UNIVERSITY OF JOHANNESBURG
FACULTY OF EDUCATION
NOVEMBER EXAMINATION 2014

PROGRAMME: B Ed (Hons) (TAKE HOME SUBMISSION)
MODULE: MATHEMATICS EDUCATION
CODE: MED0017
TIME: 3 hours
MARKS: 200
EXAMINER: Prof GJ Jacobs
MODERATOR: Dr SM Nieuwoudt (NWU)
(This paper consists of 9 pages)

INSTRUCTIONS

1. You need to answer **ANY TWO** of the essay questions, on your own in Afrikaans or in English.
2. You should present your 'hard copy' (**printed**) essays and clearly labelled **USBs** (containing a digital copy) to the examiners in the examination venue.
3. Candidates are free to exit the examination venue, as soon as the abovementioned submissions have been collected by the examiners.
4. Provide **structure** to your essays by using appropriate headings and sub-headings. Make use of the numbering system of this paper as well as the rubrics for each question.
5. You should provide a **reference list** (in respect of literature that you utilised) at the end of each of your essays.
6. Use the **Harvard technique** to refer to consulted sources, both in the text and in the reference list.
7. A **rubric**, which outlines the assessment criteria is supplied in respect of each question. Aspects like a scientific writing style, appriopriate language usage and proper referencing form part of the assessment criteria.
8. All journal **articles** and **eBooks** listed in the questions below, are available on Ulink (in the module's sub-folder *Exam literature*) for your access and utilisation. You are encouraged to also use other relevant sources of literature.

QUESTION 1

Theme: Determinants of learner achievement in mathematics

Sources of literature provided

Cretchley, P.C. 2008. *Advancing research into affective factors in mathematics learning: Clarifying key factors, terminology and measurement*. 31st Annual Conference of the Mathematics Education Research Group of Australasia (MERGA). University of Queensland, Brisbane, Australia, 28 June to 1 July 2008: 147-153.

Gladwell, M. 2008. *Rice paddies and math tests*. In: Outliers. The story of success, Chapter 8, 224−249. New York: Little, Brown & Company. [eBook version].

Kitsantas, A., Cheema, J. & Ware, H.W. 2011. Mathematics achievement: The role of homework and self-efficacy beliefs. *Journal of Advanced Academics (JAA), 22 (2)*, Winter 2011, 310−339.

1.1 According to Stanislas Dehaene (in Malcolm Gladwell's book, Outliers) Asian learners are more effective in remembering a sequence of numbers, in learning to count and in performing basic mathematical operations (e.g. adding up) than learners from Western nations. What is your view on Dehaene's explanation? Support your view by other research findings on this topic.

1.2 Gladwell's chapter posits the argument that being good at mathematics may be rooted in aspects of a nation's *culture* and *cultural legacy*. The chapter refers to the work that Asian people do (on a daily basis) in respect of their rice paddies and the influence this might possibly have on their achievement in mathematics.

(a) Outline the **main message** of the chapter in Gladwell's book in respect of important determinants of achievement in Mathematics. Also indicate whether this message might have any **implications** for mathematics teachers and learners in South African schools.

(b) Provide **your own** literature-supported views on the *determinants of learner achievement* in mathematics at school level.

1.3 By using the articles of both Cretchley (2008) and Kitsantas, Cheema & Ware (2011) and other relevant literature sources (if appropriate), distinguish the concepts **self-belief** (self-concept), **confidence** and **self-efficacy** in mathematics from each other. Finally supply your own *working definitions* of the three concepts.

1.4 In their research Kitsantas, Cheema & Ware (2011) discovered a number of elements that co-determine the relationship between **homework** and

mathematics achievement. Describe the elements of this relationship, and besides defining the concept *homework* in Mathematics, also focus your answer on the role that the following aspects might possibly play in the relationship between homework and achievement (include other relevant research findings in support of your views, if appropriate) :

(a) the *amount* of homework and *time spent* on homework;

(b) whether it made a difference to achievement if homework was done *in* or *out* of the school context; and

(c) *parental involvement* and homework *support resources* (available resources that learners might have when doing homework).

(100)

ASSESSMENT RUBRIC FOR QUESTION 1

No.	Assessed item	Marks
1.1	Stanislas Dehaene's views	**10**
1.2a	Main message of Outliers chapter and implications for mathematics teachers and learners	**15**
1.2b	Literature-supported views on the determinants of learner achievement in mathematics at school level	**20**
1.3	Concepts self-belief (self-concept), confidence and self-efficacy	**15**
1.4	Relationship between homework and mathematics achievement (including defining homework)	**12**
1.4a	Relationship between homework and achievement in respect of the *amount of* and *time spent* on homework	**6**
1.4b	Relationship between homework and achievement in respect of whether homework was done *in* or *out of* the school context	**6**
1.4c	Relationship between homework and achievement in respect of *parental involvement* and homework support *resources*	**6**
In-text referencing and the list of references		**5**
iThenticate plagiarism scoring index (**-1** for every 5% above 20%)		**3**
Scientific writing and language usage		**2**
Total marks for Question 1		**100**

QUESTION 2

Theme: Pedagogical content knowledge of mathematics teachers

Relevant sources of literature

Hill, C., Ball, D.L. & Schilling, S.G. 2008. Unpacking pedagogical content knowledge: Conceptualising and measuring teachers' topic-specific knowledge of students. *Journal for Research in Mathematics Education, 39 (4)*, 372−400.

Kwong, C.W., Joseph, Y.K.K., Eric, C.C.M. & Khoh, L.S. 2007. Development of mathematics pedagogical content knowledge in student teachers. *The Mathematics Educator, 10 (2)*, 27−54.

Shulman, L. 1986. Those who understand: Knowledge growth in teaching. *Educational Researcher, 15 (2)*, February 1986, 4−14. Available from: http://links.jstor.org/sici?sici=0013-189X%28198602%2915%3A2%3C4%3ATWUKGI%3E2.0.CO%3B2-X

Turnuklu, E.B. & Yesildere, S. 2007. The pedagogical content knowledge in mathematics: Pre-service primary mathematics teachers' perspectives in Turkey. *Issues in the Undergraduate Mathematics Preparation of School Teachers*, Volume 1 (Content Knowledge), October 2007, 1−13. Available from: http://www.k-12prep.math.ttu.edu/journal/journal.shtml

"*Mathematics education is a 'science' like pure mathematics. Although mathematics and mathematics education have a dynamic interaction with each other, they have different aspects as well. One of the most common debates among pure mathematicians and mathematics educators is 'whether having a deep understanding of mathematics is sufficient to teach mathematics?' In order to find an answer to this question, the divides between pure mathematics and mathematics education need to be bridged*." (Turnuklu & Yesildere, 2007: 12).

2.1 Lee Shulman, in his groundbreaking article of almost three decades ago, distinguishes between different forms of knowledge that 'good' teachers should ideally possess. For the very first time the notion of Pedagogical Content Knowledge (PCK) is introduced, with the view of Shulman (1986:9) that it "*…goes beyond knowledge of subject matter per se to the dimension of subject matter knowledge for teaching*." Conceptualise and critically compare views contained in the four articles above on what **Pedagogical Content Knowledge** entails, the components of (*constructs underlying*) PCK, how PCK differs from *Content Knowledge* (CK) and what *requirements* mathematics teachers should ideally meet in order to portray a high level of PCK.

2.2 Kwong, Joseph, Eric & Khoh (2007:32) propose four so-called *constructs* of **Mathematical Pedagogical Content Knowledge** (**MPCK**) and also developed an *instrument* to measure MPCK among Singaporean novice

primary school teachers. Outline their four MPCK constructs, and indicate to what extent you are in agreement with their views. Also give your opinion on whether their instrument might be considered as a realistic and an effective MPCK measure.

2.3 In their article, Hill, Ball & Schilling (2008: 372−378) conceptualise the domain of teacher's **Knowledge of Content and Students** (KCS). Present their views in a critical manner and also indicate in what way *subject matter knowledge* and *PCK* relate to their KCS domain.

2.4 Mathematics teachers that possess adequate PCK, should be able to **unpack the relationship** between answers (forthcoming from learners) to a mathematics question and the processes of the generation of learners' answers. Some mathematics education researchers suggest that because a correct answer might also be obtained through incorrect or inappropriate mathematical reasoning, one should be very mindful in the selection of a question/challenge presented to learners during assessment.

In research on the PCK of mathematics teachers in 2006, Jill Adler (University of the Witwatersrand) and Zain Davis (University of Cape Town), presented a group of Grade 10 learners with the following equation to solve for x:

$$x^2 - 2x = -1$$

They obtained the following solutions from five of the Gr 10 learners.

Learner 1: $\boldsymbol{x = 1}$, because if $x^2 - 2x = -1$, then $x^2 = 2x - 1$ and $x = \sqrt{2x - 1}$. x can't be 0 because we get 0 = $\sqrt{-1}$. x can't be negative because we get the square root of a negative. $x = 1$ works because we get 1 = 1 and no other number bigger than 1 works

Learner 2: $\boldsymbol{x = 1}$, because if $x^2 - 2x = -1$, then $x(x - 2) = -1$ and so $x = -1$ *or* $x - 2 = -1$, which leaves us with $x = 1$ (because $x = -1$ does not hold true)

Learner 3: $\boldsymbol{x = 1}$, because if $x^2 - 2x = -1$, then $x^2 - 2x + 1 = 0$ and this factorises to get $(x - 1)(x - 1) = 0$; so $x = 1$

Learner 4: $\boldsymbol{x = 1}$. I drew the graphs $y = -1$ and $y = x^2 - 2x$. They intersect in only one place, at $x = 1$.

Learner 5: $\boldsymbol{x = 1}$. I substituted a range of values for x in the equation and 1 is the only one that works.

Demonstrate your own Pedagogical Content Knowledge (PCK) in respect of Grade 10 mathematics by:

(a) Clearly indicating which of the five solutions is correct/incorrect (motivate each of your answers).

(b) Explain how you would communicate the strengths, limitations, or errors in each of the five suggested solutions to the whole class of Gr 10-learners. Outline the steps that you will take and the words (and aids, if appropriate) that you might use.

(100)

ASSESSMENT RUBRIC FOR QUESTION 2

No.	Assessed item	Marks
2.1	Conceptualisation and critical comparison of literature views on Pedagogical Content Knowledge (PCK). Components of (constructs underlying) PCK Distinguish PCK from Content Knowledge (CK) Requirements that mathematics teachers with a high level of PCK should ideally meet.	**50**
2.2	Mathematical Pedagogical Content Knowledge (MPCK) constructs Views on the Kwong, et al (2007) MPCK measuring instrument.	**10**
2.3	Critical overview of the domain of teacher's Knowledge of Content and Students (KCS). Relationship(s) between subject matter knowledge, PCK and KCS.	**10**
2.4a	Motivated views on the correctness/incorrectness of the five suggested solutions.	**10**
2.4b	Explanation of the strengths, limitations, or errors in each of the five solutions to the class of Gr 10-learners	**10**
In-text referencing and the list of references		**5**
iThenticate plagiarism scoring index (**-1** for every 5% above 20%)		**3**
Scientific writing and language usage		**2**
Total marks for Question 2		**100**

QUESTION 3

Theme: Relationship between mathematics anxiety, working memory and achievement in mathematics

Relevant sources of literature

Ramirez, R., Gunderson, E.A., Levine, S.C. and Beilock, S.L. 2013. Math anxiety, working memory, and math achievement in early elementary school, *Journal of Cognition and Development*, *14(2)*, 187−202.

St Clair-Thompson, H., Stevens, R., Hunt, A. & Bolder, E. 2010. Improving children's working memory and classroom performance. *Educational Psychology: An International Journal of Experimental Educational Psychology, 30(2)*, 203−219.

Zakaria, E., Zain, N.M., Ahmad, N.A. and Erlina, A. 2012. Mathematics anxiety and achievement among secondary school students. *American Journal of Applied Sciences*, 9 (11), 1828−1832.

A functional and frequently used working memory has been known to enhance mathematics learners' problem solving and reasoning abilities, as well as their accuracy. St Clair-Thompson, Stevens, Hunt, & Bolder (2010:203) regard working memory as "a limited capacity system responsible for storing and integrating information during complex and demanding activities", such as take place during mathematics problem solving activities.

"*Investigating the development of math anxiety from the earliest grades will not only increase our understanding of the relation between math anxiety and math performance across the school years but is also a critical first step in developing interventions designed to ameliorate these anxieties and increase math achievement.*" (Ramirez, Gunderson, Levine and Beilock, 2013: 199).

3.1 By utilising the abovementioned literature sources (and relevant others) provide literature-supported (and cited) definitions of the concepts **mathematics anxiety**, **working memory** and **mathematics achievement**. Conclude your literature oversight, by the provision of your *own working definitions* for these three concepts.

3.2 Although there are several models of working memory, St Clair-Thompson, et al (2010:203) quote a number of authors, which postulate that **working memory** basically consists of four components. It has also been found that working memory is predictive in respect of a number of academic skills. By using the abovementioned literature sources (and other relevant sources):

(a) outline the (underlying) *four components* of working memory;

(b) provide a synthesis of the *predictive qualities* of working memory in respect of mathematics achievement and

(c) give your own literature-substantiated views on the potential that *memory strategy training* (among other strategies and approaches) might have in alleviating difficulties that learners have in respect of working memory that might eventually also improve their mathematics achievement.

3.3 Mathematics achievement in learners is influenced by several factors, of which **mathematics anxiety** is one. Zakaria, et al (2012) conducted research on the relationship between mathematics anxiety and achievement among secondary school learners in Malaysia. They used the self-reporting *Fennema-Sherman Mathematics Attitudes Scale* (FSMAS) to assess the level of anxiety of the learners, comparing the results with their school marks. They also explored possible differences between the genders.

(a) A number of prominent characteristics and behaviours are usually evident in learners who experience mathematics anxiety. Use the abovementioned literature sources (and other relevant sources) to sketch five **typical features** of learners who are experiencing mathematics anxiety. Also highlight five **differences** between learners with *lower* and *higher* levels of mathematics anxiety in your outline.

(b) Does mathematics anxiety generally relate to learners' **gender**? Motivate your answer via relevant literature views.

(c) Present an outline of main **contributors** to (causes of) mathematics anxiety in school learners. Motivate your answer via relevant literature views and references.

(d) What strategies can mathematics teachers/educators consider and perform in attempting to **reduce** mathematics anxiety in their learners? Motivate your answer via relevant literature views and references.

The assessment rubric for Question 3 is on the **next page.**

ASSESSMENT RUBRIC FOR QUESTION 3

No.	Assessed item	Marks
3.1	Literature-based definitions of the concepts *mathematics anxiety*, *working memory* and *mathematics achievement*. (18) Own *working definitions* of the three concepts. (6)	**24**
3.2a	Four components of working memory.	**8**
3.2b	Predictive qualities of working memory.	**3**
3.2c	Potential of *memory strategy training* (among other approaches) to alleviate learners' working memory difficulties and its possible relationship with mathematics achievement.	**20**
3.3a	*Typical features* of learners who are experiencing mathematics anxiety. (5) Differences between learners with *lower* and *higher* levels of mathematics anxiety. (5)	**10**
3.3b	Relationship between mathematics anxiety and learners' *gender.*	**5**
3.3c	Main *contributors to* (causes of) mathematics anxiety in school learners.	**10**
3.3d	Strategies that mathematics teachers/educators can attempt to *reduce* mathematics anxiety in their learners.	**10**
In-text referencing and the list of references		**5**
iThenticate plagiarism scoring index (**-1** for every 5% above 20%)		**3**
Scientific writing and language usage		**2**
Total marks for Question 3		**100**

TOTAL: 200

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