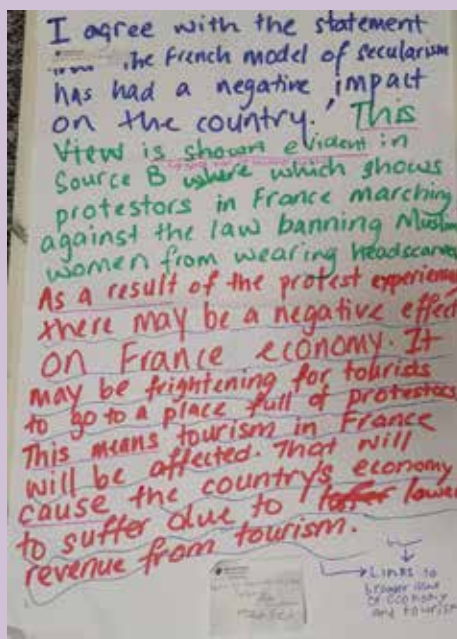


Figure 7. An example of group writing with comments by their peers.

In this example, the teachers noted that the students had carefully constructed a more coherent answer using the writing frame and sentence stems they had been taught. During peer review, another group acknowledged how the explanation attempted to relate to the broader issue of a possible decrease in revenue from tourism when tourists stayed away from France as a result of the protests, indicating that they, too, possessed an increased awareness of what makes a good explanation.

student (Student A) who had struggled with the task before was now able to use source content as evidence to support his stand and provide a more substantial explanation for his reasoning (see Figure 8).



I agree with the statement that 'foreign talent should be welcomed into Singapore'. This is suggested in source D which is from an article written by an academic. Source D states that there are too few skilled Singaporean PMETs to meet the demand'. This means that people do welcome foreign talents. This shows that Singaporeans are actually using foreign talents for their own benefit. This allows them to learn new skills from foreign talents. By doing this, Singapore's economy will improve due to the increase in skills and valuable experiences that foreign talents bring to Singapore. Therefore, foreign talents should be welcomed into Singapore.

Figure 8. Student A's response to the post-intervention task.

The teachers acknowledged that the students still had much to learn before they could excel at answering sub-question (e) of the SBCS. Many students, for example, still had difficulty writing adequate explanations or connecting their observations to the larger case issues, even though they could spot such weaknesses in their classmates'

## DISCUSSION

This study demonstrated the value of providing literacy support such as scaffolds for writing in order to help students overcome the cognitive and linguistic challenges of the SBCS question. The teachers observed that using the GRR framework provided them with an effective structure to scaffold student learning. They recognised the importance of classroom discussions, as these enabled students to ask questions, negotiate meaning, give feedback, explain their own thinking and clarify their understanding of what they were learning. Classroom discussions also surfaced student thinking and learning gaps which the teacher could then address in a timely manner.

writing. The teachers recognised that students need time to practise and internalise the literacy strategies before they can apply them skilfully. They were also reminded of the need to continue to build student knowledge about social issues and teach them the ways to think, talk and write about the issues.

Encouraged by the evidence of student learning that they found in this study, the teachers plan to use the GRR framework and literacy strategies for all their classes.

## Acknowledgement

The authors would like to thank Mrs Premaletha Gopal, Master Teacher/Social Studies, for her support in the report of this inquiry.



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# Using Visual Representations and Teacher-Guided Discussions in Biology

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## INQUIRY FOCUS

A Biology teacher embarked on an inquiry to explore how she could use visual representations and teacher-guided discussion to help her students make connections between key concepts. This article reports on her study and what she and the students learnt in the process.

## BACKGROUND

A teacher at Ang Mo Kio Secondary school observed that her students struggled to see links across concepts and “regurgitated” content without making the connections clear. Research has shown that in Biology, “visual representation of processes and concepts enables students to make sense of and see the relationships between concepts” (Ho, Wong & Rappa, 2019, p.235). Annotated sketches or diagrams can help students to “describe the processes, concepts and interrelationships shown” (Reynolds & Tewsbury, 2005, p.1). In addition, supported by teacher-guided interaction, students can engage in meaningful classroom discussion which can

further develop their individual reasoning skills and facilitate their learning of science (Mercer et al. 2004; Rojas-Drummond & Mercer 2003).

This inquiry examined the use of visual representations and teacher-guided discussion to help students make sense of the key relationships between concepts relating to the circulatory system. The research question guiding the teacher’s inquiry was: *How can visual representations and teacher-guided discussion support students’ learning in Biology?*

## PROCEDURE

The teacher conducted the inquiry with her class of 38 Secondary 4 Express students. The topic was “Transport in Humans”, with a focus on the structure and function of the heart and the cardiac cycle. The lesson was in two parts, each of one-hour duration. The teacher guided the students through the sequence of tasks shown in Figure 1.

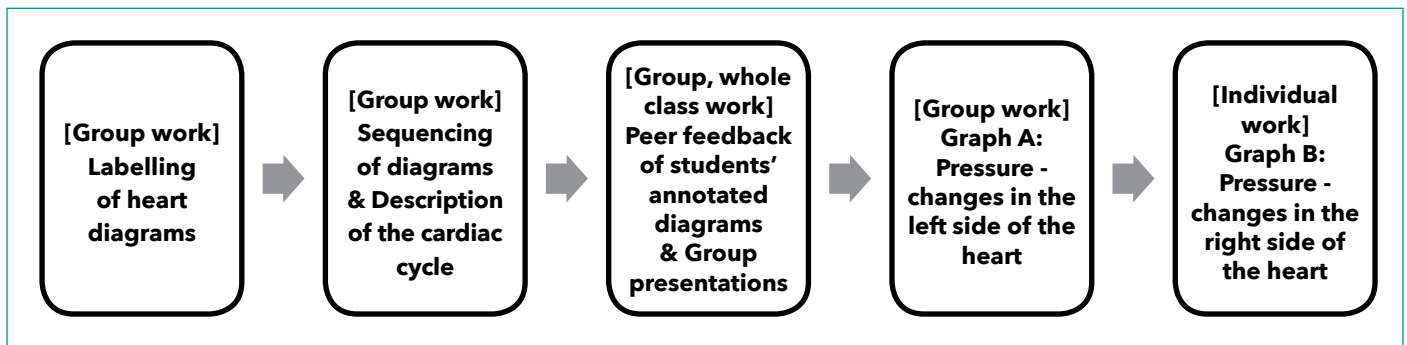


Figure 1. Overview of sequence of tasks in the lesson.

## Scaffolding students' learning through visual representations

The teacher demonstrated how to annotate diagrams in order to identify key features and describe the relevant scientific processes for the topic, which are skills outlined in the Biology syllabus (MOE & UCLES, 2018). In addition, the students were shown how to interpret graphs and explain cause-effect relationships relevant to the topic.

The teacher scaffolded the students' learning by providing visual representations of blood flow in the heart in a diagram. The students labelled different parts of the heart on the diagram (see Figure 2), wrote brief notes to describe the functions, processes and relationships, and used directional arrows to indicate blood flow and oxygen content of the blood.

Next, the students worked in groups to arrange the visual representations of the heart in a logical sequence to show the structural differences of the heart in a cardiac cycle. The students used arrows to link the visual representations of the heart in a sequence and describe the cardiac cycle, guided by a word bank which included terms such as “atria”, “ventricles”, “contract”, “systole” (see Figure 2 for an example of the students' work and the teacher's comments on their writing).

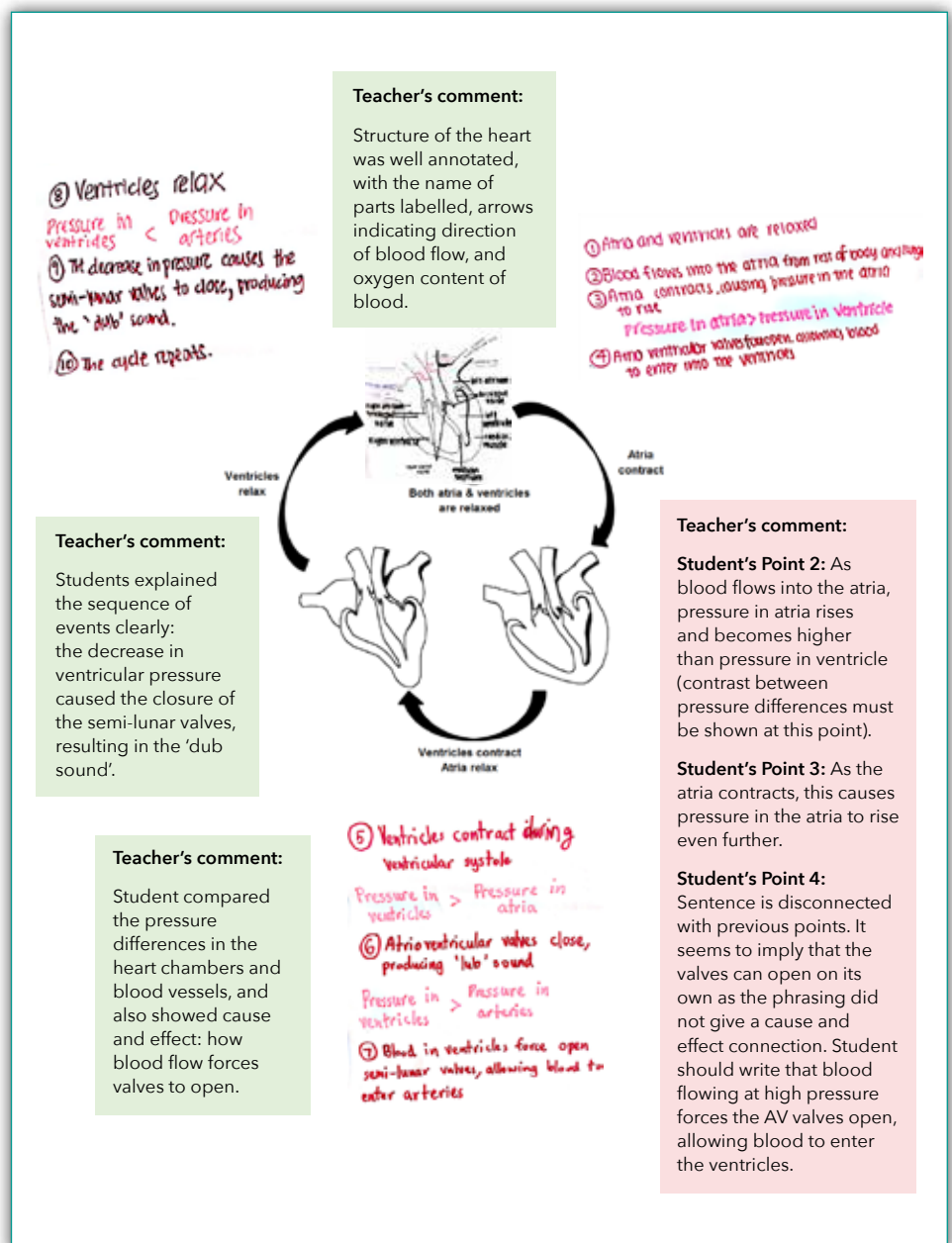


Figure 2. Sequencing visual representations of the heart in a cardiac cycle.

## Teacher-guided discussion: addressing language use

Following the task of sequencing the visual representations of the heart, the teacher asked the students to refine their annotations for each stage of the cardiac cycle and to present their work to the class. The presentations gave the teacher the opportunity to assess student understanding and to provide feedback. One example of a flawed annotation is shown in Figure 3.

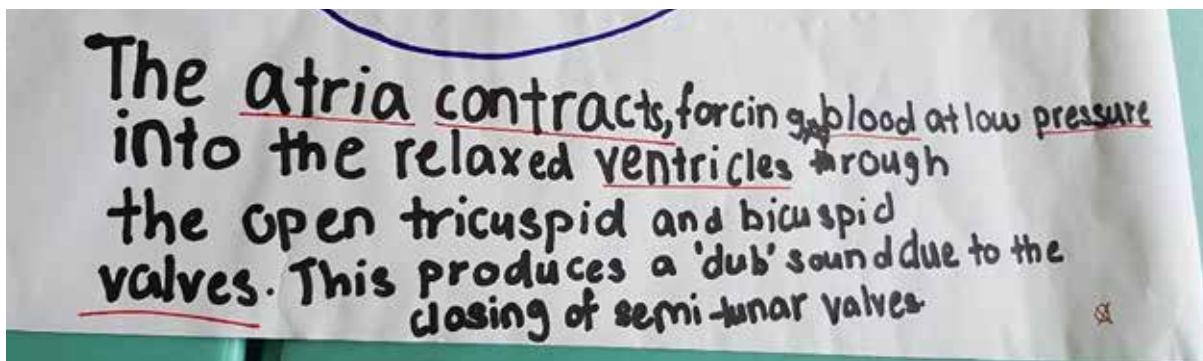


Figure 3. An annotation describing what happens during atrial contraction.

In this example, the students failed to explain in detail why the semi-lunar valves closed. Noting the conceptual gaps in their understanding, the teacher was able to address the problem during the teacher-guided class discussion that followed. An excerpt of the transcript of that discussion is shown in Figure 4.

| Turn | Speaker                     | Classroom Talk   |
|------|-----------------------------|--|
| 1    | Teacher                     | They say: The atria contracts, forcing blood at low pressure into the relaxed ventricles through the opened tricuspid and bicuspid valves. This produces a dub sound due to the closing of semi-lunar valves.<br><br>Let us take a look at the first sentence.<br><br>Anyone from the floor would like to comment on this sentence?  |
| 2    | Student 1                   | Why is blood at low pressure?  |
| 3    | Student 2<br>(Group Member) | It is directly from the lungs.   |
| 4    | Teacher                     | Okay, so Student 2 says it is at low pressure because it is directly from the lungs. Are you all convinced?  |
| 5    | Student 3<br>(Group Member) | This blood is flowing from the rest of the body and the lungs so the blood will be flowing at low pressure.  |
| 6    | Teacher                     | Okay, so what she means is that the low pressure is referring to the blood that flows from the lungs into the atrium.<br><br>Student 4, you have a question?   |
| 7    | Student 4                   | I thought it was because of the pressure difference. There is a lower pressure in the ventricle than the atria. That's why the valves open.  |
| 8    | Teacher                     | Okay, so Student 4 is comparing the pressure difference, right? What are the two regions that you are comparing?   |
| 9    | Student 4                   | The atria and the ventricle.   |
| 10   | Student 5                   | Shouldn't the atria contract only after blood is inside the atria?   |
| 11   | Teacher                     | Okay, you can see that in one sentence, we have multiple understandings, right? When I first read this sentence, it appears more to me as if they are comparing the pressure between, maybe, the atria and ventricles.<br><br>However, the group is actually referring to the blood that is entering the atrium. So over here in one sentence, the part where 'low pressure' was mentioned, it can be quite confusing, right?<br><br>Instead of just using the word 'low', maybe you can replace it with 'lower', and you must also label the regions that you are comparing.<br><br>We can say that the atria contracts, forcing blood, which is at a higher pressure, across the tricuspid and bicuspid valves, into the ventricles which are at a lower pressure. |

Figure 4. An excerpt of a transcript of the teacher-guided class discussion.

The excerpt illustrates how the teacher used talk moves to engage students in a discussion in order to clarify their understanding about atrial contraction (note Turns 1, 4, 6 and 8). In response to the teacher's invitation in Turn 1, Student 1 posed a question (Turn 2) to the group who was presenting. The teacher revoiced the answer given by the group (Turn 3) and invited the rest of the students to respond (Turn 4), withholding her own

evaluation of the answer. The teacher built on Student 4's response, encouraging the student to be specific (Turn 8), before drawing attention to the incorrect language in the presenting group's explanation (Turn 11). The class discussion allowed students to engage with one another's ideas with close guidance from the teacher. In this example, the students learned to be more attentive to their use of language.

### Guiding students to make connections using different resources

To help students make connections across key concepts, the teacher provided a task that made use of graphs to represent pressure changes in the heart (see Figure 5).

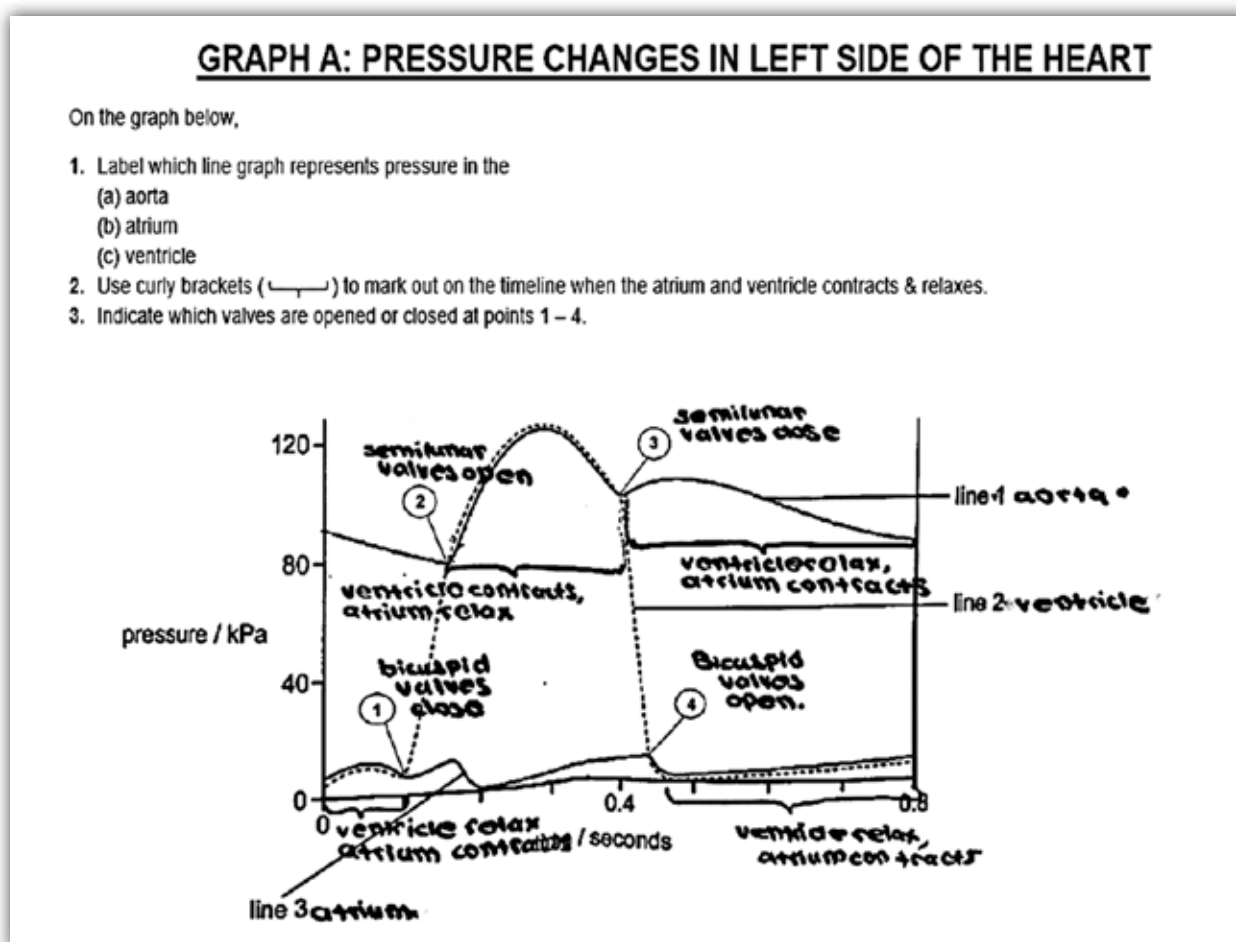


Figure 5. Students' annotation of a graph showing pressure changes in the left side of the heart.

A sequence of steps was provided in the task instructions (numbered 1 to 3 in Figure 5) to help students systematically analyse the graph by breaking down the process into a series of tasks. First, the students identified which chamber or vessel was represented by the line graphs. Next, using brackets on the timeline, they marked when atrial and ventricular contraction and relaxation occurred. Finally, they annotated the graph, indicating whether the valves were opened or closed.

After the lesson, the teacher reflected on the effectiveness of her instructional strategies in an interview. Her students were asked to take an online survey that sought their perspectives on the use of the visual representations. A month later, a review task was given to the students in order to assess their learning, and to ascertain the effects of the lesson.

## FINDINGS

An analysis of the students' written work, teacher interview and online survey was conducted to assess the effects of the intervention.

### Students' written work

The review task required students to relate the trend shown in a set of graphs to the events in the cardiac cycle during a specified period (Figure 6). The teacher observed that students who were able to answer the question could show the link between the parts of the heart at various points in the graphs by using information from the graph.

The students' written answers provided insights into their conceptual understanding, and their ability to make connections to the data and show cause-effect relationships. Figure 7 shows an example of a clearly written student's response. The student could identify the relevant event with the appropriate content vocabulary (ventricular systole) and describe what happened in the heart during the stated period P-Q, with reference to the data given in the graph. He could also make the comparison between the pressure in the heart chambers and vessels using data from the graph and identify the correct valves that were opening or closing.

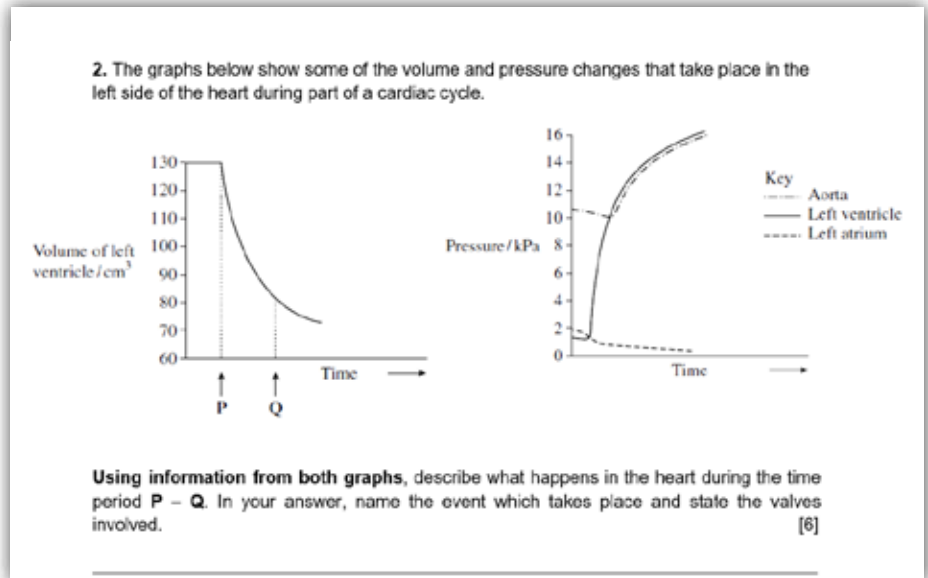


Figure 6. The review task.

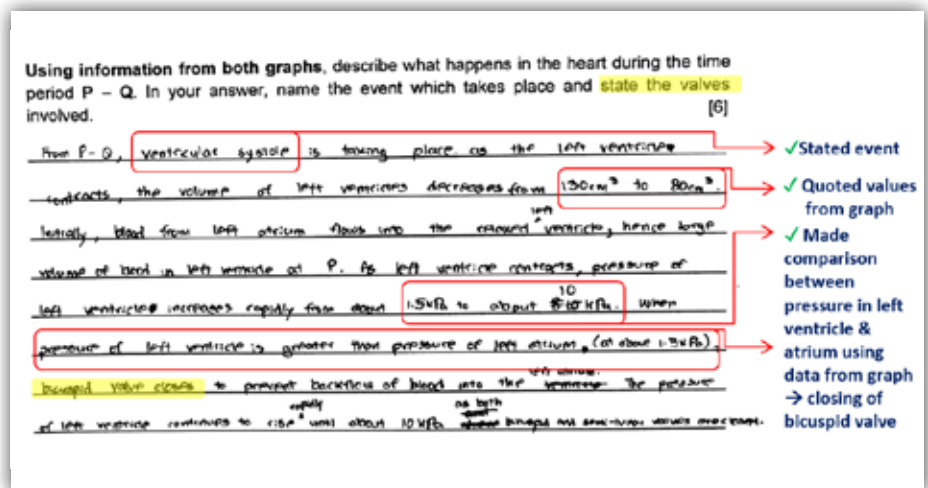


Figure 7. Sample of a student's response.

### Teacher's perspectives

During the interview, the teacher expressed her belief that scaffolding students' learning through a carefully planned sequence of activities was valuable. With the help of visual representations, students were able to activate their prior knowledge of the heart structure. As the focus centred on the heart diagrams, students paid attention to the differences among the diagrams. They could differentiate what the heart would look like at the different stages of the cardiac cycle, sequence the diagrams correctly and describe the process. They could then move on to analysing and interpreting the pressure graphs. The annotated diagrams helped students to visualise how the heart functions and make links to other concepts. They became more confident and could apply what they learnt to subsequent topics. The teacher was convinced that the range of tasks, comprising hands-on activities, collaborative learning in groups, group presentations and class discussion, helped to engage the students in their learning.

The teacher's observations of the students during group work led her to recommend that a word bank, enhanced with terms organised into specific categories such as "muscle - contract/relax", "pressure - increases/decreases" and "valves - open/close", could be used to help students achieve precision in their answers. She co-constructed the word bank with the students by inviting them to suggest what could be included.

The teacher observed during the lesson that her weak students initially could not identify which line graphs belonged to the atrium, ventricle and aorta. To better guide the students in identifying the pressure line graphs, the teacher realised she could begin with highlighting the trend in one line graph as an example, modelling for her students how to analyse and interpret visual data. She could then prompt the students to identify the remaining two graphs by following her lead.

## Students' perspectives

A survey was conducted with the students to elicit their perspectives on the use of the visual representations in the lesson. 32 students participated in the survey. The survey showed that the majority of the students found the strategy of annotating diagrams useful and felt more confident about describing the cardiac cycle after the lesson (see Figure 8). A majority of the students indicated that they could make meaning of visual representations.

In response to an open-ended question in the survey asking for their "greatest takeaway from the lesson", a majority of the students reported that they found the lesson to be helpful and engaging. Figure 9 lists some of their responses.

| Question  | Response                            |
|---|-------------------------------------|
| Do you find the annotation of diagrams a useful learning strategy?  | Yes: 93.8%                          |
| How confident are you in describing the cardiac cycle after this lesson?  | Moderately to Very Confident: 96.9% |
| How confident are you in analysing the pressure changes graph after this lesson?  | Moderately to Very Confident: 81.3% |
| Are you able to link the events occurring during the cardiac cycle to the changes in pressure represented by the graph? | Yes: 84.4%                          |

Figure 8. Summary of students' responses to survey questions.

*Beneficial lesson as it strengthened my knowledge.*

*Allows us to get the full picture of what is exactly happening at different pressure points.*

*I can look at the graph carefully to determine at which points the atrioventricular (AV)/bicuspid valves open/close.*

*I can relate to where the valves open and close relative to the pressure in ventricles.*

*Actually writing it out helped the thought process.*

*Lesson was fun and engaging.*

Figure 9. Student responses to a survey question asking about their greatest takeaway from the lesson.

## DISCUSSION

This study showed how the teacher's use of visual representations scaffolded the students' learning. When students moved from the initial task of annotating diagrams to the next task of sequencing diagrams, they were able to give more coherent answers with more precise use of language. The study also highlighted how teacher-guided discussion promoted student learning, when feedback from the teacher and other students enhanced students' awareness of the need for clarity and precision in writing.

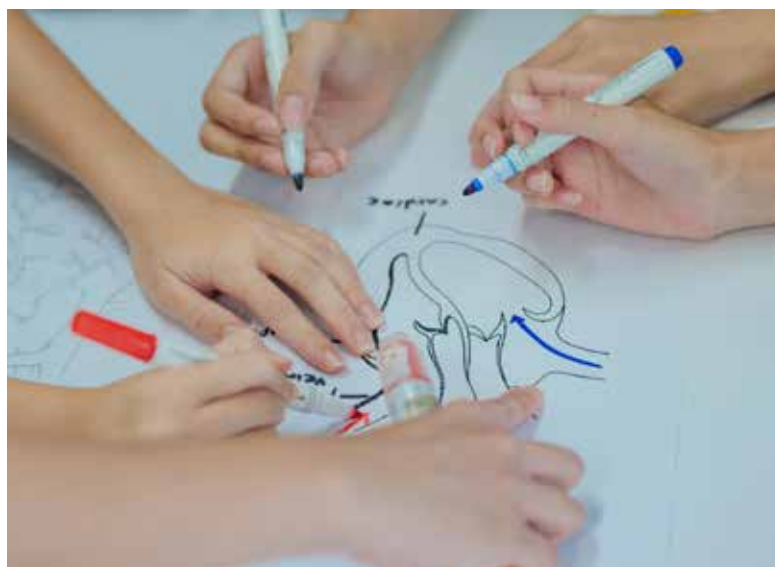
With such benefits in mind, the Science department plans to extend the use of visual representations and teacher-guided discussion to other classes, and for the revision of topics at the Secondary Four level such as Nutrition in Humans and Transport in Flowering Plants.

## Acknowledgement

The authors would like to thank Ms Davina Chai, former Academy Officer with ELIS and presently Level Head at Northland Primary School, for her support during the study.

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# Developing Exploratory Talk in the Primary 4 Mathematics Classroom

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## INQUIRY FOCUS

This article reports on the use of the Clue, Idea and Disagreement (C.I.D.) model in an intervention aimed at providing structure for student discussions. The study explored the effects of the model on students' talk during problem solving in the Mathematics classroom. The results showed that, after the introduction of the C.I.D. model, the students engaged in more episodes of exploratory talk.

## BACKGROUND

Vygotsky (1978) postulated that learning was a social activity and that social involvement in problem-solving activities was a crucial factor for individual development. Increasingly, educators have focused on the role of language and social interaction in the learning and pursuit of Mathematics (Forman & van Oers, 1998).

Mercer (1995) identified three types of talk that students engage in: disputational talk, cumulative talk and exploratory talk. The characteristics of disputational talk include disagreement and individualised decision-making with few attempts to pool resources or to offer constructive criticism of suggestions or to substantiate disagreement. In cumulative talk, speakers build positively but uncritically on what others have said. The characteristics of cumulative talk include repetitions, confirmations and elaborations. In exploratory talk, speakers jointly engage in explicit reasoning, displaying identifiable hypotheses, challenges and arguments, and reach eventual consensus.

Exploratory talk in the Mathematics classroom often takes place during collaborative problem-solving tasks. Collaborative learning is broadly defined as "a situation in which two or more people learn or attempt to learn something together", and more specifically as joint problem-solving (Dillenbourg, 1999, p. 1). Students are required to talk to solve a problem but are often not taught the nuances of holding a productive discussion, with the result that their discussions are confined to disputational and cumulative talk. Howe and Mercer (2007) found that only a small proportion of the interactions taking place during group work contributed to the children's learning. The children were often unclear about what they should be doing and what the aims of the activity were in collaborative learning situations (Mercer, 1996). For the potential benefits of small group work to be realised in practice, it is necessary to provide a structure that enables children to work together effectively (Gillies, 2003).



## The C.I.D. Model of Discourse

The C.I.D. model of discourse was adapted from Toulmin's (1958) model of argumentation. This model was developed to systematically analyse arguments. Toulmin's (1958) model of argumentation has been widely used to improve discourse in science classrooms (Erduran, Simon, & Osborne, 2004; von Aufschnieder, Osborne, Erduran, & Simon, 2008) as well as in composition classes (Bizup, 2009). The abbreviation 'C.I.D.' is taken from the components of the model: Clue, Idea and Disagreement (Figure 1). This structured approach gets students to

use the target words, 'from', 'so' and 'but' associated with each of the components, to scaffold the process of discussion for the students. It also enables them to support the ideas they put forward and to put forth valid arguments. Recognising the potential of the C.I.D. model for promoting mathematical discussion and learning, the teachers embarked on a classroom inquiry to investigate its use. They were guided by the question, *What are the effects of the C. I. D. model on students' talk during problem-solving in the Mathematics classroom?*

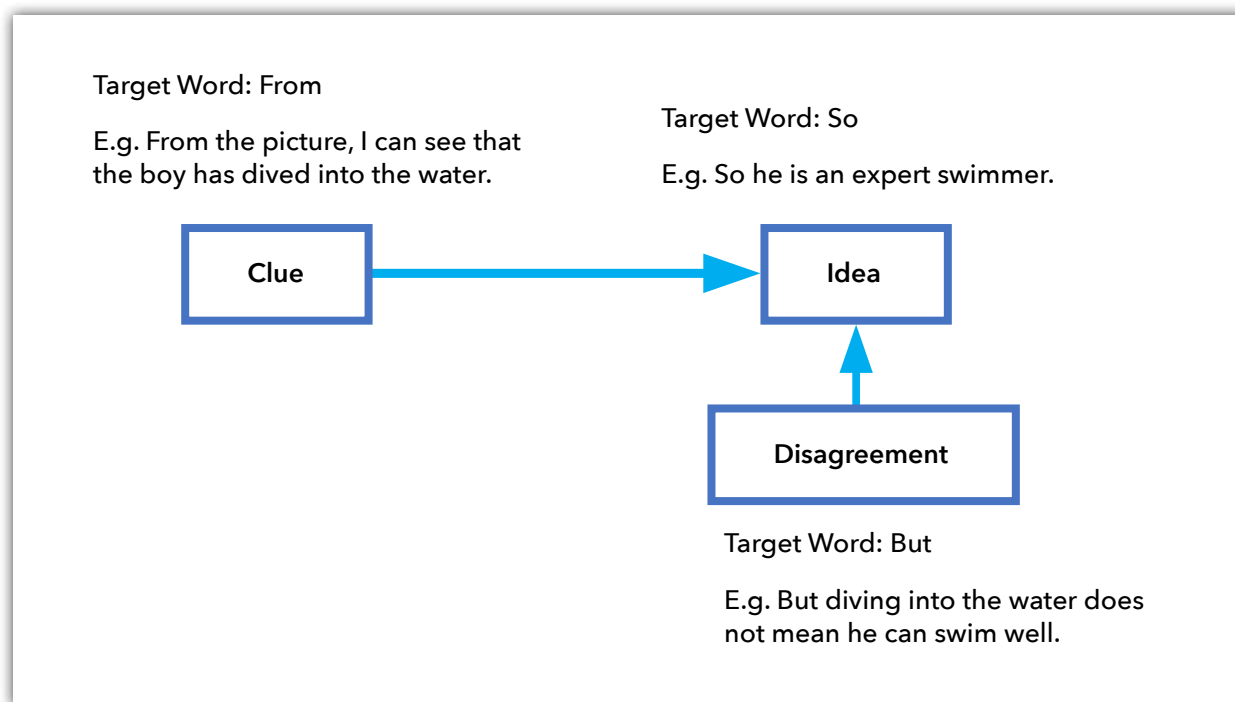


Figure 1. The C.I.D. model (Adapted from Toulmin, 1958).

## PROCEDURE

One teacher and her class of 40 Primary 4 students participated in the study. The students were grouped heterogeneously into threes, with a high progress student, a middle progress student and a low progress student in each group. There was a total of 12 groups. One particular group was selected for study based on the quality of the discussion as a fair representation of the class. For the analysis, the students in the group were identified as P1, P2 and P3.

The students were video-recorded during their problem-solving discussion sessions. The recordings were transcribed and then classified into task-related talk and non-task-related talk using the data-reduction method (Thomas, 2006).

Non-routine problems on the topic of 'volume' were selected to ensure that they were sufficiently challenging. Such problems require some degree of creativity or originality to solve. They can be solved in multiple ways, using concepts that the students have learnt to derive the

answers. Two problems were selected for the pre- and post-intervention tasks.

During the pre-intervention stage, the students studied the first problem in their groups and discussed the best solution within a thirty-minute period. The teacher was a facilitator and guide when needed.

During the intervention stage, an instructional video was shown to prepare the students for their discussion. The video featured some students using the C.I.D. model to engage in discussion while completing a task, including the use of cue words to support their clue, idea and disagreement.

During the post-intervention stage, the students were given another problem-solving task, which was also on the topic of volume (Figure 3). Their discussions were video recorded and transcribed. The teachers then analysed the transcripts, looking out for task-related and non-task-related conversations, as well as instances of the three types of talk (disputational, cumulative and exploratory).

## FINDINGS

When comparing the pre-intervention videos with the post-intervention ones, the teachers noted improvements. There was a reduction in cumulative talk and an increase in exploratory talk in the post-intervention videos. Additionally, there were no disputational episodes in the post-intervention videos at all (see Table 1).

Table 1. Number of Episodes for the Various Talk Types in the Pre- and Post-intervention Videos

| Recording session       | Type of talk  |            |             |
|-------------------------|---------------|------------|-------------|
|                         | Disputational | Cumulative | Exploratory |
| Pre-intervention video  | 5             | 6          | 1           |
| Post-intervention video | 0             | 4          | 3           |

Moreover, while the students were unable to solve the question in their pre-intervention discussions which featured more disputational and cumulative talk, they were able to do so in their post-intervention discussions when they engaged in more exploratory talk. (See Figures 2 and 3 for examples of the students' pre- and post-intervention discussions.)

*Pre-Intervention*

| Speaker | Video Transcript   |
|---------|--|
| P2      | <i>This one has markings. (Takes out highlighter and highlights paper.) This one has markings then this one don't have markings.</i>                                     |
| P1      | <i>So five litre. So this one minus 1 then you put here. So if equals that so we keep on making like that.</i>   |
| P3      | <i>Yes.</i>  |
| P1      | <i>So, you put four litre then got space right. So, we take out this, put, I mean like, put a line here lah. So when we use the line here we, err, forget. [Laughs].</i> |

Figure 2. A transcript excerpt showing students engaging in cumulative talk during the pre-intervention stage, when they were working out the solution in a linear manner.

This transcript excerpt shows the students discussing how to solve Problem 1. Each student speaks in an extended turn, followed by another student's input, which adds to the statement uttered previously. Student P3 gives a single-word utterance, an agreement with the previous statement uttered by Student P1. The interaction ends without a solution. The students uttered confirmations and elaborations, which are characteristic of cumulative talk.

*Post-Intervention*

| Speaker | Video Transcript  |
|---------|---|
| P2      | <i>1 times 1, 1, 3 times 3, 9.</i>                      |
| P4      | <i>No, 3 times 4.</i>                                   |
| P2      | <i>Hello, this one like that eh, 1, 2, 3, 1, 2, 3.</i>  |
| P3      | <i>Yeah.</i>  |
| P2      | <i>3 times 3, not 3 times 4.</i>                        |
| P4      | <i>Can you look behind?</i>                             |
| P2      | <i>No, you see ah. 1, 2, 3, 1, 2, 3. So you take 1.</i> |
| P3      | <i>Then 1, 2, 3, 4, [5, 6, 7, 8, 9]</i>                 |
| P2      | <i>[5, 6, 7, 8, 9]. 3 times 4 is 12. 5, 6, 7, 8, 9.</i> |
| P4      | <i>Ok, ok.</i>  |
| P2      | <i>So, 9 plus 1 is 10.</i>                              |

Figure 3. A transcript excerpt of a group discussion showing students engaging in exploratory talk in the post-intervention video.

This transcript excerpt shows three students engaging in a discussion at the post-intervention stage about how to solve Problem 2. The discussion features multiple short exchanges including disagreement and a question as they work together to find their solution. Characteristic of exploratory talk, the speakers engaged in reasoning and giving challenges to reach an eventual consensus.

## DISCUSSION

The observations and results generated suggest that the C.I.D. model had positive effects on students' discussions. The result of this study echoes research by Tay and Lim (2015) who found that students engaged in productive talk after the introduction of the C.I.D. model for English composition.

Despite the increased episodes of exploratory talk following the introduction of the C.I.D. model, the teachers recognise that this increase could be attributed to the type of problem selected for the lesson and not the model itself. Non-routine questions require students to think and provide novel answers, which may not be taught in class. The use of routine questions could mean that students might revert to cumulative talk where everyone agrees on one solution. During the video, the students could be seen trying to use the 'model' method, which is one of the main heuristics taught in Singapore. They started their exploratory talk to discuss possible solutions only after failing to find an answer.

While the findings of the inquiry are promising, the study has some limitations. As the intervention was limited to just two lessons of 30 minutes each, the students' increased use of exploratory talk may not be sustained beyond these lessons. Moreover, as the instructional video shows students completing an English task, the difference in the subject might have limited the application of the C.I.D. model in the Mathematics context.

Nevertheless, students engaged in more cumulative and exploratory talk after the introduction of the C.I.D. model, which could pave the way to individual cognitive development. For collaborative learning to take place, students must learn the art of productive talk. Incorporating the explicit teaching of the C.I.D. model provides students with a structure to organise their ideas and thoughts, which has broader implications because it is applicable across subjects and enables students of all progress levels to engage in productive talk.

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