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**QUALITATIVE ANALYSIS OF LEARNER RESPONSES AND EVALUATION OF QUESTION PAPERS: NSC 2021**

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| **REPORT 1: EVALUATION OF THE QUESTION PAPER AND MARKING GUIDELINE** |

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| **SUBJECT** | **LIFE SCIENCES** |
| **PAPER** | **2** |
| **DURATION OF PAPER:** | **2½ HOURS** |

**SECTION 1: (General overview of Learner Performance in the question paper as a whole)**

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| General performance  The general performance of the learners was evaluated from a sample of 100 scripts from the 12 districts in the province covering the low, mediocre and high performance. Only one script was sampled per centre to allow sampling over a wide range of centres.  The range of the sampled scripts was distributed as follows:  Low Performance (Level 1 - Level 2 i.e., 0-59 marks) - 30 scripts  Mediocre Performance (Level 3- Level 5 i.e., 60-104 marks) - 40 scripts  High performance (Level 6 to Level 7 i.e., 105-150 marks) - 30 scripts  The graph below depicts the average performance of the learners per question and average performance in the paper as a whole: |
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| The overall average performance of the sampled learners has slightly declined by approximately 3% compared to 2020. The learners performed best in Question 1, which correlates with the 2020 performance. Although the format of the paper changed to 3 questions in 2021 compared to 4 questions in previous years, the average performance in question 2 and 3 is almost consistent with the performance in 2020 with a variance of -2%. |

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| The graph below depicts the learner average performance per sub-question.  . |
| As can be seen from the graph, learners performed well in Question 1 with the best performance in question 1.5 which was based on Meiosis (crossing over) followed by question 1.4 based on a DNA molecule structure. The performance in question1.2 on terminology is slightly lower compared to 2020. The most poorly answered questions (i.e., below 50%) are:   * Question 3.1 based on Cloning, 1% lower than the performance in 2020 in a similar question * Question 3.3 based on evolution in present times and application of natural selection to resistance of bacteria to antibiotics * Question 3.2 based on biogeography and speciation, also 1% lower compared to a similar question in 2020 * Question 2.2. based on non-disjunction as applicable to Down syndrome * Question 2.3 (44%) based on the human karyotype * Question 2.6 (48%) based on an extract on gene mutation |

**SECTION 2: Comment on candidates’ performance in individual questions**

**(It is expected that a comment will be provided for each question on a separate sheet).**

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| **QUESTION 1** |
| (a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered? |
| The question was well answered. The average performance in this question was 64% and this is the highest average attained in a question in this paper. This performance is, however, 7% lower than in 2019 and 2% lower than in 2020. In Q 1.2 learners’ performance decreased by 3% compared to the same type of question (terminology) in 2020. There was a marked decline (16%) in the average performance of the learners in question 1.6 based on dihybrid cross compared to a similar question in 2020.  A breakdown of learner performance in sub-questions is as follows:   |  |  |  | | --- | --- | --- | | **Average mark from the sample of 100 scripts**: | | | | **SUB-QUESTION** | **TOPIC OR ASPECT TESTED** | **AVERAGE % FROM SAMPLE** | | 1.1 | MCQ | 63 | | 1.2 | TERMINOLOGY | 54 | | 1.3 | AB MATCHING | 63 | | 1.4 | DNA STRUCTURE | 74 | | 1.5 | MEIOSIS (CROSSING OVER) | 80 | | 1.6 | DIHYBRID CROSS | 54 |   The average learner performed fairly well in this question, attaining a 64% average which boosted their overall score. The above average learners easily scored 80-100% for the question and very few learners were below average and could not answer the questions. |

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| 1. **Why the question was poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.** |
| 1.2.1 Learners confused phylogenetic tree with pedigree diagram and sometimes misspelled it e.g., phylogenic, polygenetic |
| 1.2.2. Some learners could not differentiate between peptide and hydrogen bond. Some could not distinguish between a polypeptide (structure made up of many amino acids) and peptide bond (a bond linking amino acids in a polypeptide/protein) |
| 1.2.4 Learners are still confusing the terms homologous and homozygous and seem to use them interchangeably. It is worrying to note that some learners are still writing about analogous structures which have been removed from the examination guidelines since 2017. A few learners gave modification by descent as the answer. This was not credited as modification by descent is a type of evidence that supports evolution theory using presence of homologous structures as indication of common ancestry. |
| 1.2.5 Learners confused artificial selection with altricial. |
| 1.2.6 Learners cannot differentiate between the different types of dominance. Instead of giving co-dominance as the answer, they mostly wrote complete dominance, and a few learners wrote incomplete dominance |
| 1.3.2 Most learners failed to give a correct answer in this question which indicates that learners do not know which fossils were discovered in South Africa as stipulated in CAPS and the 2021 Examination Guidelines. Most gave the ‘B only’ as the answer. |
| 1.4 1 Many learners cannot differentiate between a nucleotide and a nitrogenous base. |
| 1.4.2 Some learners could not give the correct natural shape of a DNA molecule. Instead of saying double helix, they wrote double stranded. |
| 1.4.4 Confused DNA replication with transcription. |
| 1.4.5 Learners confused the location of DNA with types of DNA e.g., mitochondrial DNA or nuclear DNA. |
| 1.5 Learners confused the centromere with centrosome and sometimes the centriole. |
| 1.5.1(b) & 1.5.2 (a) Learners confused the process of crossing over and area P where crossing over occurs, which is the chiasma. They wrote chiasma in place of crossing over and vice versa. |
| 1.6.2 (a) Learners struggled to determine the genotype of the parents based on the given gametes in the Punnet square. |
| 1.6.2 (b) Some learners gave the answer as 2 instead of 3 and counted the similar genotypes as 1 which was not credited as the ratio is 9:3:3:1 in a dihybrid cross. |
| 1.6 2 (c)Learners cannot differentiate between a genotype and phenotype and instead of giving an allele (h) they gave a genotype(hh) |
| 1.6.2 (d) Learners have a tendency of ignoring information given in the question such that, in this question, they came up with their own phenotypes when these were given in the question. For example, instead of continuous hairline they talked about non-widow’s peak or discontinuous hair line, instead of long finger they wrote tall fingers. |

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| 1. **Provide suggestions for improvement in relation to Teaching and Learning** |
| * Learners must be encouraged to carefully read the instructions of each question and take note of the information given in the question which will assist them in answering the question. They must be made aware that, if phenotypes or letters representing genotypes are given, they can only use those that are given. They may not decide to use their own letters to answer the question, or they will lose marks. * At the beginning of each topic, the teacher should compile a list of terms for that topic * The importance of spelling and pronunciation of different terms must be emphasized. Teachers can assist by writing these terms on the board to encourage correct spelling. Many words used in Life Sciences can change to mean something else if incorrectly spelt e.g., homologous vs homozygous, centromere vs centrosome or centriole. * Learners must be taught the different types of dominance as, in Question 1.2.6, it was evident that the learners cannot tell the difference between the different types of dominance. Teachers can refer to page 161 of the 2020 Diagnostic Report on Life Sciences Paper 2 for clarity on these different types of dominance. * Teachers should do spelling tests to improve learners’ spelling of terms. * Learners should be given short tests or topic tests to improve their ability to answer questions. * Learners must be in possession of a textbook or any type of reference e.g., Mind the Gap Study Guides so that they can read and know these terms and not just rely on the teacher saying the words. * Teachers should emphasize the different types of bonds and where they are found e.g., hydrogen bonds between the nitrogenous bases in DNA, peptide bonds link amino acids in polypeptides/proteins. * Use of latest examination guidelines to avoid use of terminology that is out of the scope of the syllabus e.g., allopatric speciation, analogous structures, point and frameshift mutations. |

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| **(d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.** |
| * All learners should be provided with a copy of the examination guidelines so that they can be aware of exactly what can be assessed and how. * Teachers must use the Chief Marker’s reports and the DBE diagnostic reports as these outline the problems encountered by previous learners and suggestions on how to improve. * Teachers must use previous question papers and choose topic-focused questions to revise with the learners each time they are busy with a particular topic. Learners need to be aware of the style of questioning used in the national NSC papers and not only see this during an examination. * Extensive revision per topic is encouraged as this will help improve learner performances * All learners must have textbooks which must be used in conjunction with the CAPS document and examination guidelines by the teacher. The teacher can alert learners if the textbook has incorrect or outdated information, no longer required in the examination guidelines. * English remains a learning barrier to many learners that use it as a second language. It is either that the learners do not understand the question, or they do not know how to express themselves in English, although they might know the answer. * Subject Advisors must continue monitoring the implementation of English across the Curriculum and this must form part of the aspects to be monitored during onsite visits to the schools. * ICT integration can also be incorporated to lessons where teachers can design games which test multiple choice questions where learners can go in teams to quickly answer the question and score points. Teachers can visit kahoot.it to create the games. |

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| **QUESTION 2** |
| 1. **General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?** |
| Learners all attempted to answer Question 2. This question was answered fairly well. Learners performed fairly well and many learners did better in Question 2 than in Question 3. The average for the whole question was 53% which is 1% below than the performance in Question 2 in 2020. The range of marks from the sample of 100 scripts was from 5 to 47 out of 50 and most learners obtained 20 or more in this question.  The average performance per sub-question is tabled below:   |  |  |  | | --- | --- | --- | | **AVERAGE MARK FROM THE SAMPLE OF 100 SCRIPTS** | | | | **SUB-QUESTION** | **TOPIC OR ASPECT TESTED** | **AVERAGE % FROM SAMPLE** | | 2.1 | PROTEIN SYNTHESIS | 66 | | 2.2 | ABNORMAL MEIOSIS (NON-DISJUNCTION AND DOWN SYNDROME) | 33 | | 2.3 | HUMAN KARYOTYPES | 44 | | 2.4 | PEDIGREE DIAGRAM: INHERITANCE OF DEAFNESS | 54 | | 2.5 | GENETIC CROSS: SEX DETERMINATION | 67 | | 2.6 | EXTRACT ON GENE MUTATION | 48 | |

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| 1. **Why was the question poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.** |
| 2.1 This question was answered well with 2.1.3 directly from the examination guidelines. So, learners could really do well. This can be seen on the average performance of 66% from the sampled learners.  2.2 This was the most poorly answered subquestion in Question 2 with learners attaining an average of 33%. Learners needed to be specific when answering about chromosomes failing to separate. Most did not mention chromosome pair 21 fails to separate. The answers were too general, for example they wrote the cell will have an extra chromosome without indicating whether they were referring to the gamete or the zygote as well as when and where did the non-disjunction occur. Some learners indicated that non-disjunction occurred in chromosome pair 23. A few learners mentioned that the non-disjunction occurs during Metaphase I or II instead of Anaphase.  2.3.3 (b)Some learners had difficulty in correctly mentioning more than two characteristics of homologous chromosomes especially those that relate to the position of the genes, genes coding for the same characteristics and location of the centromere. They wrote answers such as: they are held by the centromere; they have the same genetic material etc.  2.3.4 Several learners lost a mark for not indicating that Gonosomes/chromosomes at position 23 are not identical. They just went on to describe the difference between Individual 1 and 2. Some did not refer to individual 1 or 2 but indicated in the correct sequence that one is a male/boy, and the other is a female/girl. This way of answering questions is not encouraged as learners are expected to refer to the individuals given in the question and describe how they differ from each other by examining their two karyotypes.  2.4.1, 2.4.2 and 2.4.4 were well answered. However, in Question 2.4.2 some learners lost the mark for identifying the dominant phenotype simply because they ignored the key given in the pedigree diagram and decided to use their own phenotype such as unaffected/normal.  2.4.3 Some learners struggled to explain why hearing is the dominant phenotype. Several learners associated the pedigree diagram with sex-linked inheritance. They described Bob (father) as being normal for hearing and Ann (mother) as being heterozygous and that Bob passed the Y chromosome to the deaf male offspring and Ann passed the recessive allele. In the example given, learners could not make the connection that both parents were heterozygous and therefore the dominant allele for hearing masked the recessive allele for deafness, hence both parents were hearing.  2.5 Many learners attempted this question and obtained full marks. It is obvious that teachers pay a lot of attention to genetic crosses. However, some learners did not see this question as a stand-alone question. They linked it to the deafness question in question 2.4 when it was just a simple question of sex determination and some even treated this question as an example of sex-linked inheritance. In such a case, learners gave phenotypes such as hearing male x 6hearing female and they used genotype such XAY x XAXa.. There was no credit for such answers and learners only got marks for the correct format of the monohybrid cross.  2.6.1 The answer was directly taken from the extract and therefore the question was answered very well.  2.6.2 Many learners, including the above average learners, failed to give a correct definition of a gene mutation. Pg 161 of 2020 Diagnostic Report on Life Sciences Paper 2 addresses the differences between a mutation, gene mutation and chromosomal mutation. It appears that this information did not filter through to many teachers and 1learners despite it being addressed last year.  2.6.3 Most learners lacked the insight to answer that the DNA samples were collected to check if all the family members with high bone density had the same gene mutation and therefore this specific mutation is responsible for the high bone density in the family members.  2.6.5 More than 50% of the learners were able to do the calculations and scored full marks. However, there were those learners who did the calculations using the 7 members who had high bone density instead of 13 members with normal bone density which they had to calculate by subtracting 7 from the total number of family members, which was 20. There was also evidence of some learners who had no calculators to get the answer even though the substitution was correct, but no answer was given or some who did it mentally got the answer wrong. |

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| 1. **Provide suggestions for improvement in relation to Teaching and Learning** |
| * Learners should be given more opportunities to explain processes and check if they understand the differences between related processes e.g., DNA replication, transcription and translation using tabulations. Teachers can refer to page 166 of the 2020 Diagnostic Report on Life Sciences Paper 2 for a table outlining the differences between DNA Replication and Transcription1. * Learners must also be shown animations using videos on processes to cater for those who understand visuals as opposed to memorizing descriptive text. * Teachers should emphasize when teaching abnormal meiosis that learners are expected to know one example which is Down Syndrome (Trisomy 21). It is important that they know when (phase) and how non-disjunction that leads to Down Syndrome occurs. Teachers should clearly describe the nature of the gametes that will result from this non-disjunction and what will happen when this gamete fuses with a normal gamete. Teachers need to make learners aware of examples of Trisomy in other chromosome pairs which are not for exam purposes, hence it is important when dealing with Down Syndrome they must be specific that it is chromosome pair 21 that is involved. * Learners should also be taught the correct terminology related to karyotypes. They must know the difference between the different types of chromosomes in a karyotype i.e., autosomes and gonosomes. Page 157 of the 2020 Diagnostic Report on Life Sciences Paper 2 addresses these important aspects of the Human Karyotype. * It is important to stress that homologous chromosomes carry genes for the same characteristic but because a gene has two alleles inherited from each parent, the two alleles may not necessarily be the same. For example an allele from the maternal side may be dominant whilst the allele from the paternal side may be recessive although they are controlling the same characteristic. * Although learners know the terms dominant and recessive, they cannot explain why a phenotype is dominant or recessive. Teachers can refer to page 161 of the 2020 Diagnostic Report on Life Sciences Paper 2 on the description of complete dominance and highlight to learners that in examples involving complete dominance, the dominant allele masks the recessive allele when an individual is heterozygous. * Keep on working out as many question papers from previous years as possible |

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| **(d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.** |
| * Information sharing workshops to expose all teachers to areas of poor performance and learner misconceptions. * Information sharing on how to approach certain topics must be done by the Subject teachers to make topics easier to teach. * Teachers should take care to explain that pedigree diagrams are not only for sex-linked diseases but serve to trace the transmission of characteristics from generation to generation. |

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| **QUESTION 3** |
| 1. **General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?** |
| Generally, the question was poorly answered by most learners. Very few learners performed exceptionally well.  The average for the whole question was 39% and this is 2% below the average performance in this question in 2020.The range of marks from the sampled learners was from 3 to 45 out of 50 in this question.  The average performance per sub-question is shown in the table below:   |  |  |  | | --- | --- | --- | | **AVERAGE MARK FROM THE SAMPLE OF 100 SCRIPTS** | | | | **SUB-QUESTION** | **TOPIC OR ASPECT TESTED** | **AVERAGE % FROM SAMPLE** | | 3.1 | CLONING | 30 | | 3.2 | BIOGEOGRAPHY AND SPECIATION | 32 | | 3.3 | EVOLUTION IN PRESENT TIME: RESISTANCE OF BACTERIA TO ANTIBIOTICS | 31 | | 3.4 | SCIENTIFIC INVESTIGATION: EVOLUTION GENETIC VARIATION IN GALLFLIES | 50 | | 3.5 | HUMAN EVOLUTION: DIFFERENCES IN SKULLS AND PELVIC STRUCTURES | 50 |   As can be seen from the table above, the best answered sub-questions are 3.4 on Scientific Investigation and 3.5 on Human evolution, where the learners attained a 50% average. It is encouraging to note a 1% improvement in the performance in Scientific Investigation question compared to 2020. The average performance in the rest of the sub-questions was around 30%. |

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| 1. **Why was the question poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.** |
| 3.1 Some learners were not able describe a somatic cell as being diploid and a sperm cell as being haploid. Instead, they used the chromosome number of humans to explain the concepts of diploid and haploid e.g., they wrote the somatic cell has 46 chromosomes and the sperm cell has 23 chromosomes. As the question was related to horses, no credit was given for answers giving chromosome number as horses have a different chromosome number to humans. Learners do not understand the significance of the steps in the cloning process and as a result they failed to answer questions 3.1.1 and 3.1.2 respectively. This, despite the suggestions provided on page 160 of the 2020 Diagnostic Report on Life Sciences Paper 2.  3.2 Many learners were not able to define a biological species. The inclusion of ‘biological’ seems to have confused some learners although this definition is given on page 16 of the 2021 Examination Guidelines. They were writing that they are species which share a common ancestor or even gave the definition of a population or speciation. |
| 3.2.3 The same misconceptions or errors from 2019 and 2020 on speciation were repeated in 2021. This year’s question on speciation required learners to work backwards to explain how three closely related species could have evolved from a common ancestor. As a result, learners described the process referring to species from the beginning. This clearly shows that the misconceptions about species vs population outlined in 2019 and 2020 Diagnostic reports were not addressed by the teachers. Learners had to indicate the specific geographical barrier in this question, being continental drift or oceans. Most learners failed to identify that the original population/common ancestor lived on a large continent and was split into three populations by continental drift. Some learners merely regurgitated the generic speciation process as outlined in the examination guidelines and as a result they referred to two populations instead of three populations. Most learners do not know when to use the term species or population in the application of speciation. Consequently, many learners lost a lot of marks in this question. Some learners cannot differentiate between speciation and natural selection and as a result gave a detailed description of natural selection within their description of speciation.  3.3.1 Some learners did not understand the purpose of the antibiotic and how to link it with the results shown in the graph and the economic benefit of it.  3.3.2 An application of natural selection, learners struggled in this question with the average mark being 1,6 out of 6 marks. Learners are confused about which organism has the variation. Some referred to the variation in cattle/animals or in antibiotics. They know the generic description of natural selection but struggle with application thereof. Some learners lost marks for not writing both ‘survive and reproduce’ as outlined in the 2021 Examination Guidelines. They could not identify the change in the environment as being the addition of the antibiotic to the animal feed.  3.4.1 Most learners could identify the independent variable; however, many learners lost a mark for writing the dependent variable as gallfly larvae killed instead of percentage of gallfly larvae killed as indicated in the aim of the investigation. A few learners swapped the variables around and lost 2 marks.  3.4.2 This question was answered well by most learners. Most learners could interpret the information given in the extract and identified the advantage of the gall to the gallfly with many learners quoting directly from the text.  3.4.3 Many learners could not answer this question. Some generalised by saying there is a range of phenotypes instead of being specific about gall size.  3.4.4 Another poorly answered question. Many learners struggled to interpret the data given in the table. Most wrote as the gall size increases more larvae are eaten. The results showed that only when the galls are the largest (30mm) more larvae will be eaten (10%) by the birds. Many learners referred to the gall size being directly proportional to the percentage of larvae killed.  3.4.5 Some learners transposed the axes labels resulting in loss of the mark for labelling axes. Marks were also lost for  labelling if the units were not indicated on both the X- and Y axes. Most learners left out (%) on the Y-axis. Many learners lost marks for scale on the x-axis as their values started from 0 to 10 followed by values in intervals of 5 i.e., 0, 10, 15, 20 etc. For the Y-axis some learners just wrote the values from the table without working out a scale. A few learners drew a bar graph, consequently lost 3 marks out of 6 - 1 mark for the type of graph and 2 marks for plotting.  3.5.1 (a) Most got the Z but some included Y while some wrote A and C.  (b) Most learners got the correct answer, but a few wrote A and B.  3.5.2 Most learners were able to give the correct answer and even gave an explanation which was not required for this question. However, learners were not disadvantaged in any way for giving an explanation. It was just not credited as it was not required. Some learners only mentioned ‘long’ and left out ‘narrow’ in their answer.  3.5.3 Some learners lost a mark for spine because they wrote spinal cord. Some lost both marks for shape as they wrote more or less curved. Some learners referred to the foramen magnum as being at the back or front and lost marks. Some described the difference as bipeds walk on two legs and quadrupeds walk on four legs. |

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| 1. **Provide suggestions for improvement in relation to Teaching and Learning** |
| * Refer teachers to previous year’s Chief Marker’s and Diagnostic report and use them religiously. * Teachers must refer to examination guidelines as some learners are still using old terms such as allopatric. Learners must be given examination guidelines and be encouraged to use it. * Make use of previous question papers and marking guidelines to guide learners on how they should answer questions. * Teachers must train learners to look at mark allocation and be guided by that in presenting their answer. * Teachers must familiarise themselves with the action verbs used when assessing Life Sciences and ensure that learners are aware of the expectation of their answer based on the action verb. For example, if a question says explain, a learner is expected to give the answer in a form of cause and effect or statement and reason approach. Teachers can refer to the Abridged Section 4 of CAPS for Grade 12 implemented in January 2021. * Give more informal tasks on application of natural selection, speciation etc. * Learners must be given more activities on investigations and drawing of graphs in informal assessments. * Identify variables from the aim * Teachers should start every academic year by doing some scientific investigation questions before doing the Grades 10, 11 and 12 content. |

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| **(d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.** |
| * Markers must share information with other teachers in the district on how the questions were marked and the misconceptions of the learners. That may assist those who do not always refer to the Chief Marker’s and Diagnostic reports. * Workshops on Scientific Investigation should be presented to Grade 10, 11 & 12 teachers to ensure that this is taught correctly from Grade 10 onwards. |