

VOLUME 5 NO. 2
DEC 2008

ISSN 1675-7017

SOCIAL AND MANAGEMENT RESEARCH JOURNAL



RESEARCH MANAGEMENT INSTITUTE



SOCIAL AND MANAGEMENT RESEARCH JOURNAL

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Social and Management Research Journal is jointly published by Research Management Institute (RMI) and University Publication Centre (UPENA), Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.

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Vol. 5 No. 2

December 2008

ISSN 1675-7017

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Inverse Proportion: A Constructivist View of College Students

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ABSTRACT

From the constructivist paradigm, knowing misconceptions of students regarding a particular concept is deemed vital in designing effective instruction. Ausubel (1968) commented that 'The most important single factor influencing learning is what the learner already knows; ascertain this and teach him accordingly'. The symbiosis between science and mathematics is a profound one. Science views mathematics as a significant branch. Science likes to refer mathematics as the Queen, as mathematics nurtures the growth of science especially in the areas such as scientific prediction and manipulation. On the other hand, many concepts of mathematics are invented for the purpose of science such Proportion and Calculus to name a few. Two major ideas in Proportion are the Direct and the Inverse. A good grasp of these mathematical ideas is paramount for students in understanding the fundamental nature of science in its quantitative form. This paper offers a comprehensive description of seven hundred and fifty nine science based students (385 female and 374 male) from a local university in their developmental understanding of this mathematical idea of Inverse Proportion from the six domains i.e., Definition of Inverse Proportion, Graphical Representation of Inverse Proportion, Mathematical Representation of Inverse Proportion, Data Characteristic of Inverse Proportion, Relational Understanding of Inverse Proportion, and

Problem Solving in Inverse Proportion. It discusses these six domains from two perspectives i.e., Academic Ability and Gender. The paper is based on a study by Beh et al (2008) anchoring on Constructivism. Among the major findings are: Students irrespective of high or low academic ability generally performed poorly in domains requiring conceptual understanding, but showed relatively higher competency for the domain requiring procedural skills. Students of higher level academic ability demonstrate a significant in dept understanding of Inverse Proportion than students of lower level of academic ability; and Male students overall understanding of Inverse is significantly higher than their female counterparts at the 5% level. Since the study is based on Constructivism, it also highlights students' alternative frameworks. Implications for teaching and learning will be discussed.

Keywords: *Constructivist paradigm, problem solving, relational understanding*

Introduction

Constructivism's central idea is that human learning is constructed. Learners build new knowledge upon the foundation of previous learning. Research in this paradigm has revealed the ideas on what students have constructed in the science classroom are often not the ones intended by the instructors. These ideas are coined using many different terms such as misconceptions, alternative frameworks, or naïve ideas (Driver 1988; Driver and Easley, 1978; Barrass, 1984). This view of learning sharply contrasts with the one in which learning is the passive transmission of information from one individual to another, a view in which reception, not construction, is the key.

Students' misconceptions in Science and Mathematics are tenacious to change. Hence, it is a challenge for teachers to design effective methods of instruction in facilitating learning among students. In the paradigm of constructivist classroom, one of the essential elements teachers need to consider is identifying the nature and source of the misconceptions students do harbour and teach them accordingly. Recent reform in the Malaysian Science curriculum has recommended the inclusion of the constructivist philosophy in its pedagogical design for teaching and learning approaches in Science (Curriculum Development Centre 2006).

The topic of Proportion from the perspective of students' understanding in problem solving has gained the interest of many researchers in Malaysian from the views of Science and Mathematics Education. From the view of Physics Education, for example, Yap (1992) reported that sixty pre-service science teachers (majoring in Physics and Mathematics) enrolled in a Bachelor of Science Education Programme were weak in the understanding of Direct Proportion.

From the Mathematics perspective in the domain of problem solving, for example, Parmjit (1998) reported that only a small percentage of students who did well in the Penilaian Menengah Rendah (PMR) at year three secondary school (age 15) were able to solve complex proportional problems. The study further concludes that the grades obtained in the PMR examination were a weak indicator of students' knowledge of ratio and proportion. In year 2006 Beh et al. (Beh et al, 2006; 2007) sought the procedural and relational understanding of college students from six domains of Direct Proportion had concluded that students irrespective of high or low academic ability and gender generally performed poorly in the conceptual domains however showed high competency in procedural domain.

Two major ideas in proportion are the Direct and the Inverse. The study by Beh et al.(2006) had focused on Direct Proportion. This study would like to explore the Inverse counterpart as a complement to the study by Beh et al (2006). The results revealed would provide a wholesome understanding regarding university science based students' understanding of Proportion as a whole. In order to achieve this noble goal, the objectives of the Direct Proportions are use as a template for this study with minimal modification. This purposeful design enables researchers to compare and contrast the results as revealed in this study to that of the study of Direct Proportion. Thus this paper explores the developmental change in understanding of Inverse Proportion among college students in terms of student academic ability (as gauged by the grade obtained for SPM Additional Mathematics subject) and gender difference.

Research Methodology

A written questionnaire to test both conceptual understanding and problem-solving skills was developed. The questionnaire consists of six major sections, Sections 1 to 6, measuring six different domains of Inverse Proportion, i.e., Definition, Graphical Representation, Mathematical Representation, Data Characteristic, Relational Understanding, and problem Solving.

A pilot test was carried out on 21 Semester Two students from engineering diploma programme at a local university. Content validity of the questionnaire was established by ten lecturers with more than 10 years of teaching experience in various fields of Applied Sciences. Reliability of the instrument was obtained using test-retest procedure. The Cronbach's Alpha was found to be 0.5. However, using t-paired test for the test and retest, the result shows that there is no significant difference between the mean score of the test and retest at 5% level.

The Sample

Participants consisted of seven hundred and fifty eight students (385 female and 373 male) from a local university. They were students enrolled in the various diploma courses in the Faculty of Applied Sciences, Faculty of Engineering and Pre University Sciences. These students had studied the topics of Proportion when they were in year 11 (Form five). The sample were categorized into three academic ability groups A, B, and C according to the Additional Mathematics grade obtained at the SPM level as shown in the following table:

Table 1: Distribution of the Categories of Students According to Additional Mathematics

Academic Ability	Category	Additional Mathematics Grade	Number of Students
High	A	A1, A2 & C3	246
Average	B	C4, C5 & C6	358
Low	C	P7, P8 & F9	154

Result

Due to the limitation of space, authors could only briefly discuss the findings. For details, please refer to the full report (Beh, Tong, Noor 2008)

Section 1: Definition

The question in this section (figure1) requests students to identify the statement (or a statement) that defines Inverse Proportion.

Mark [/] on statement (or statements), which explains ' y is inversely proportional to x '.

- (A) When x increases y increases.
 - (B) When x increases two times y also increases two times.
 - (C) When x increases y decreases.
 - (D) When x increases two times y decreases by half.
 - (E) When x increases y increases linearly.
 - (F) When x increases by 3 units y decreases by 3 units.
 - (G) The rate of change of y with respect to x is constant.
-

Figure 1: Question in Section 1

The correct answer for this question is D. Result shows that only about half of the students (54.1%) had included D in their answers. Among these students 64.7%, 48.6%, and 53.9% are from Categories A, B, and C, respectively. However, the most popular choice is statement C; about 90% of students from each category of student had chosen C. Statements F(49.9.3%), and G (30.7%) are among students' favourite too. To almost all students, statements A, B and E were obvious a non-description of Inverse Proportion, this is because in the statements, the two variables involved (i.e., x and y) increase simultaneously. Only 2.6%, 1.8% and 3.4% of the students had chosen statements A, B and E respectively.

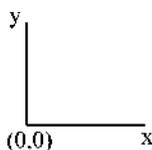
Unlike statements A, B and E which convey the general idea that the two variables involved (i.e., x and y) increase simultaneously, statements C, D and F carry the general notion that as one variable increases, the other related variable decreases reflecting the general notion for Inverse Proportion. The high percentage for statements C, D and F indicate majority of the students possessed only the general notion of Inverse Proportion, i.e., as x increases y decreases. These students failed to perceive accurately the precise mathematical idea for Inverse Proportion.

Section 2: Graphical Representation

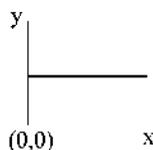
The question in this section (figure 2) requests student to identify the graph or graphs that represent Inverse Proportion. Graph C is the representation of Inverse Proportion between two variables which is a hyperbola.

Mark [] on the graph (or graphs) that represents 'y is inversely proportional to x'.

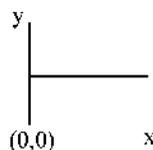
(A)



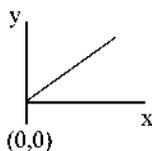
(B)



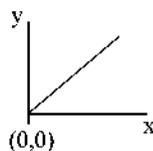
(C)



(D)



(E)



(F)

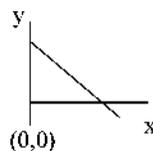


Figure 2: Question in Section 2

Result shows a high percentage of students (60.0%) had included C in their answers. Among these students, 61.0%, 58.1%, and 63.0% are from Categories A, B, and C respectively. However, the most popular choice is graph F, 71.6% of the students had chosen Graph F. Of these students, 71.1%, 71.5%, 72.7% are from Categories A, B, and C respectively. Graph F represents decreasing mode. Graph F (71.6%) attracted more students than did Graph C (60.0%). The only difference between Graph F and Graph C is that one is linearly decreasing and the other is non-linear. Many students held the notion that for Inverse Proportion, the relationship between the variables is linear.

Section 3: Mathematical Representation

Question in this section (Figure 3) requests students to identify the mathematical statement or statements that represent Inverse Proportion.

Mark [] on the mathematical relationships (equations) that represent 'y is inversely proportional to x' (a, b and k are constants).

- (A) $y=k/x$ (B) $yx = k$ (C) $y = a/x + b$ (D) $y = a/x^2 + b$
 (E) $y = \ln(1/x)$ (F) $y/x = k$ (G) $y_1x_1 = y_2x_2$ (H) $y \propto 1/x$
 (I) $y \propto (x+k)$ (J) $y \propto 1/x^2$

Figure 3: Question in Section 3

The mathematical relationships/equations that represent Inverse Proportion are statements A, B, G, and H. Among the four correct mathematical equation/relationships A, B, G, and H. more than half of the students recognized equation (relationships) A (71.2%), B(56.2%), and H(65%). Only 9.4% of students had chosen equation G although this type of mathematical equation is commonly used in problem solving where the scientific phenomenal is of the inverse relation such as in the topic of gas in Chemistry and Physics, equation $P_1V_1 = P_2V_2$ has been introduced in computation involving the use of Boyle's law. Although equation G is derived from the equation B, many students who have picked B failed to realize this relationship leading to a high percentage for equation B and low percentage in G. A high percentage of students (45.3%) had included C in their answers.

Section 4: Data Characteristic

The question in this section (Figure 4) requests students to identify the pattern of data (numerical values) which enable them to conclude that 'y is inversely proportional to x'.

In an experiment, students are asked to complete the following table:

y	x	yx	y/x	y+x	x/y	y-x	xy
[] (A)	[] (B)	[] (C)	[] (E)	[] (D)	[] (F)	[] (G)	[] (H)

Mark [] on the column (columns) whose pattern of data (numerical values) enables you to conclude that 'y is inversely proportional to x'.

Figure 4: Question in Section 4

The values yx in column C and xy in column H which are constant for any pair of values x and y will enable students to gauge that 'y is inversely proportional to x'. Result shows that 17.2% (A = 11.4%, B = 17.9%, C = 24.7%) of the students had chosen C, i.e., yx . Only about 15% (A = 10.2%, B = 17.0%, C = 19.5%) offered H, i.e., xy . About a half of the students chose column A, i.e., y values and column B, i.e., x values. About 40% of the students had chosen column E which is y/x and 20% for column F (x/y) that is the pattern for direct proportion. About 10% of the students had chosen other columns, for instant D for $y+x$ and G for $y-x$. This shows that a vast majority of students from all categories failed to conceptualize the unique nature of the values of xy and yx , that is a constant, if x and y are inversely proportional. Students were conceptually unclear about the data characteristic for Inverse Proportion.

From the combinations of students' choice for Section 4, data reveals that many students had included A and B column i.e., y and x values in their choice, about 5% of the students had chosen A and B column only; about 15% of the students had the correct answers of columns C and H, i.e., yx and xy values; only 5% of the students had offered column C i.e., yx only and 1% for column H only.

For the correct answers only, i.e., C, H and CH, it is noted that the scores are very low even for high achievers and the scores are in decreasing order from high to low achievers, (A = 30.5%; B = 17.9%; C = 12.9%). It is inferred from here that generally students irrespective of their academic achievement do possess a vague notion regarding the unique characteristic in term of numerical values that represent Inverse Proportion.

Section 5: Relational Understanding

This section consists of two sub-sections i.e., 5(a), and 5(b). Both the questions are of words type with experimental data for two variables. Students are to ascertain the relationship of the variables with explanations. Section 5(a) is an example of Inverse Proportion, where else Section 5(b) is a non example of Inverse Proportion.

Section 5 (a): Relational Understanding of Inverse Proportion: An Example

The question for this section (Figure 5) requests students to determine the relationship between F and V based on the values given in the table.

An experiment is carried out at room temperature to investigate the effect of external force applied on a volume of a gas. The results are tabulated as follows;

Force, F (N)	40	20	10	5
Volume, V (cm ³)	10	20	40	80

- (a) What is the relationship between F and V (if any)?
(b) Justify your answer.
-

Figure 5: Question in Section 5(a)

The relation between F and V is Inverse Proportion. This can be gauged from the values of the product FV, a constant, as F decreases when V increases. Result revealed that 88% (A = 86.0%; B = 88.0%; C = 87.0%) of the students managed to state correctly that F is inversely proportional to V. However, from the reasons offered, it was found that 89.1% of the reason offered (A = 86.0%; B = 89.2%; C = 93.8%) was 'F decreases as V increase'. The results is congruent with the results in Section 1 where 90% of the student chose the statement C, which is 'When x increases y decreases' for statement that best describes inverse Proportion.

Section 5 (b): Conceptual Understanding of Inverse Proportion: A non-example

The question in this section (Figure 6) requires students to determine the relationship between t and θ in the table of values given. It is a test of the application of conceptual understanding.

An experiment is carried out to investigate the relationship between temperature and time of solid X, which is heated over a constant rate until it melted. The results are tabulated as follows;

Time t (min)	2	4	8	12	14
Temperature θ (°C)	10	20	30	30	40

- (a) What is the relationship between θ and t (if any)?
(b) Justify your answer.
-

Figure 6: Question in Section 5(b)

The relationship between t and θ is a non- direct proportional type as at 8 min to 12 min, the temperature remains the same. Only 19.9% of the students got their answers correct. Among these students, 28.9% was from the high achiever category, 15.4% was from average achiever category, and 16.1% was from low achiever category. This indicated that although the high achievers had done better than others but the percentage is rather low. Result also revealed that only a small per cent offered correct reason that the rate of decrease is not constant as reflected in the readings for 8min and 12min where no change in temperature has been indicated. Majority of the students offered the idea that 't increases and θ increases'.

The results from Section 5(a) and 5(b) further establish the fact that has been revealed in the earlier sections that students' mathematical idea of Inverse Proportion is not well established conceptually even among the high achievers.

Section 6: Problem Solving

This section consists of two subsections, i.e., 6(a) and 6(b). Both the questions in this section belong to the problem solving types that are often found in most mathematics textbooks. Question 6(a) involves only numerical data and Question 6(b) is in words form.

Section 6(a): Problem Solving of the Numerical Type

The question in this section (Figure 7) requests students to complete the table with appropriate values if the relation between x and y is 'y is inversely proportional to x '. It is a test of student computational skills.

If 'y is inversely proportional to x ', complete the following table:

x	1	2	3	4	5
y			20		

Figure 7: Question in Section 6(a)

The success rate for the section is only 40.8%. Among these students, 60.2% was from high achievers (category A), 34.9% was from average achievers (category B), and 23.4% was from low achievers (category C). The success rate increases from low to high achiever categories. The achievement shown here is slightly better than the achievements attained in the earlier sections which focus more on conceptual understanding regarding idea of Inverse Proportion in various contexts and representations.

Section 6(b): Problem Solving of the Words Type

The question in this section (Figure 8) requests students to solve a word problem that involves inverse proportion.

En. Samad needs to surface the floor of a hall with new square tiles. If 2016 tiles of size $0.4\text{ m} \times 0.4\text{ m}$ would be needed to surface the floor, how many tiles are required if he uses tiles of size $0.3\text{ m} \times 0.3\text{ m}$? (Area of tile = length x breadth)

Figure 8: Question in Section 6(b)

Student achievement in this section is good with 80.0% of the students succeeded in solving the problem correctly. The score of the students from all the three groups are high with 83.7% for the high achievers; 81.6% for the average achievers, and 70.3% for the low achievers.

Relationship between Sections

The research instrument consists of 8 major questions in 6 Sections measuring different aspects of student competency. The achievement of students for each section is determined by the percentage of students who offered the correct response only. When the performance for each section is ranked in terms of percentage of successful response, the following descending order is obtained:

A	5a(88.6)	6b(76.8)	6a(60.2)	4(47.2)	5b(28.9)	3(22.8)	2(18.3)	1(2.0)
B	5a(88.0)	6b(64.0)	6a(34.9)	3(25.4)	4(22.9)	5b(15.4)	2(9.5)	1(1.4)
C	5a(87.0)	6b(46.8)	3(24.7)	6a(23.4)	5b(16.2)	4(13.6)	2(7.8)	1(1.9)
Overall	5a(88.0)	6b(64.6)	6a(40.8)	4(28.9)	3(24.4)	5b(19.9)	2(12.0)	1(1.7)

The result indicates that generally students are weak at Definition of Inverse Proportion, Graphical Representation of Inverse, Mathematical Representation of Inverse Proportion, and Relational Understanding of Inverse Proportion: A non-example. Students' academic strengths are at Question 6(a): Problem Solving of Inverse Proportion- Numerical and Question 6(b): Problem Solving of Inverse Proportion – Words Problem. Since these types of questions are often employed as problem solving exercise in Mathematics at SPM level, we shall classify these problems as testing of Procedural Understanding of Inverse Proportion. Question 5(a): Relational Understanding of Inverse Proportion: An Example is ranked first as most of the students (88%) had stated the correct answer. However, it has been discussed earlier in Section 5 that although the students had offered the correct answer but failed to offer the most valid reason. Analysis

in Section 5 showed that the high score in this section does not reflect an in depth relational understanding that students have.

The score for Question 5(a) is high but the score for Question 5(b) is low. This reveals that students' conceptual understanding is limited. This is because a majority of the students who had stated that the relation in Question 5(a) was of Inverse Proportion but offered their reason for saying so as 'as F increases V decreases'. For Question 5(b) a majority of students got it wrong as they perceived the relationship as direct proportion because to them the data showed that 'when t increases θ increases'.

The data reveals that generally students' conceptual understanding is not well grounded however their procedural skills for problem solving are considerably well rehearsed. For achievement in terms of academic ability, high achiever students are better than students from low and medium categories.

Performance and Academic Ability of Students

Chi Square test of independent reveals that there is no relationship between the performance of the students and the academic ability for Sections 1, 3, and 5a. However for Sections 2, 4, 5b, 6a and 6b, the performance of the students does depend on academic ability. The results revealed that for these five sections, students of Category A did perform better than students from Categories B and C. Students from Category B did perform better than students from Category C except for Section 5b where students from Category C did perform better than B although the difference is small.

Gender

When ranking is performed for the eight sections in terms of percentage of correct response for both male and female students, the following descending order is obtained:

Male	5a(89.0)	6b(71.6)	6a(40.8)	4(29.5)	3(28.7)	5b(22.0)	2(14.7)	1(1.9)
Female	5a(87.0)	6b(57.9)	6a(40.8)	4(28.3)	3(20.3)	5b(17.9)	2(9.4)	1(1.6)

The trend of the percentage of correct response of the eight questions for both male and female are the same, i.e., the results indicate that generally both male and female students are weak at Definition of Inverse Proportion, Graphical Representation of Inverse Proportion, Relational Understanding of Direct Proportion: A non-example, and Mathematical Representation of Inverse Proportion, Students' academic strengths for both male and female are at Procedural Understanding of Inverse Proportion as gauged by Question 6(b)

and 6(a). Although Question 5(a) “Relational Understanding of Inverse Proportion: An Example” is ranked first, further analysis had revealed that students from both genders could state the answer correctly but they failed to offer the valid reason. Generally the success rate for male is higher than the female for all the eight questions. For the overall result, an independent t test for difference of means shows that mean score of male is significantly higher than the female at the 5% level.

Conceptual Understanding versus Procedural Understanding

Understanding can be classified into two categories, i.e., procedural/ instrumental and Conceptual/ relational (Skemp1978; Hiebert and Carpenter 1992). Procedural/ instrumental understanding in Mathematics concerns with computational skill and Conceptual/relational understanding involves mathematical knowledge that is rich in connection. By this classification for understanding, the six sections in this study can be further grouped to two categories, i.e.

- Conceptual understanding of the inverse proportion as represented by Sections 1, 2, 3, 4, 5a, & 5b, and
- Procedural understanding of the inverse proportion as represented by Sections 6a and 6b.

Result reveals that the conceptual understanding of Inverse Proportion is very low even among the high achievers. The overall mean score is 0.292. The mean score of the Category A students is 0.346 which is higher than that of Categories B (0.273) and C(0.252) . The performance of the students for the procedural understanding is high for the high achievers (0.685). The overall mean score is 0.527. The mean score for Category A students is much higher than the Categories B(0.494) and C(0.353) students. There is a significant positive correlation between performance of conceptual and procedural understanding at 5% level (coefficient correlation = 0.313).

The performance of the students for procedural understanding is much better than conceptual understanding. A paired t test for difference of means was carried out; the result shows that the difference is significant at 5%. The conclusion is also true for each academic category.

Conclusions

As indicated earlier, one of the many objectives of this study on Inverse Proportion is to complement the study by Beh et al. (2006) on Direct Proportion as Direct and Inverse are the two majors in Proportion. The design of the questionnaire in this study is in congruent with the Direct counterpart. In addition the same student sample was used in both the studies.

Result indicates that students' understanding in both Direct and Inverse Proportion offers similar trend, i.e., weak in conceptual but strength in problem solving. Although the mean scores for both Direct and Inverse are relatively low i.e., 0.437 and 0.350 respectively, a paired t test for comparison of means shows that the difference is significant at 1% level. The result of this finding is in coherence with the findings by Orfanzo(2003) regarding learning of Physics and by (Porter and Masingila, 2000) regarding learning of Mathematics.

Implications to Teaching and Learning

According to Hiebert and Carpenter (1992), both conceptual and procedural understandings are important since well-rehearsed procedures guide seemingly effortless solution of routine problems. However, they suggest that teaching environments should be designed to help students build internal representations of procedures that become part of larger conceptual networks before encouraging the repeated practice of procedures. This suggestion by Hiebert and Carpenter should be adopted in actual practice in teaching mathematics.

It is noted that out of the eight aspects of Inverse Proportion (as represented by the 8 questions used in the study) only two are emphasized in the mathematics class room, that is, Problem Solving of Inverse Proportion of the numerical and the words types. It is prudence in the teaching of Proportion the other six aspects need to be explicitly attended to and discussed while highlighting examples and non-examples.

A discussion with the mathematical teachers revealed that in graphical representation, the hyperbola curve (i.e., graph (C) in Section 2) is not emphasized, instead the emphasis is on linear form of y vs. $1/x$. However, in physics, especially in the section on ideal gas, the hyperbola curve has been used in the discussion of Boyle's law. Since the learning of mathematics for science students is to enhance learning in science hence this lack of emphasis is deemed non-prudent.

References

- Barrass, R. (1984). Some Misconceptions and Misunderstandings Perpetuated by Teachers and Textbooks of Biology. *Journal of Biological Education*, 18 (3), 201-206.
- Beh, K.L., Tong, S.F. and Noor, C.N. (2007). *Competency in the Six Domains of Direct Proportion among College Students from the Perspectives of Academic Ability and Gender Difference* : CSSR 2006-2007 Conference, Biro of Research and Consultancy, UiTM. Shah Alam. Hotel Sunway lagoon July 2007.

- Beh, K.L., Tong, S.F. and Noor, C.N. (2006). *Procedural and Relational Understanding of Direct proportion Among College Student from the Perspectives of Academic Ability and Gender Difference*. Unpublished Research Report. Biro of Research and Consultancy, UiTM. Shah Alam.
- Beh, K.L., Tong, S.F. and Noor, C.N. (2006). Procedural and Relational Understanding of Direct proportion Among College Student from the Perspectives of Academic Ability and Gender Difference. *Proceedings: INCULT 2006: Third International Conference on University Learning and Teaching, Faculty of Education, UiTM. Shah Alam*, 159-171.
- Curriculum Development Centre (2006). *Integrated Curriculum for Secondary Schools*, Curriculum Specifications. Ministry of Education Malaysia.
- Driver, R. (1988). *The Pupil as Scientists* Open University Press. Milton Keynes. Philadelphia.
- Driver, R. and Easley, J. (1978). Pupils and Paradigms: A Review of Literature Related to Concept Development in Adolescent Science Students. *Studies in Science Education*, 5, 61-84.
- Giancoli, D.C. (1991). *Physics* (third edition). Englewood Cliffs, New Jersey. Prentice Hall.
- Hiebert, J. and Carpenter, T. P. (1992). Learning and Teaching with Understanding. In D. A. Grouws (Ed.), *Handbook of Research on Mathematics and Learning*. Macmillan, 65-97.
- Orfanos, S. and Dimitracopoulou, A. (2003). <http://www.modellingspace.net/Documents/orfanos-dimitracopoulou-m-icte-10-10-2003.pdf>
- Parnjit, S. (1998). *Understanding The Concept of Proportion and Ratio Among Students In Malaysia*. PhD Dissertation. Florida State University.
- Porter, M. K. and Masingila, J. (2001). Examining The Effects of Writing on Conceptual and Procedural Knowledge in Calculus. *Educational Studies in Mathematics*, 42, 165-177.
- Skemp, R. R. (1978). Relational Understanding and Instrumental Understanding. *Arithmetic Teacher*. November issue, 9-15.
- Yap, K.C. (1992). Meaningful Understanding Of Direct Proportionality And Consistency Across Different Task Among Preservice Science Teacher. *Int. J. Sc. Edu.*, 14 (3), 237-247.