



## A Trial of the Five Es: A Referent Model for Constructivist Teaching and Learning

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### Abstract

The science and technology education literature indicates that teaching within a constructivist paradigm is an effective way to promote student learning. Despite this, most primary school teachers do not use constructivist theoretical approaches because they are perceived as difficult and impractical to implement. To promote constructivist teaching and learning approaches in schools, teachers need access to models and strategies they can implement effectively and with relative ease. A unit of work was developed, based on the *Five Es* model (Engagement, Exploration, Explanation, Elaboration and Evaluation), and taught to a year 3 class. Ten students were participants in the study and became the sample. Data were analysed using two different methods to compare and validate findings. The unit of work, based on the *Five Es* model, was found to be interesting and fun by students, and motivated student learning and promoted student higher-order thinking.

**Key Words:** constructivism, elementary science, higher-order thinking, science learning, teaching strategies

Many teachers measure good and successful teaching by equating it with success in student achievement (Driver, Asoko, Leach, Mortimer, & Scott, 1994). Contrary to this belief, research (see, for example, Bell, 1993; Driver, 1983; Driver et al., 1994; Osborne & Freyberg, 1985; Richardson, 1997) suggests that the recall and use of information in assessment does not signify that students have learnt new knowledge and concepts. Since, when the knowledge is no longer required, it may be forgotten with students reverting to their original ideas – ideas learnt and reinforced by life experiences.

According to Skamp (1998), constructivism (in this case, neo-Piagetian social-constructivism) can contribute to effective teaching and learning, which is experiential learning generating high student motivation and higher-order thinking skills. Constructivist theory recognises that students have existing views about world phenomena and assumes that children need to be exposed to learning experiences that enable them to construct their own knowledge in synergy with their existing views. A constructivist view of teaching and learning recognises that children may not necessarily change their views about a concept because they are told something to the contrary. Children need to be given the opportunity to think about phenomena, and construct their own knowledge, if they are to experience conceptual change (Osborne & Freyberg, 1985). Consequently, one of the basic principles of a constructivist view

of teaching and learning is that teachers need to establish students' preconceived ideas before attempting to teach new concepts because new knowledge may not override children's learning and prior life experiences (Driver, 1983). Children need to 'experience' if they are to learn effectively.

One of the most important factors affecting student achievement is motivation (Karlsson, 1996). If students are interested in the subject being taught, and motivated by the way it is being taught, they will want to learn to satisfy their natural curiosity. Although the term learning may be difficult to define, it is less difficult to understand. According to Boud and Miller (1996, p. 8), "Learning is an act of becoming aware of experience, building upon it, extending it and in the process creating new experiences which become part of what we know." Moreover, learning is a process – it perceives an experience and for people to understand an experience they must be actively engaged throughout it (Boud & Miller, 1996) and the engagement of a student in lessons depends on their personal motivation. According to Karlsson (1996, p. 11), motivation is "the development of conditions promoting intention to act, or learn." The desired motivation for students is intrinsic motivation because if students are internally motivated they are more likely to reach their full potential (Karlsson, 1996). Teachers can increase student motivation by facilitating enjoyable learning experiences and allowing students to make decisions about their learning (Karlsson, 1996). Increased student motivation increases learning which leads to increased student achievement because the student is consciously and actively engaged in the learning experience (Barry & King, 1993; Galloway, Rogers, Armstrong, & Leo, 1998).

What may be relevant in science and technology education today may be obsolete tomorrow due to constant technological advancement (O'Tuel & Bullard, 1995). Students need to develop skills to help them benefit from change rather than be disadvantaged by it. Students need to think convergently and divergently to investigate challenges and problems as well as to think in complex and creative ways (O'Tuel & Bullard, 1995). These skills are higher-order thinking skills sometimes known as critical thinking skills. Although the age of students needs to be considered, Wilks (1995) has shown that higher-order thinking can and should be taught to students of all ages (O'Tuel & Bullard, 1995). In most primary schools, only lower levels of thinking are taught such as knowledge, comprehension and application (Brooks, 1990). Students are encouraged to develop their memory, but not thinking skills. Higher levels of thinking include analysis, synthesis and evaluation. Learning experiences focussed around these levels develop skills in problem solving, inferring, estimating, predicting, generalising and creative thinking (Wilks, 1995). The development of higher-order thinking skills can benefit all students including younger students because they are encouraged to ask questions, answer them intelligently and share their ideas with others (Heiman & Slomianko, 1987). A constructivist view of teaching and learning incorporates higher-order thinking skills because it encourages exploration, inquiry and direct experience with materials and information and, in order to uncover students' preconceptions, students are encouraged to share experiences with others (Brooks, 1990).

The reason constructivism (in its many forms and interpretations) is not widely used in primary school science and technology education is because teachers find it difficult to implement (Matthews, 1994). Many believe there is not enough time, due to an over-crowded curriculum (Richardson, 1997), while others find its construct theoretical framework and practices vague and difficult to comprehend. Constructivism is seen as an orientation towards teaching and learning, a way of viewing how teaching and learning occur or simply a way of thinking about learning (Richardson, 1997). Teachers do not view constructivism as a view of teaching and learning that can be followed to implement a teaching program (Aubusson, Watson, & Brown, 1998). Nevertheless, it has been shown that constructivist theory can be implemented through many different teaching models or designs, one of these being the *Five Es* (Bybee, 1997; Bybee & Powell, 1993). The *Five Es* is a teaching model, based on Piagetian theory, which can be used to implement an implicit constructivist (more specifically neo-Piagetian, human or social-constructivist) view of teaching and learning. It is built around a structured sequence and designed as a tangible and practical way for teachers to implement constructivist theory (Bybee, 1997). It purposefully promotes experiential learning by motivating and interesting students, as they are encouraged to engage in higher-order thinking. This is not to say that by following such a model, students will become intrinsically interested in the content presented and therefore motivated to construct meaning for themselves and so critically analyse and incorporate new views and different perspectives. Rather, the model provides a tangible referent (Ritchie, 1998; Tobin & Tippins, 1993) for teachers to scaffold their developing expertise in structuring a learning environment that will facilitate students' interaction with a learning context in a critical, reflective and analytical way. The *Five Es*, as such, is an aid or organiser for the teacher to structure and sequence potential learning experiences in a systematic and synergistic way consistent with a constructivist view of teaching and learning. In itself, the *Five Es* is not an essential part of student learning. The *Five Es* is a model, scaffold or framework for the teacher (see Bybee, 1997 for a full description).

Each 'E' in the *Five Es* model represents a specific phase in the model – namely, Engagement, Exploration, Explanation, Elaboration and Evaluation. Engagement promotes interest and motivation. Its purpose is to capture children's imagination (Swanage & Lane, 1999). The implementation of this phase is successful if students appear puzzled and are actively motivated to inquire and learn (Bybee, 1997). Exploration is designed to give students common, practical experiences, allowing them to build on their developing concepts and skills. These experiences can be used in subsequent steps to formally introduce scientific conceptions and language (Bybee, 1997). In this phase students are effectively exploring ideas including their ideas. Explanation gives students the opportunity to explain their findings to others. Students must give their explanations first with the teacher subsequently introducing relevant scientific explanations. These explanations need to be clearly linked to the engagement and exploration activities and student explanations (Swanage & Lane, 1999). Essentially students are provided with a learning environment that encourages them to explain their ideas and understandings. Elaboration gives students the

opportunity to extend their knowledge of concepts to other contexts. Children have a tendency to associate concepts with specific situations, and are often unable to identify relationships in different circumstances (Osborne & Freyberg, 1985). This phase is vital in developing more general views of phenomena, as children identify similarities in different contexts (Swanage & Lane, 1999). Essentially, children apply their new understandings to different contexts in a problem solving environment. The final phase is Evaluation in which students' understandings may be assessed more formally. Students are also encouraged to question their own conceptions. The structure and purpose of the *Five Es* can be implemented in individual lessons and on a larger scale throughout an entire science and technology unit. Each lesson taught using the model can incorporate aspects of a number of phases, and each phase should be evident in the planning and implementation of the unit as a whole (Bybee, 1997).

The purpose of this study was to determine if and how the *Five Es*, as an example of a teaching model, was able to transfer a constructivist perspective on teaching and learning into classroom practice.

### Method

Participant observation, specifically the teacher as researcher, was the enquiry method used for this research. The teacher as researcher methodology facilitates practitioners (teachers) using their "expert knowledge and understanding of practice in *their* research of *their* practice" (Loughran, Mitchell, & Mitchell, 2002, p. 3). The methodology focuses on the relationship between teaching and learning and addresses the gap between theory and practice (Loughran et al., 2002). The two main sources of data were taped student interviews and taped video footage of lessons taught from a unit of work, *Making and Marketing Products*. The unit of work was developed from the NSW Science and Technology K-6 Syllabus (Board of Studies, 1993) and was written to meet the Stage 2 outcomes from the Products and Services strand. In NSW science is integrated with technology as one of six key learning areas (KLAs). Consequently, the unit of work, upon which this study is based, includes activities such as marketing – as part of a broader technological process – as well as food groups and human nutrition which have a more traditional science focus. The unit was taught as part of the class's normal curriculum. The teaching/learning sequence for the unit of work followed the 5 Es model and was taught for between one and one and a half hours per week for six weeks. An example of the relationship between unit outcomes, unit activities, the *Five Es* and a constructivist view to teaching and learning is shown in Table 1.

Teacher field notes were used as supporting anecdotal data. Extracts from the teacher field notes were compared with findings from the main data sources. Teacher field notes were not used as a source of primary data. They were used to either substantiate findings from primary data sources or to raise questions for further investigation. The validity of findings was checked by comparing findings for consistency across the two primary data sources and with the teacher field notes. This triangulation process served to increase the reliability of findings. Student interviews were

Table 1

*Relationship Between the Unit of Work, the Five Es and Constructivism.*

| Unit outcome                                                       | Activity                                                                | <i>Five Es</i><br>perspective | Constructivist<br>perspective                                                           |
|--------------------------------------------------------------------|-------------------------------------------------------------------------|-------------------------------|-----------------------------------------------------------------------------------------|
| Materials and resources are used to produce goods and commodities. | After a field trip to McDonald's, students will investigate hamburgers. | Engaging and exploring.       | Students use common, everyday experiences to develop and build new concepts and skills. |

conducted by the teacher researcher and were based on a semi-structured interview schedule. The interviews provided student views of their learning. The taped video footage of lessons provided an independent data source against which the findings from the student interviews could be compared and validated.

The transcribed student interviews and the taped video footage were analysed differently. The student interviews were analysed using phenomenography, which is grounded in the data. Phenomenography is the empirical study of the limited number of qualitatively different ways in which phenomena are experienced, conceptualised, understood and perceived (Marton, 1988; Prosser, 1993). Essentially, the different perceptions and understandings individuals have of a phenomenon (e.g., hamburgers at McDonalds) have fundamental features in common. Some students would describe what they learnt about the hamburgers at McDonalds (they are made from bread, meat and salad). Some would categorise their composition, relating it to what they learnt in class about food groups (they are made from foods in different food groups), while others would evaluate them (the hamburgers are nutritious because they contain a variety of foods from different food groups). Students analysing at still higher levels would extend their analysis beyond the immediate context (McDonalds hamburgers are nutritious because they contain a variety of foods from different food groups but if you eat too many of them they may lead to a health problem because you could get fat). Each group of responses is called a category of description. However categories of description are related to each other in a way determined by the nature of the data. An ordered, hierarchical set of categories of description is called the outcome space of the phenomenon (Marton, 1988). In the example above the outcome space (hierarchy) would be determined by the level of analysis characterising each category. The categories of description and therefore the outcome space for a given phenomenon, in a given context, are determined by the data. In the example above, the students may have described the hamburgers in terms of taste rather than type of food. A phenomenographic analysis not only provides a list of different participant views for a given question about a phenomenon, but also incorporates an understanding of what these views mean. For example, the response in the last category described above indicates knowledge about hamburger nutrition as well as the

ability to position knowledge in a broad context and draws a conclusion about overall health. The results of the phenomenographic analysis of the interviews were checked independently by an expert in phenomenographic analysis. In such checking, total agreement is not necessary. However, there has to be agreement that an allocation to categories of description and determination of outcome space is probable, given the data (see Marton, 1988 for a full description of the checking process).

The taped video footage was analysed using an existing set of criteria known as the 'list of observable good learning behaviours' (LOGLB) (see Baird & Northfield, 1992). The LOGLB is a list of observable student 'public actions,' which are considered outcomes of meta-cognitive learning (Baird & Northfield, 1992), with examples ranging from low-order thinking behaviours to high-order thinking behaviours. For example, the first category in the list is 'seeks assistance'. Two examples of behaviours that identify this category include *tells the teacher when they don't understand* and *tells the teacher what they don't understand*. A middle category in the list is 'reflects on the work', and includes behavioural examples such as *seeks links between adjacent activities and ideas* and *independently seeks further information, following up ideas raised in class*. The final category in the list, 'assumes a position', includes the behaviours *offers ideas, new insights and alternative explanations*, and *challenges the text or an answer the teacher sanctions as correct*. The categories and examples of behaviours shift from requiring low-order thinking skills to requiring high-order thinking skills. The videotapes were used to provide data for analysis of the behaviours exhibited by students during lessons. Identified learning behaviours were allocated to the categories described and therefore defined by the LOGLB. The use of different methods of analysis is designed to validate the overall findings by comparing those emerging from the interview data with those identified when learning outcomes are categorised in terms of those identified by other researchers, namely the LOGLB. Therefore, student learning that was identified in this study need not be compared with learning outcomes previously identified from the same students because they can be compared with an existing set of general, previously researched and standardised learning outcomes. There are two advantages of this research design. Firstly, the study can be completed in a shorter time with data collected from just one topic, and with findings in terms of the actual learning outcomes encountered, rather than trying to locate learning outcomes in previously determined categories found in the literature. This allows for unanticipated findings (learning outcomes) to survive the analytical process rather than be subsumed by it. Secondly, the actual learning outcomes, which emanate from the data, can still be compared with those found in the literature. Findings from both analyses were checked for their reliability through triangulation with the anecdotal evidence from the teacher field notes.

A primary school teacher who taught a year 3 class in Western Sydney gathered the data as a teacher researcher. The participants in the study were the class teacher/researcher and students in the teacher's class who, along with their parents, gave consent to be part of the research. Seventeen of the 28 students in the class met the consent requirements of which ten (6 girls and 4 boys) were randomly selected for interview. The same sample provided the data from the ten videotaped lessons

although the video footage included the whole class. Since a description of actual views and attitudes held by participants is an outcome of this study pseudonyms are used to guarantee anonymity.

The school is a NSW Department of Education public school in Western Sydney with a population of 473 students of which 22% have non-English Speaking Backgrounds (NESB) and 12% are Aboriginal or Torres Strait Islanders. The school is part of the Disadvantage Schools Program (DSP) and receives additional funding because students come from a low socioeconomic background. This additional funding allows for numerous support staff to be working in the school, alongside classroom teachers. Despite the additional funding most students perform below the state average in Basic Skills Testing (NSW Department of Education and Training, 2000).

### Findings and Discussion

The findings are reported in three sections. The first is the phenomenographical analysis of the interview data to determine if the unit of work, using the *Five Es* model, promoted learning. The second is an analysis of both the interviews and videotapes to determine how effective the *Five Es* model was in promoting learning, if this was shown to be the case. The third section compares the interview and videotape findings to establish the validity of the overall findings. Throughout the discussion, anecdotal evidence from the teacher's notes is used in context to elaborate on and corroborate findings.

#### *Interview Analysis*

The interview data were analysed phenomenographically and produced three distinct categories of description. All students found the unit of work "interesting" and "fun." The outcome space (Table 2) was achieved by ordering responses according to student perception of their learning and in some cases higher-order thinking.

Table 2  
*Phenomenographic Analysis of Interview Data.*

| Defining Features of the Unit of Work                                                   | Response<br>( <i>N</i> = 10) |
|-----------------------------------------------------------------------------------------|------------------------------|
| 1 activities were fun but no reason was given                                           | 3                            |
| 2 activities were fun because they promoted learning                                    | 5                            |
| 3 activities were fun because they promoted learning and because they promoted thinking | 2                            |

The students in the first and second categories expressed a view that the activities in the unit were interesting because they were fun. However, even after probing, the students with views in the first category did not give any reason for their 'interest' or 'fun' whereas students in the second category gave reasons such as "because we were making stuff we knew it" ('it' meaning what they were suppose to learn). The two students with views in the final category also said the activities were interesting and fun because they helped them learn and promoted their thinking skills. Having an awareness of conceiving ideas reflects involvement in the process of learning at a higher intellectual level (Skamp, 1998). Kellie said:

We usually don't have fun when we learn cause it's like all stencils, but yours just made us think and we had fun with that too. You knew you were thinking about things you didn't think of before. . . . Thinking is fun – you wanted to (think).

All students stated that the reason for the unit being interesting and motivating was because the activities were fun. This finding was supported by evidence from videotaped lessons where many students were observed smiling and giggling among their peers, which shows amusement and pleasure, and having fun. This occurred in all lessons and was consistent with the teacher's field notes:

The students are so excited about preparing for the craft stall (the marketing activity in the unit of work). They enjoy doing things, which are fun. I now have a new positive reinforcement reward. Students who are working well and can demonstrate they have met the required outcomes (in other areas of their work) are given the chance to work on craft and our craft stall and this is acting as a real incentive for kids to finish all their work and to do it well. They enjoy their work and learning new things.

Although a student being permitted to working on the craft stall is external motivation, as far as learning in other subject areas is concerned, the production of craft and preparing for the craft stall is enjoyable and in terms of the unit of work it is intrinsic motivation. Learning is being used to motivate students generally.

According to Elliot, Kratochwill, Littlefield, and Travers (1996, p. 331), student motivation leads to student learning, "Everything that we know about learning indicates that if motivation is faulty, learning will suffer." The findings from this study, as evidenced by Table 2 and the teacher field notes, indicate that this is not a one-way relationship and that although interest and motivation promote learning, an overt recognition of learning by students promotes interest and motivation. Children's natural curiosity promotes learning, and when an activity stimulates learning and thinking, students are further motivated to participate and learn. Motivation and learning are synergistic, each reinforcing the other.

### *Effectiveness of Learning and Thinking*

The findings from the student interviews show that the unit of work, employing the *Five Es* model, motivated students to learn and promoted thinking because the

Table 3  
*Student Learning and Thinking.*

| Defining features of student learning and thinking            | Responses<br>(N=10) |
|---------------------------------------------------------------|---------------------|
| 1 • teacher prompting required for activity descriptions      | 4                   |
| • no relating activities to concepts                          | (Charles, Nicola,   |
| • no use of specific terminology even after teacher prompting | Jonathan, Michael)  |
| 2 • activities described                                      | 3                   |
| • activities related to concepts                              | (Tahlia, Kylie,     |
| • teacher prompting required for use of specific terminology  | Lara)               |
| 3 • activities described                                      | 2                   |
| • activities related to concepts                              | (Wayne, Kellie)     |
| • unprompted use of specific terminology                      |                     |
| 4 • activities described                                      | 1                   |
| • activities related to concepts                              | (Narelle)           |
| • unprompted use of specific terminology                      |                     |
| • transfer of understandings to different contexts            |                     |

activities were interesting and fun. To describe and interpret the nature of student learning and thinking, data from the student interviews, taped video footage and anecdotal evidence from teacher field notes were used. The student interview analysis was grounded in the data while the video footage was analysed using the list of good learning behaviours (Baird & Northfield, 1992). The analysis of the interview data leads the discussion followed by an analysis of the videotapes.

Coincidentally, like the LOGLB, the categories of description for the interview data were hierarchically ordered as the outcome space in terms of higher-order thinking with four categories generated as shown in Table 3. Therefore, Table 3 states the main features, identified from the interviews, which characterise the learning and thinking of each student.

The four students in the first category viewed the unit activities as a series of experiences and recall facts but did not use the terminology introduced in lessons even after being encouraged by the teacher. The three students with the view in category two were able to describe activities and recall information as well as relate activities to concepts. These students demonstrated an awareness of basic terminology associated with concepts. The views of the two students in category three differed from those of the previous category because specialised terminology was used without prompting or the student having to think of the word they had in mind. This signifies

that the students had constructed new knowledge and were using it to communicate new understandings. When Lara was asked what she had learnt about businesses she replied:

You would need people to work for you, your employees. You need money for all your bills like electricity, water, telephone and you need money to pay your employees, and you have to have money left over and this is your profit. It's what you get.

The fourth category stated the views of one student who used correct terminology, connected information to develop concepts and related concepts and understandings to a wider context:

Narelle: I know to desex my cat now because there are too many cats in the world.

Teacher: Where did you get that from?

Narelle: The ad on TV where it said desex your cat. That was an ad to help our universe, like the world. It was advertising like we did for our craft stall.

Narelle was able to generalise her idea of advertising from a way of selling a product to a way of informing or educating. She was able to see that the RSPCA advertisement was selling a message (educating) rather than a product. Narelle had not only generalised her view of advertising but had transferred what she had learnt to a different context – her everyday life.

The evidence indicates that participants in category one did not learn as much as those in subsequent categories because students required prompting to describe activities, activities were not related to concepts and they did not use specific terminology even after prompting. Alternatively, it is recognised that category one students may have been less able to articulate their knowledge or may have been shy because they were being interviewed. Nevertheless, it is evident that students in category one did not demonstrate an awareness of the concepts the activities were designed to promote and were not demonstrating the use of higher-order thinking skills.

By examining the language and terminology used by participants in the latter categories it is evident they recognised that activities are not isolated learning experiences; rather they are part of larger concepts. Therefore, student use of terminology (language) can be used as an indicator of their incorporation of learning into the fabric of existing information and understandings. The students in the latter categories were able to use language to show a more holistic perspective of what they had learnt and therefore demonstrated higher-order thinking skills.

An indication of even higher-order thinking is when generalisations can be made and transferred to different contexts. This demonstrates that the unit of work and the way it was being taught promoted the development and use of higher-order thinking skills. This point is evidenced by an extract from the teacher's notes:

This style of teaching seems to suit students who don't respond well to the traditional chalk and talk routine. In previous topics it has been difficult to get Lara and Narelle to write anything in their books. However, they were leading the discussion today and coming up with some great ideas. I can see that Narelle knows more than she puts down on paper. ... I'm also really amazed at Lara's level of understanding compared with other topics.

The evidence suggests that this unit of work, employing the *Five Es* model, has promoted higher-order thinking at least for some students since they had not previously demonstrated these skills. Moreover, the teacher was able to conclude that the majority of students were engaging in higher-order thinking compared to that experienced in previous science and technology lessons as stated below:

I really feel that this approach to teaching is allowing the kids to think so much more than they were encouraged to in past science and technology lessons. I am not spoon feeding them; they are thinking for themselves.

Students who did not demonstrate higher-order thinking skills did not seem to be disadvantaged by the *Five Es* teaching model because they were able to talk about things they learnt, even if they were not making connections between new experiences and concepts (category 1 participants). Consequently, the evidence indicates that the unit of work, employing the *Five Es* model, benefited students by promoting higher-order thinking over a range of student abilities.

### *Videotape Analysis*

The Baird and Northfield (1992) LOGLB was used to analyse the videotape data. The first step was to allocate each student behaviour, for all ten participants and all videotaped lessons, to the appropriate LOGLB category. A short but indicative example is shown in Table 4 where Tahlia's behaviours (questions and comments) have been categorised.

The number of lower-order behaviours (total number of behaviours in the first two categories) was then compared to the number of higher-order behaviours (total number of behaviours in the last two categories) for each participant. In the example for Tahlia this is 2 and 4 respectively. This enabled the percentage of lower-order behaviours to be calculated by dividing the number of lower-order behaviours by the total number of behaviours in all categories. A similar calculation was made to obtain the percentage of higher-order behaviours for each participant. For Tahlia this was 2/7 (29%) and 4/7 (49%) respectively. Each participant was then assigned a Percentage Difference Score which was calculated by subtracting the percentage of lower-order behaviours from the percentage of higher-order behaviours. The Percentage Difference Score for all participants is shown in Table 5.

This method was chosen because it enabled a value to be calculated for each participant using only data for that individual. Students who may not have the confidence to speak in front of the class are not compared to those who are more outgoing. The aim of the process was not to assign a value to the number of contributions a student made compared with others, but to indicate the degree to which they were engaging in higher order thinking. Consequently, the analysis is not affected by the individual participant's personality. It is concerned with the type of thinking skills the participant was demonstrating at the time.

Table 4  
*Tahlia's Behaviours in Terms of List Categories.*

| List categories                  | Behaviours (questions and comments) |                                                                                           |
|----------------------------------|-------------------------------------|-------------------------------------------------------------------------------------------|
| Seeks assistance                 | Lesson 1                            | Miss, everyone in our group keeps doing their own (help me).                              |
| Checks personal progress         | Lesson 4                            | When do these have to be finished?                                                        |
| Plans and anticipates            | Lesson 1                            | What are other things we'd need?                                                          |
| Reflects on the work             | –                                   |                                                                                           |
| Links to beliefs and experiences | Lesson 2                            | I have a worm farm at home to recycle our food scraps.                                    |
| Assumes a position               | Lesson 2                            | Food needs to be wrapped up so it's not contaminated by bacteria.                         |
|                                  | Lesson 5                            | More people could have made things at home to make our stall bigger and make more profit. |
|                                  | Lesson 6                            | Expenses – that's money you need to use towards the business.                             |

Table 5  
*Percentage Difference Scores.*

| Participant | Percentage difference score | Percentage difference score groups |
|-------------|-----------------------------|------------------------------------|
| Charles     | 10                          | Less than 20                       |
| Kellie      | 17                          |                                    |
| Jonathan    | 18                          |                                    |
| Kylie       | 24                          | 21 to 40                           |
| Lara        | 25                          |                                    |
| Michael     | 25                          |                                    |
| Wayne       | 25                          |                                    |
| Tahlia      | 29                          |                                    |
| Nicola      | 33                          |                                    |
| Narelle     | 47                          | More than 40                       |

Table 5 shows that all students were asking or answering higher-order questions or making higher-order comments more often than lower-order questions or comments. The analysis indicates that the unit of work, using the *Five Es* teaching model, encouraged students to be involved in higher-order thinking. This is consistent with the findings from the interview analysis. However, the question remains: how consistent?

*Comparison of Findings from the Interviews with Findings from the Videotapes*

The ten students who were the focus of the videotape analysis were also those interviewed. This allows for comparison of the two sets of findings to check their validity. It also allows for a comparison of the interview analysis findings with a standardised set of learning behaviours in place of a comparison with learning behaviours exhibited by these students in a previous unit of work. In both analyses students were placed in categories which were hierarchical, ordering students from lower-order to higher-order thinking. Table 5 shows three groups for the Percentage Difference Scores that emerged as natural groupings when the data were listed. Table 6 compares the ranking of students in these three groupings with the four categories of description for the interview analysis detailed in Table 3.

Seven of the 10 participants were ranked in equivalent order in both analyses. Michael and Nicola were in adjacent categories and this is an inconsistency in terms of the overall comparison. However, Kellie was further apart in the overall comparison and this does suggest there may be additional factors involved that this research

Table 6  
*Comparison of Student Learning by Type of Analysis.*

| Category | Interviews | Videotape                                |         |                               |
|----------|------------|------------------------------------------|---------|-------------------------------|
| Lowest   | Category 1 | Charles<br>Jonathan<br>Michael<br>Nicola | Group 1 | Charles<br>Jonathan<br>Kellie |
| Middle   | Category 2 | Tahlia<br>Kylie<br>Lara                  | Group 2 | Tahlia<br>Kylie<br>Lara       |
|          | Category 3 | Wayne<br>Kellie                          |         | Wayne<br>Michael<br>Nicola    |
| Highest  | Category 4 | Narelle                                  | Group 3 | Narelle                       |

failed to address. Nevertheless, overall, the evidence accumulated and analysed from videotape data is consistent with and supports the findings of the student interviews and teacher's field notes. Therefore, irrespective of the data source or how it was analysed, the findings are largely consistent and supportive of one another, helping to validate the overall findings. One of the findings was that students exhibited good learning behaviours when engaged in a unit of work, based on the *Five Es* teaching model, and that these good learning behaviours included higher-order thinking. This is particularly significant when it is remembered that the students were from a disadvantaged school. Although socio-economic status does not affect a student's level of achievement, it is recognised that there is a correlation between under-achievement in school and low socio-economic status (Henry, Knight, Lingard, & Taylor, 1988). In addition, the students from the school in this study performed below the state average in Basic Skills Testing (NSW Department of Education and Training, 2000). This needs to be considered when considering and interpreting the findings of this study, especially the finding that only one student in the study was working in the highest category.

### Conclusion

This study has shown that the unit of work, based on the *Five Es* teaching model, can be used successfully to implement a constructivist view of teaching in the primary school classroom. Students found the unit of work fun and interesting and were motivated to learn while others said they were interested and motivated because they were learning. The study showed that motivation led to learning, and that learning can also lead to motivation. Motivation and learning are synergistic, each reinforcing the other. It was also shown that the unit of work, based on the *Five Es* model, promoted higher-order thinking because each student demonstrated a greater percentage of higher-order thinking than lower-order thinking. This is not to say that such a model is the best way to implement a constructivist (socio-, neo-Piagetian) view of teaching and learning but that it has been demonstrated to be a successful referent for a novice teacher. In fact, there is likely to be a number of complexly, interrelated reasons why the implementation of this unit of work was successful. However, this study suggests that the use of the *Five Es* model was one of them.

The *Five Es* is one model that can be used to implement a constructivist view of teaching and learning in the classroom. Although this model was successful, it may not be suited to all teachers and to all strands of a curriculum. Teachers have available a variety of structured, convenient and effective ways to teach based on a constructivist theory of teaching and learning. The perception that teaching from a constructivist perspective is not practical can be overcome by the use of teaching and learning models or referents, such as the *Five Es*, which provide useful and practical ways for teachers to implement a constructivist view of teaching. Such models or referents need to be developed, refined and researched if theoretical underpinnings, such as constructivism, are to be transferred to mainstream classroom practice.

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