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APPENDIX

APPENDIX I

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

321 Soutter Street,
Pretoria West.
20th March, 2009

Dear Sir / Madam,

SELECTION AND PARTICIPATION IN RESEARCH PROJECT IN MATHEMATICS

I wish to refer to the above subject and to inform you that you have been selected as one of the groups of teachers whom I wish to participate in my research study in mathematics. I am therefore requesting for your consent to participate voluntarily in the research project. The research revolves around how mathematics teachers develop pedagogical content knowledge in statistics teaching.

The research activities that will be required of you are as follows:

a) You will be required to respond to some set of questions on teachers' conceptual knowledge in statistics.
b) You will be interviewed on how you develop your pedagogical content knowledge in statistics teaching.
c) A classroom observation will be conducted in your class while teaching some aspect of statistics on schedule dates.
d) You will complete teachers' questionnaire on how you develop your pedagogical content knowledge in statistics teaching.
e) You will draw a concept map of some topics in statistics on how you can teach them sequentially.

I undertake to maintain confidentiality and that neither you nor your school identities will be disclosed to the public or published in the research reports. If you wish to discontinue participating in the research project for any reason, you are free to withdraw and there will be no consequences for withdrawing from participating in the research project for any reason.

Kindly indicate your willingness to participate in the research on voluntary basis by signing the space provided below.

Yours sincerely,

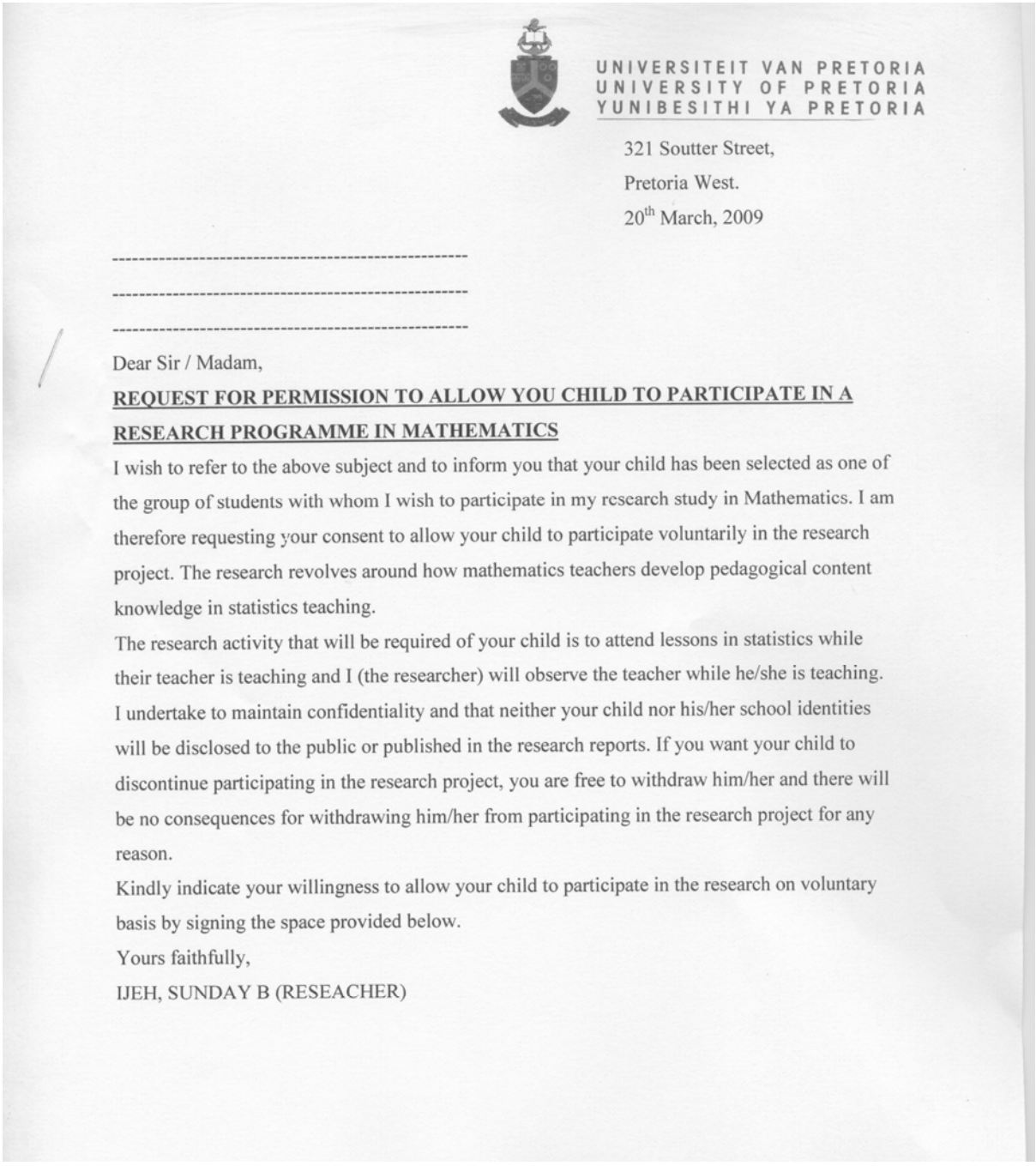
IJEH, SUNDAY B. (Researcher).

I, Mr/Mrs/Miss_____of_____ high school have agreed to participate in the research project in mathematics education conducted by Mr Ijeh, Sunday B.

_____ _____

Signature of Participant Date

APPENDIX II



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

321 Soutter Street,
Pretoria West.
20th March, 2009

Dear Sir / Madam,

REQUEST FOR PERMISSION TO ALLOW YOU CHILD TO PARTICIPATE IN A RESEARCH PROGRAMME IN MATHEMATICS

I wish to refer to the above subject and to inform you that your child has been selected as one of the group of students with whom I wish to participate in my research study in Mathematics. I am therefore requesting your consent to allow your child to participate voluntarily in the research project. The research revolves around how mathematics teachers develop pedagogical content knowledge in statistics teaching.

The research activity that will be required of your child is to attend lessons in statistics while their teacher is teaching and I (the researcher) will observe the teacher while he/she is teaching. I undertake to maintain confidentiality and that neither your child nor his/her school identities will be disclosed to the public or published in the research reports. If you want your child to discontinue participating in the research project, you are free to withdraw him/her and there will be no consequences for withdrawing him/her from participating in the research project for any reason.

Kindly indicate your willingness to allow your child to participate in the research on voluntary basis by signing the space provided below.

Yours faithfully,

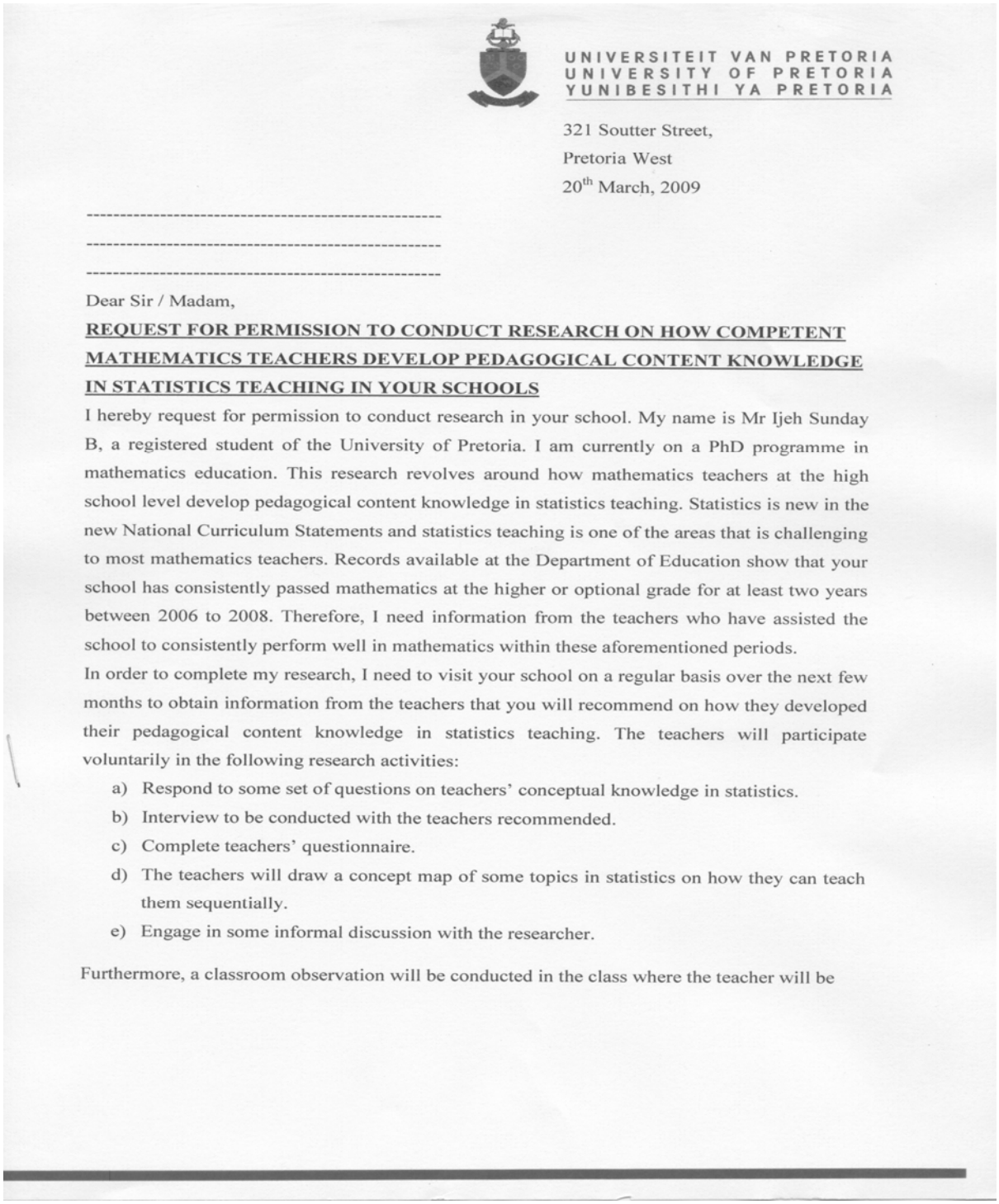
IJEH, SUNDAY B (RESEACHER)

I, /Mr/Mrs/Miss_____ being the father/mother have agreed that my child will attend lessons/ participate in the research project in Mathematics education conducted by Mr. Ijeh, Sunday B (Researcher).

_____ _____

Signature of Parent Date

APPENDIX IIIA



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

321 Soutter Street,
Pretoria West
20th March, 2009

Dear Sir / Madam,

REQUEST FOR PERMISSION TO CONDUCT RESEARCH ON HOW COMPETENT MATHEMATICS TEACHERS DEVELOP PEDAGOGICAL CONTENT KNOWLEDGE IN STATISTICS TEACHING IN YOUR SCHOOLS

I hereby request for permission to conduct research in your school. My name is Mr Ijeh Sunday B, a registered student of the University of Pretoria. I am currently on a PhD programme in mathematics education. This research revolves around how mathematics teachers at the high school level develop pedagogical content knowledge in statistics teaching. Statistics is new in the new National Curriculum Statements and statistics teaching is one of the areas that is challenging to most mathematics teachers. Records available at the Department of Education show that your school has consistently passed mathematics at the higher or optional grade for at least two years between 2006 to 2008. Therefore, I need information from the teachers who have assisted the school to consistently perform well in mathematics within these aforementioned periods.

In order to complete my research, I need to visit your school on a regular basis over the next few months to obtain information from the teachers that you will recommend on how they developed their pedagogical content knowledge in statistics teaching. The teachers will participate voluntarily in the following research activities:

a) Respond to some set of questions on teachers' conceptual knowledge in statistics.
b) Interview to be conducted with the teachers recommended.
c) Complete teachers' questionnaire.
d) The teachers will draw a concept map of some topics in statistics on how they can teach them sequentially.
e) Engage in some informal discussion with the researcher.

Furthermore, a classroom observation will be conducted in the class where the teacher will be

to teaching some aspects of statistics on scheduled dates.

I undertake to maintain confidentiality and that neither the school nor the mathematics teacher involved in my research will be identified, and, will be free to withdraw at any time.

In line with the department regulations, a letter of consent will be given to the mathematics teacher recommended by you, requesting for his/her voluntary participation.

I will be very appreciative of your assistance in this regard. Kindly indicate your willingness by signing the space provided below.

Yours faithfully

IJEH, SUNDAY B.
(Researcher)

I, Mr/Mrs/Miss _____ the principal of _____ hereby grant Mr Ijeh, Sunday B. (Researcher) the permission to conduct a research project on the topic indicated above.

_____ _____

Signature of the Principal Date

APPENDIX IIIB

GAUTENG PROVINCIAL GOVERNMENT

UMnyango WezeMfundo
Department of Education

Lefapha la Thuto
Departement van Onderwys

Enquiries: Nomvula Ubisi (011)3550488

Date:	28 January 2009
Name of Researcher:	Ijeh Sunday
Address of Researcher:	Flat 18
	321 Soutter Street
	Pretoria West
Telephone Number:	0784956211
Fax Number:	0127172877
Research Topic:	How Competent Mathematics Teachers Develop Pedagogical Content Knowledge for Statistics Teaching
Number and type of schools:	18 Secondary Schools
District/s/HO	Tshwane North

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

Permission has been granted to proceed with the above study subject to the conditions listed below being met, and may be withdrawn should any of these conditions be flouted:

1. *The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*

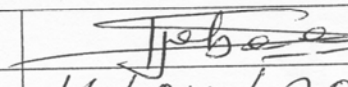
Office of the Chief Director: Information and Knowledge Management
Room 501, 111 Commissioner Street, Johannesburg, 2000 P.O.Box 7710, Johannesburg, 2000
Tel: (011) 355-0809 Fax: (011) 355-0734

4. *A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year.*
8. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
11. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
12. *On completion of the study the researcher must supply the Director: Knowledge Management & Research with one Hard Cover bound and one Ring bound copy of the final, approved research report. The researcher would also provide the said manager with an electronic copy of the research abstract/summary and/or annotation.*
13. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

Pp Nomvula Ubisi
CHIEF DIRECTOR: INFORMATION & KNOWLEDGE MANAGEMENT

The contents of this letter has been read and understood by the researcher.	
Signature of Researcher:	
Date:	16/04/2009

APPENDIX IV

Criteria for Validating Interview Schedule for Teacher on How They Develop PCK in Statistics Teaching.

Preamble

An educational background means where and what school you attended within a particular period. Basically all the schools that one has been to study a given or a particular subject (DoE, 2008). It comprises the university attended, courses/modules studied, qualification obtained and duration of the study. According to Bucat (2004), subject matter content knowledge is the knowledge of the subject matter about what should be taught and how it should be taught for effective learning. The outstanding teacher is not simply a 'teacher', but rather a 'history teacher', a 'chemistry teacher', or an 'English teacher'. While in some sense there are generic teaching skills, many of the pedagogical skills of the outstanding teacher are content-specific. Beginning teachers need to learn not just 'how to teach', but rather 'how to teach mathematics', how to teach world history', or 'how to teach fractions in mathematics. With these skills, subject content knowledge can be transformed into pedagogical content knowledge (PCK) (Geddis, 1993). In order to be able to transform subject matter content knowledge into a form accessible to students, teachers need to know a multitude of particular aspects about the content that are relevant to its teachability (Bucat, 2004). Those teaching aspects that the teacher needs to know included the topics, method of teaching, effectiveness of the lesson, nature of the topic, how to assess learners' understanding of the topic and effective participation, instructional strategies used and relevance of the topic to the learners. Others included are how to identify learners' learning difficulties and the intervention used to address the learning difficulties such as workshops, extra tutoring and more problem solving activities that can enhance learners' participation in the topic or subject. Kindly indicate in the space provided whether the attached interview covered what it supposes to cover in terms of assessing the mathematics teachers' content knowledge and educational background that enabled them to develop their PCK in statistics.

1)	**Educational Background and subject matter content knowledge**	**Options**	**Response**
	a) Does the schedule request for the university/college attended?	**Yes/No**	
	b**)** Does the schedule request for the participants' qualifications?	**Yes/No**	
	c) Does the schedule request for the course/module/subject studied in the university/college?	**Yes/No**	
	d) Does the schedule request for how the module/subject help in lesson preparations?	**Yes/No**	
	e) Does the schedule request for how the teacher knows that his teaching was effective?	**Yes/No**	
	f) Does the schedule request if the teacher has interest in teaching mathematics?	**Yes/No**	
	g) Does the schedule request for how the teachers understand the nature of the subject/topic?	**Yes/No**	
	h) Does the schedule request if learners understand the topic?	**Yes/No**	
	i) Does the schedule request if the learners enjoy the topic?	**Yes/No**	
	j) Does the schedule request for how the teachers update their content knowledge for teaching the topic/subject?	**Yes/No**	
	K) If the teachers attend workshop for instance, does the schedule request to know how effective was the workshop?	**Yes/No**	
	l) Does the schedule request to know if the facilitators of the workshop are mathematics teachers or not?	**Yes/No**	
	m) Does the schedule request for the duration of the workshop?	**Yes/No**	
	n) Does the schedule request for what was benefited from the workshop?	**Yes/No**	
	o) Does the schedule request if the workshop participants need similar workshop in subsequent time?	**Yes/No**	
2	**Instructional skills and strategies**		
	a) Does the schedule request if the teachers are adhering to the instructional approach as recommended in the NCS curriculum?	**Yes/No**	
	b) Does the schedule request for how learners can be assisted if they experience some learning difficulties based on the instructional approach used by the teacher?	**Yes/No**	

	c)	Does the schedule request for instructional skills and strategies used for teaching statistics?7	**Yes/No**	
	c)	Does the schedule request for other instructional approach used by teachers apart from the recommended approach according to NCS?	**Yes/No**	
	d)	Does the schedule request for how learners learning difficulties were resolved if any?	**Yes/No**	
3	**Learners' learning difficulties**			
	a)	Does the schedule request for the learning difficulties which learners encounter during teaching?	**Yes/No**	

Comments

_____

_____

_____

_____

_____

NAME AND SIGNATURE OF RATTER

APPENDIX V

TRANSCRIPTION OF VIDEO RECORDS OF FIRST LESSON OBSERVATION OF TEACHER A

The teacher came into the classroom and began the lesson as follows:

Teacher A: Good afternoon learners?

Learners: Learners answered, Good afternoon sir.

Teacher A: "Let somebody tell me how to calculate mode, median and mean of ungrouped data?"

Learner: "Mode is the number that appears most often in a distribution. For example; 1, 2,3,2,5. The mode is 2. For the median, the learner continued, you arrange: 1, 2. 2. 3, 5. Therefore, Median is 2, because it is the middle number after arranging the numbers according to size".

Teacher A: Wrote down the numbers mentioned by the learner as an example of the data and requested another learner to tell him how to calculate mean. In their mother tongue, he said, ***ke bokae?*** Many learners raised their hand to answer the question but the teacher A nominated one of the learners to calculate the mean with the data on the chalkboard.

Learner: Mean is the average of the numbers. i. e. Mean = $\frac{1+2+3+2+5}{5}$,

Mean = $\frac{12}{5}$ = 6.0

Teacher A: Gave an example and explained to the learners how to prepare the frequency table. How many members are their ages within 16-20?

Learner: One of the learners counted and said: it is 7. Another learner said it is 6 (The correct one).

Teacher A explains: The class boundaries are calculated thus, $\frac{15+16}{2}$ = 15.5,

$\frac{20+21}{2}$ = 20.5, etc; Mid-values = $\frac{16+20}{2}$ =18; and fx is calculated as: 6 x 18 = 108.

Teacher A: "I have completed the first three rows." Then, "complete the remaining rows by calculating the frequencies, class boundaries, mid-values and fx".

Teacher A: Is it clear? In their mother tongue, he said, ***le a nkutlwa?***

Learner: Yees Sir.

Learner: Completed the frequency table individually. "I have completed mine" (The learners who have finished raise their hands).

Teacher A:	Constructed the histogram by drawing the vertical and horizontal axes on the chalkboard, choose scale, label the axes with class boundaries as on the table and draw the bars on the axes (Teacher A drew three bars and asked them to complete the remaining bars).
Learner:	Listened and watched how the teacher constructed the histogram using topic specific construction skills (Drawing of axes, choosing of scale and labelling of axes, drawing the line of best fit).
Teacher A:	"Now complete the histogram."
Learner:	Completed the histogram individually.
Teacher A:	Went round to check how learners were constructing the histogram and further to answer the follow-up questions (By explanation).
Teacher A:	Calculated the mode from a histogram by drawing a diagonal form the top right corner of the highest bar of the histogram to the top right corner of the next bar on the left hand side and draw a second diagonal from the top left corner of the highest bar to the top left corner of the next bar on the right of the highest bar. He further refers the learners to how mode is calculated in a stem and leaf diagram and to use that method for confirmation of the answer obtained.
Learner:	Learners did as teacher A explained with their graph sheet on individual basis.
Teacher A:	Analysed and interpreted the histogram i.e. 7 members of a netball club are within the ages of 16-20 years. 67% of the members of the club are within the ages of 21-30 years (e.g. add all numbers within the ages 20 – 30 divide by 27 and multiply by 100).
Learner:	Watched how the teacher calculates the percentage of learners within the ages of between 21-30 years and write it on their notebook.
Teacher A:	Now, do this as classwork.
Learner:	Did classwork by preparing class boundaries, drawing of axes, choose scale for drawing and labelling the axes, draw the line of best fit (bars).
Teacher A:	Monitored and guided learners as they did the classwork.
Teacher A commented:	"I can see that your (some of them) diagrams are not correct. Make sure that you have chosen the correct scale as in the example, otherwise you diagram cannot be correct. Some of you have constructed the histogram very well, but many have not, because you choose a wrong scale. Please, go back to your example and see how we choose the scale and do the same for this exercise."

Learner:	Continued with classwork and were still experiencing some difficulties about the construction and interpretation of histogram especially determining the mode from the histogram.
Teacher A explains:	"The lesson is about to end. Please, those of you who have not completed their classwork should do so at home and bring it to school tomorrow. Here is your homework (referring them to the exercise on their mathematics textbook) which you have to submit with the classwork you could not complete. I want to see those of you who could not complete your classwork immediately after closing tomorrow so that I can assist you on those areas where you are experiencing problems."

APPENDIX VI

RANSCRIPTION OF VIDEO RECORDS OF SECOND LESSON OBSERVATION OF TEACHER A

The teacher came into the classroom and began the lesson as follows:

Teacher A: "Good afternoon learners?"

Learner: Learners answered, "Good afternoon sir".

Teacher A: "Let me see how you did the homework which I gave you yesterday?"

Learner: Opened to the page in their mathematics notebooks where they did the homework.

Teacher A: Checked and marked the homework from one learner to the other.

Teacher A: Solved homework on chalkboard.

Learner: Wrote correction on notebook.

Teacher: Provided a photocopied exercise on ogive and requested learners to interpret it. That is; calculate first, 2^{nd}, $3^{rd\ quartiles}$, minimum and maximum values.

Learner: Find first quartile, 2^{nd} quartile, third quartile, minimum and maximum value in Groups.

Teacher A: Used the values got from the interpretation of graph to construct a box-and whisker plot while learner watched.

Learner: "Could you please explain again how to calculate the first and third quintiles?"

Teacher A Explains: Using the formula as in previous examples, $Q_1 = \frac{1}{4}(N + 1)^{th}$ position you Can find the position of the first quartiles and $Q_3 = ¾ (n + 1)^{th}$ can be used to find the position of the third quartiles Q_3 can be traced from the cumulative frequency to the curve down to the horizontal axis to determine the value of the first quartile. The same applies to the value of the third

	quartiles. While $Q_1 = 52$, $Q_2 = 63$ and $Q_3 = 73$ the maximum 100 (using a similar example in their textbook for explanation).Further interpretation: 25% of the learners got less than 52%, 50% the learners got less than 63% and 75% of the learners got less than 73%.
Teacher A:	"The formula can also be applied to ungrouped data. You may apply it to the exercise you did previously in ungrouped data."
Learner:	Wrote the reference for the homework and noted it in their textbooks as indicated above.
Teacher A Comment:	"It appears that some of you do not understand how to calculate the quartiles in ungrouped and grouped data. Can I see you tomorrow at 15h00 to explain more?"
Learner:	"Thank you, see you tomorrow."

APPENDIX VII

TRANSCRIPTION OF VIDEO RECORDS OF FIRST LESSON OBSERVATION OF TEACHER B

Teacher B:	Greeted the learners, "Good afternoon class"
Learner:	"Good afternoon sir?"
Teacher B:	"Can we move to the science laboratory because we want to use electricity in our lesson today?"
Learner:	Moved to the laboratory before the lesson began.
Teacher B Commented:	"I want you to solve the exercise on preparation of frequency table on the photocopied paper within 5mins"
Learner:	Prepared a frequency table.
Teacher B explained:	**"**A bar graph is a pictorial representation of statistical data in the form of rectangle called bar. A bar graph is often needed to compare two or more values that are taken under different conditions or over time." The frequency table prepared (pre-activity) by the learners was used further used to explain and construct a single bar graph. Teacher B drew the vertical and horizontal axes, label vertical axis as frequency and horizontal as scores. Draw the bar for each score", teacher B said.
Learner:	Watched as the teacher explains how to construct and interpret the bar graph and write explanation in their notebook and asked "How do we know that the test is easy or difficult using these scores?"
Teacher B Explains:	"If the number of learners that scored 7 and above was more than six, then the test was easy." (**Teacher B** read out the number of persons who scored 7 and above as 3 x 1 = 3.) "This means that about 60% of the learners scored between 7 and 10. But if seven learners scored between 1 and 3 (teacher B read from the graph), and the highest score was 5, the test was difficult, as 70% of the learners scored below 4 marks, and the highest score was 5."

Thus, with a bar graph, it is easy to visualise and interpret learners' performance in a test. From Figure 4.5.2a, it is evident that the test was within the level of the learners, as the learners' marks are not too low, and if the pass mark is 4 (40%), then only four of the learners failed.

Teacher B: After explanations, he gave classwork on the construction and interpretation of bar graph (referring to their textbooks).

Learner: Did their classwork as instructed by the teacher on one to one basis.

Teacher B: Monitored and guided learners while they were doing their classwork.

Learner: Some learners did not consider the concept of spacing which resulted to misconception.

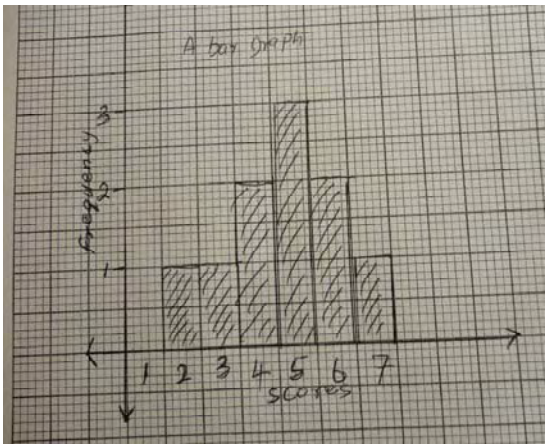


Figure A7: Learners constructed a histogram instead of bar graph.

Teacher B: Indicated to some of them that their classwork was wrong

Learner: Demanded clarity why their classwork was wrong.

Teacher B: Explained and re-explained and gave extra activities for learners to solve in class and at home on how to solve the problem in the afternoon next day.

APPENDIX VIII

TRANSCRIPTION OF VIDEO RECORDS OF SECOND LESSON OBSERVATION OF TEACHER B

Teacher B: Greeted the learners "Good afternoon learners?"

Learner: "Good afternoon sir?"

Teacher B: Wrote the topic on the chalk board

Learners: Watched and listened.

Teacher B "Mention two ways of presenting data."

Learner: Mentioned frequency table, bar graph, pie chart, histogram

Teacher B: Referred the learners to the exercise in their textbook. Explained how to prepare a cumulative frequency table with the first three rows and instructed the learners to complete the preparation of the frequency table with the remaining rows.

Learners: Completed the frequency table.

Teacher B: Wrote all the cumulative frequencies calculated to ensure that every body agreed on common cumulative frequency table.

Teacher B: "Draw the vertical and horizontal axes like this .Label the axes with the vertical as cumulative frequency and the horizontal with the marks value. Plot the point (10, 0); (20, 2); (30, 8) etc. Continue with the remaining points," the teacher said

Learners: Learners plotted the remaining points e.g. (40, 15); (50, 29); (60, 49), (70, 84); 80,113), (50, 29) ;(90,119); 100,120); in groups

Teacher B "This is how to interpret the graph."

Learners: Listened and watched as teacher B interprets the graph (Using the follow up questions).

Teacher B: Interprets the ogive by determining the quartiles e.g. 1st, 2nd and 3rd quartiles as 52, 63 and 73 respectively.

Teacher B: "Now do this exercise as classwork but with class internal beginning from 20-30, 30-40, 40-50, 50-60, while he monitored and guided them.

Teacher B Commented: "Most of you appear not to know how to label the horizontal axis with class boundaries beginning from 0-10 , 10-20, 20-30, etc and beginning from 20-30, 30-40 40-50 etc. Look at how you can do it (referring the learner to a graph paper and showing how to mark out the value on the horizontal axis."

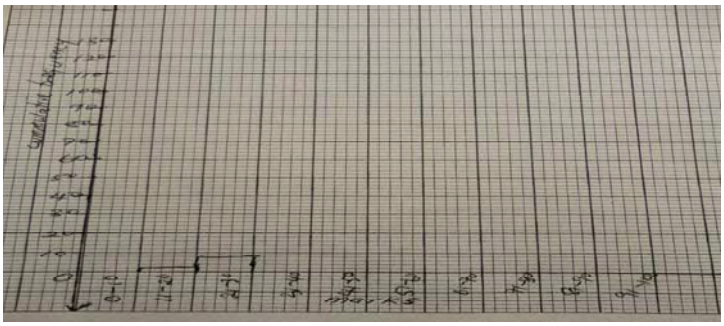


Figure A8. Learners constructed a histogram instead of an ogive.

Learners: Tried to do as the teacher instructed, yet some were still experiencing problems.

Teacher B: Re-explains how to construct and interpret the ogive.

Teacher B: "Now do the exercise at 8.11, 8.12, and 8.13 in your textbook." Teacher B instructed them to finish and submit the extra activities before going home (The activities were divided into two: one part as homework for those who were not experiencing problems and the other part for learners who were experiencing some difficulties.

Teacher B: Asked oral questioning as a way of concluding the lesson: 'What does 'n' represent in the formula for calculating the quartiles? Where can I locate the quartiles using the formula?' Learners nominated by Teacher B gave satisfactory answers which were followed by homework and post-teaching discussion.

APPENDIX IX

TRANSCRIPTION OF VIDEO RECORDS OF FIRST LESSON OBSERVATION OF TEACHER C

Teacher C:	"Good after noon learners?"
Learners:	"Good afternoon sir."
Teacher C:	Specified the outcome of the lesson and said, "We are going to learn how to construct, analyse and interpret the ogive. Before we do that, let us look at the homework on the histogram."
Teacher C:	Marked and checked the homework on histogram on a desk to desk basis.
Learner:	Some of the learners wrote corrections from friends who got the homework correct for the questions they got wrong before the teacher could do that.
Teacher C:	"What is the difference between a class interval and class boundary?"
Learner:	"They are the same. Both of them contain groups of numbers."
Teacher C:	"Mention various ways of representing data?"
Learners:	Mentioned bar chart, pie chart, scatter plots, line graph, etc.
Teacher C Comment:	"Let us prepare a cumulative frequency table using the table on the paper that I gave you."
Teacher C:	Prepared the cumulative frequency of the first 3 rows and instructs learners to complete the cumulative frequency table of the remaining rows.
Learner:	Completed the cumulative frequency of the remaining row.
Teacher C Explains:	"Now we can construct the ogive. Draw the two axes, label them using the Cumulative frequencies for the vertical axis and profit for the horizontal axes. Now I will plot three points and you will plot and connect the remaining points and lines of best fit for the curve."

Learner: Completed the plotting and connect the curve.

Teacher C: Walked around the class from desk to desk, analysing learners' classwork and monitoring how learners are completing the plotting and connect the curve.

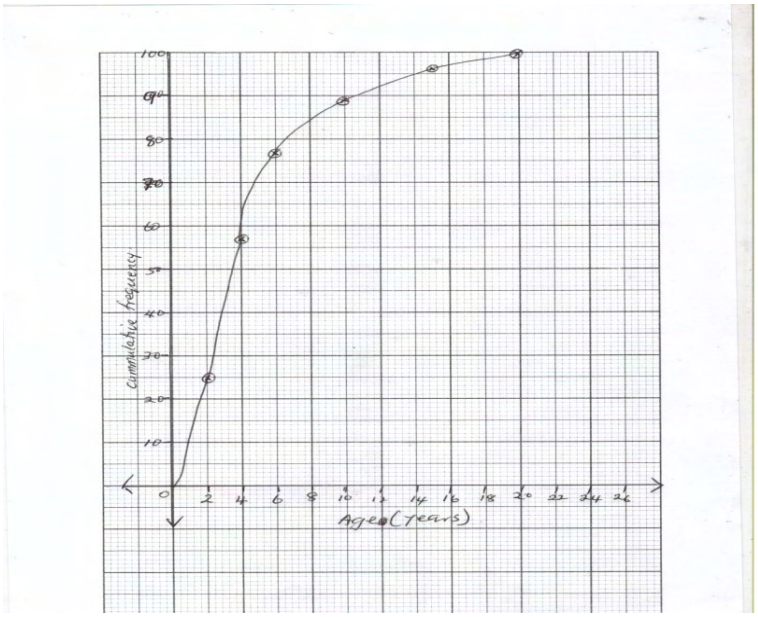


Figure 4.5.3: An ogive showing the ages of cars of a sample of 100 car owners.

Learner: Continued with the completing of the ogive.

Teacher C: "How do we calculate the median?"

Learner: Quoted a formula; $Q_1 = \frac{1}{2}(N + 1)$.

Teacher C: How do we calculate First quartile, second quartile and third quartile?

Learner: Quoted some formulae: $Q_1 = \frac{1}{4}(N + 1)$ and $Q_3 = ¾ (N + 1)$. These formulae were used to calculate the quartiles' position as a way of interpreting the graph and further explain how we calculate the quartiles.

Learner: Listened and watched as he described how the quartiles were obtained.

Learners:	Some learners drew a histogram instead of an ogive. This is a misconception.
Teacher C:	"Now I observed that some of you constructed a histogram instead of ogive the question says construct an ogive and not a histogram"
Learner:	Reconstructed the ogive with the help of the teacher.
Teacher C:	Identified learners who are experiencing difficulties due to the misconception and requested them to see him after the lesson one by one in order to help them correct the difficulties they had.
Teacher C:	Summarises the lesson with oral questioning (How do you calculate the cumulative frequencies? In constructing the ogive, and do you plot the cumulative frequencies against the lower or upper class boundaries? He gave the learners homework by referring them to their textbooks and other statistics related materials. Some of the learners who got their classwork correct went home at the end of the lesson but those who were experiencing difficulties had to wait and see the teacher one after the other for immediate assistance.
Learner:	Noted the homework given to them.

APPENDIX X

TRANSCRIPTION OF VIDEO RECORDS OF SECOND LESSON OBSERVATION OF TEACHER C

Teacher C:	**Indicate the Outcomes of the Lesson**: The purpose of the lesson is to learn how to construct, analyse and interpret scatter plots.
Teacher C:	Wrote the topic on the chalk board and introduces the lesson by giving the learners some photocopied exercise to analyse as a pre- test (requesting them to indicate how they have constructed the scatter plots (analysis).
Learner:	Analysed the scatter plot in groups of two and three.
Teacher C:	Wrote a table and requested for a volunteer to plot the point on the chalkboard as a way of explaining more about the construction of scatter plots.
Teacher:	Teacher C walked around the class to monitor how learners are analysing the scatter plots. He further asks, “Do you need to draw a line of best fit in order to determine how the variable x and y are connected?”
Learners:	“Yes sir.”
Teacher:	“Some of you interpreted diagram C as having negative correlation. Why?”
Learner:	“Because the points are scattered all over (misconception).”
Teacher C Explains:	“No; only one point stood out of others as outliers. It has little or no impact on the correlation of the two variables. He presents more photocopies of related examples in real life situation (see table 4.4.4c).
Learners:	“How do you account for outliers in a scatter plot?”

Teacher C: "Outliers of two or more can affect the correlation of two variables and it depends on the number of the correlating points."

Learner: Wrote explanations.

Teacher C: "Why do we say that diagram A has a strong positive correlation?"

Learner: Explains how the points are clustered along a given line indicating that the more learners are taught, the more they perform in the test. This shows a relationship between learner performance and the period they were taught.

Teacher C: Summarises the lesson with oral question and gave homework.

APPENDIX XI

TRANSCRIPTION OF VIDEO RECORDS OF FIRST LESSON OBSERVATION OF TEACHER D

Teacher D:	Wrote the topic on the chalk board and gave learners photocopies of statistics exercises. “Do the exercise I have given to you for 5mins”
Learners:	Solved the exercise individually involving the preparation of the frequency table of given data.
Teacher D explains:	After all learners had agreed on a common answer to frequency table prepare, he showed the learners how to construct and interpret a bar graph: “Draw the axes, label them with number of rows on the vertical axis and accompanied on the horizontal axis constructing the bar graph.”
Learner:	Listened and watched the teacher as he constructed the bar graph. In their mother tongue, he said***, labella ga ke go bontsha.***
Teacher D:	After he had finished, he asked the learners, “What was the first thing I did, when constructing a bar graph?”
Learner:	“You draw the vertical and the horizontal axis and label it”
Teacher D:	Which company manufactures the least number of cars?
Learner:	“Tata”
Teacher D:	“Why do I have to leave space between the bars?”
Learner:	“To show that they are different companies.”
Teacher D:	Gave a classwork on construction and interpretation of the bar graph.
Learner:	“Do the classwork by constructing and interpreting the bar graph and find out how many learners fail the test if the pass mark is 5.”

Teacher D:	Monitored and guided learners as they were doing their classwork.
Learner:	"Why do we need to leave space between the bars?"
Teacher D:	"All companies manufacture cars but of different types (or different companies)"
Learner:	Some learners drew a histogram instead of a bar graph by not leaving a space between the bars. Some did not consider the constancy of equal spacing between the bars.
Teacher D explained:	Re -explained the constructed bar graph as some learners are still experiencing difficulties in terms of constructing the bar graph as explained above. And a bar graph is not a histogram as some of you have done. While a bar graph have a common space between the bars, a histogram does not.
Learner:	Listened, watched and wrote explanation on their notebooks. In their mother tongue, he said***, labella ga ke go bontsha.***
Teacher D:	Gave homework on construction and interpretation of bar graphs.
Learner:	Wrote down the homework.

APPENDIX XII

TRANSCRIPTION OF VIDEO RECORDS OF SECOND LESSON OBSERVATION OF TEACHER D

Teacher D: Requested for the homework given to the learners in the previous lesson.

Learner: Presented their completed homework individually.

Teacher D: Checked and marked the learners' completed homework on stem and leaves.

Learner: Wrote corrections on the homework (for those who got some answers wrong).

Teacher D: Wrote the topic on the chalkboard (construction, analysis and interpretation of histogram).

Learner: Listened and watched.

Teacher D: Presented photocopies of exercise which was used to explain the topic.

Learner: Received the photocopy and watched as the teacher demonstrated how to construct, analyse and interpret a histogram.

Teacher D: Prepared the frequency table of the data (To determine preconception).

Learner: Prepared the frequency table using a given class interval.

Teacher D explained: "This is how you draw a histogram. Draw the vertical and horizontal axis. Label the vertical as frequency and horizontal axis as masses of the player. Join the line of best fit in the form of a rectangle. I will draw two rectangles and you will complete the remaining one."

Learner: Completed the histogram as the teacher had instructed.

Teacher D: Interpreted the histogram by determining the measures of the central tendency (Mode, Mean) that best describes the players according to their weight, and gave learners classwork.

Learner: "Why is it necessary to start marking the horizontal axes with 70 and not 0?"

Teacher D: "You may make a zig-zag to indicate that you did not start from 0 or start from the vertical line as shown in the table of values. You will have enough space to construct the histogram."

Learner: Looked on for some time as a way of showing that they were not satisfied with the explanation. They noted it and used the same method to do their class work.

Teacher D: Summarised and concluded the lesson with more explanation on the examples and gave them homework on the same topic. Some of the learners who were still experiencing some difficulties about how to construct a histogram of grouped data were given extra compulsory activities to solve after the lesson from their recommended textbook. "All of you who failed this activity have to do this exercise and see me tomorrow after the normal school hours or closing so that I can explain to you more about how to construct histogram."

APPENDIX XIII

Criteria for validating questionnaire schedule for teachers on how they develop PCK in statistics teaching.

Preamble

The attached questionnaire aims at investigating what the teachers actually did while teaching such as the method applied, content of the lessons, nature of the topic, how the teacher identified the learners preconceptions and learning difficulties, how the difficulties were resolved if any and how the lessons were evaluated. Kindly indicate with the options provided, your opinion about using the schedule to assess what the teacher actually did while he was teaching statistical graph during the case study period.

S/No	Descriptions	Option	Respond
1	**Instructional strategies used for teaching statistical graphs**		
A	Does the questionnaire asked for the duration of the lesson?	Yes/no	
B	Does the questionnaire request for the topic of the lesson?	Yes/no	
C	Does the questionnaire request for the objective of the lesson?	Yes/no	
D	Does the questionnaire request for the prior knowledge the lesson needed?	Yes/no	
E	Does the questionnaire request if learners have prior knowledge of the topic?	Yes/no	
f	Does the questionnaire request for how the teacher identifies the preconception with which learners come to the class about the topic?	Yes/no	
G	Does the questionnaire request whether learners achieved the objective of the lesson or not?	Yes/no	
H	Does the questionnaire request for how learners responded to class activities, homework and assignments?	Yes/no	
I	Does the questionnaire request if the teachers were able to follow the planned lesson from beginning to the end?	Yes/no	
J	Does the questionnaire request for how teachers will improve their lesson if their lesson was not successful?	Yes/no	
K	Does the questionnaire request whether teachers evaluate their lesson or not?	Yes/no	
L	Does the questionnaire request how the teachers evaluate their lessons?	Yes/no	
M	Does the questionnaire request the reason for evaluating a lesson?	Yes/no	

S/No	Descriptions	Option	Respond
2	**Learning difficulties in the teaching of statistical graph**		
a	Does the questionnaire request for information about learning difficulties that learners are experiencing?		
b	Does the questionnaire request for how teachers resolve learners' learning difficulties if any?		
c	Does the questionnaire request for what makes the learning of statistics easy or difficult?		

APPENDIX XIV

Criteria for validating written reports schedule for teacher on how they develop PCK in statistics teaching

The attached is a teacher written report schedule for a period of four weeks for teaching statistical graph. The schedule focuses on what has made the lessons easy or difficult as well as where the learners' learning difficulties lie during the teaching of statistical graphs for a period of 4 weeks. Kindly indicate with the options provided, your opinion about using the schedule to assess what has made the lesson easy or difficult.

S/No	Descriptions	Option	Response
1	**Learners' learning difficulties**		
A	Does the written report schedule request for information about the learning difficulties the teacher identifies when teaching the statistics?	Yes/no	
b	Does the written report schedule request for the difficulties that the teacher experiences when teaching statistical graphs?	Yes/no	
C	Does the written report schedule request for what the teacher finds interesting or difficult when teaching the statistics?	Yes/no	
D	Does the written report schedule request why the teacher finds certain topic interesting when teaching?	Yes/no	
E	Does the written report schedule request what the teacher find less difficult to teach in the topic?	Yes/no	
F	Does the written report schedule request for how the teachers identify the preconceptions and misconceptions which learners have about statistics during teaching?	Yes/no	
G	Does the written report schedule request the preconception identified when teaching statistics?	Yes/no	
H	Does the written report schedule request for the misconceptions identified by the teacher when teaching the topic?	Yes/no	
J	Does the written report schedule request for how the teachers address the misconceptions which they identified when teaching the topic.	Yes/no	
2	**Instructional skills and strategies used for teaching**		
a	Does the written report schedule request for how learners respond to class activities, homework and assignments		
b	Does the written report schedule request for the changes that the teacher will make next time with regards to the difficulties encountered while teaching the topic both on the part of the teacher or the learners'.		

APPENDIX XV

Criteria for validating document analysis schedule for teachers on how they develop PCK in statistics teaching

The teacher and learners' portfolios, learners' workbook and recommended mathematics textbooks are the documents that will be used to examine if mathematics teachers are complying with the National Curriculum Statements (NCS) policy for teaching and learning of mathematics and have sufficient content knowledge of school statistics. Using these criteria listed in the table below, kindly indicate with the options provided if the documents contain adequate information that can be used to determine how well the mathematics teachers are complying with implementation plan according to NCS.

S/No	Descriptions	Option	Response
1	**Learners' workbook**		
a	**Authenticity**	**Yes/No**	
i	Is learners' workbook a genuine instrument for capturing where their learning difficulties lie?	**Yes/No**	
b	**Credibility**	**Yes/No**	
ii	Can the workbook be used to gather enough evidence that is free from error and distortion about learners' learning difficulties in statistics teaching?		
c	**Representativeness**		
iii	Can the evidence obtained from the learners' workbook give a true representation about the learning difficulties they have in statistics teaching.	**Yes/No**	
d	**Meaning.**		
iv	Is the evidence about the learners' learning difficulties, gathered with the learners' workbook, clear and comprehensible?	**Yes/No**	
2	**Learners' portfolio**	**Yes/No**	
a	**Authenticity**	**Yes/No**	
i	Is learners' portfolio a genuine instrument for capturing where their learning difficulties lie?	**Yes/No**	

S/No	Descriptions	Option	Response
b	**Credibility**	**Yes/No**	
ii	Can the Learners' portfolios be used to gather enough evidence that is free from error and distortion about learners' learning difficulties in statistics teaching?	**Yes/No**	
c	**Representativeness**	**Yes/No**	
iii	Can the evidence obtained from the learners' portfolios give a true representation about the learning difficulties they have in statistics teaching.	**Yes/No**	
d	**Meaning.**		
iv	Is the evidence about the learners' learning difficulties gathered with the learners' portfolio clear and comprehensible?	**Yes/No**	
3	**Teachers' portfolio**	**Yes/No**	
a	**Authenticity**	**Yes/No**	
i	Can the teachers' portfolio be used to gather genuine evidence about how they (teachers) are complying with the teaching and learning policy in mathematics such as using the work schedule, instructional strategies used for teaching and learning difficulties that learners encountered?	**Yes/No**	
b	**Credibility**	**Yes/No**	
ii	Can the teachers' portfolios be used to gather enough evidence that is free from error and distortion about work schedules, instructional strategies used for teaching and the learning difficulties encountered by the learners?	**Yes/No**	
c	**Representativeness**		
iii	Can the evidence obtained from the teachers' portfolios give a true representation about the learners' learning difficulties in statistics teaching?		
d	**Meaning.**	**Yes/No**	
iv	Is the evidence about the learners' learning difficulties gathered with the teachers' portfolio clear and comprehensible?		
4	**Textbooks**	**Yes/No**	
a	**Authenticity**		
i	Is/are the textbook(s) the recommended textbook(s) for teaching and learning in mathematics in the school?	**Yes/No**	

S/No	Descriptions	Option	Response
b	**Credibility**		
ii	Is the textbook(s) used error free in terms of the content of statistics in school mathematics	**Yes/No**	
c	**Representativeness**		
iii	Does the textbook(s) contain adequate statistics content in school mathematics according to the National curriculum statements (NCS).	**Yes/No**	
d	**Meaning**		
iv	Is the content of statistics in school mathematics in the textbook(s) clear and comprehensible?	**Yes/No**	

APPENDIX XVI

Criteria for validating the lesson plan and observation schedule.

The attached lesson plan/observation schedule was adopted from the Department of education for classroom practice (DoE, 2009). Please indicate with the options provided, if the schedule contains enough information for assessing a normal classroom practice in terms of lesson planning/observation what the teacher did while teaching an assigned topic.

S/No	Description	Option	Response
1	**PLANNING**		
a	Does the schedule request for lesson topic?	**Yes/No**	
b	Does the scheduled request for learning outcomes?	**Yes/No**	
c	Does the Schedule request for assessment standard?	**Yes/No**	
d	Does the schedule request for resources used during the lesson?	**Yes/No**	
2	**Pedagogical issues**		
a	Does the schedule request for how the lesson was introduction?	**Yes/No**	
b	Does the schedule request for general handling of the class e.g.		
	i) Classroom organisation?	**Yes/No**	
	ii) Discipline?	**Yes/No**	
	iii) Classroom interaction?	**Yes/No**	
	iv) Movement?	**Yes/No**	
	v) Learning climate?	**Yes/No**	
	vi) Involvement of the learners?	**Yes/No**	
c	Does the schedule request for lesson development (progression)?	**Yes/No**	
d	Does the schedule request for how lesson is consolidated?	**Yes/No**	
e	Does the schedule request for the description of the lesson in terms of:		

	i) Language?	**Yes/No**	
	ii) Questioning techniques?	**Yes/No**	
	iii) Assessment?	**Yes/No**	
	iv) The use of resources?	**Yes/No**	
	v) Knowledge of the teacher?	**Yes/No**	
	vi) Errors and misconceptions	**Yes/No**	
3	**Learner related activities**		
a	Does the schedule request learners' related activities?	**Yes/No**	
4	**Teacher related activities**		
a	Does the schedule request teacher related activities?	**Yes/No**	
5	**Evaluation/Conclusio**n		
a	Does the schedule request how a lesson is concluded?	**Yes/No**	

Comments

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NAME AND SIGNATURE OF RATTER

Appendix XVII

Analysis of participants' responses to interview, questionnaire and teachers' written report

Table 4.7.1: Teachers' responses to interview about teachers' subject matter content knowledge in statistics teaching

Items	Interview Question	Responses				
		Teacher A	Teacher B	Teacher C	Teacher D	Coding
1	Which university /college did you attend?	Unisa & University of North-West	University of Zimbabwe	Aerica University, Zimbabwe	Vista University, South Africa	-all attended university
2	What qualification did you obtain?	BEd Maths Ed., BA Psychology, & Dip. in Maths Ed.	BSc Maths & Statistics	BSc Mathematics	BEd Maths Ed., SED Maths and Biology	- 2 had degree in maths education -2 had B.Sc in mats. - one also had diploma
3	What course, subject/module did you study at the university/college?	Maths, Physical Sc, & Ed Psychology. The importance, advantages and disadvantages of different instructional strategies.	Maths, Statistics & Edu. Methods of teaching, advantages and disadvantages of different strategies.	Maths & other courses. Different instructional strategies, advantages and disadvantages of the strategies for teaching various topics..	Maths courses & Maths method course. Advantages and disadvantages of different teaching approaches.	-all 4 study mats and education courses. Advantages and disadvantages of different teaching strategies
4	How long did you study this course/subject?	BEd is 3yrs & Dip is 2yrs.	Four (4) years	Four (4) years	Two (2) **&** Four (4) years	-One for 3yrs, three of them for 4 yrs, and two 0f them for 2 yrs in Dip.
5a	If one of the courses in (3) is mathematics methodology, how did it help you to prepare your lessons for teaching?	Use of varied instructional strategies.	Varied formulae and strategies for teaching the same topic	The courses helped me to prepare the lessons using the required format and knowledge for teaching with the objectives of the lessons in mind.	It helps me for planning in line with the work schedule, assessment and evaluation of my lessons.	- Help to plan lessons and vary instructional strategies.
5b	How do you know that your teaching is effective?	Response from learners or feedback to class works, assignments, homework etc.	Response from the learners to classworks, homework and assignments.	Learner's response to class activities, homework and examinations.	Feedback to class activities, homework and other related tasks on the topic.	-Analysis of learners' responses to classwork, homework and assignments.
6	Do you have interest in the teaching of mathematics? If yes / no why?	Very well. I love teaching. Mathematics helps one to improve one's thinking skills and provides opportunity for problem solving.	Yes, because answers are always there for a particular question.	Yes. It is very challenging but interesting, as it makes one to be precise and accurate.	Yes. It is straight forward. It is either you get it right or wrong.	-All four have interest in teaching statistics as mathematics improves ones thinking skill and opportunity for problem solving.

7	What is your understanding of the nature of the statistics you teach?	Statistics is practical in nature and an aspect of mathematics that one can apply in everyday real life situation especially in summarizing data.	I am quite comfortable with the concepts during teaching because of its practical way of solving problems. It helps to organised and summarized data in a meaningful way.	It helps to simplify complex data into understandable one that can be used for interpretation and analysis.	It is a practical topic that allows learners to participate actively especially during the construction of statistical graphs and preparation of frequency tables. Statistics helps in summarising data in a meaningful and understandable way.	-statistics help to organised and summarise data in an understandable manner for making decisions. The ways statistical graph are constructed make it look practical in nature.
8	Do learners understand the topic?	Yes and I notice it through their response and I make sure that they understand by employing appropriate method of teaching which the topic demanded.	About 90% of the learners were very much comfortable with the topic.	Yes. Learners' level of participation during the lesson is high.	Yes, I understand it through their response to class activities and homework.	-all four claim learners understood their lesson and it is observed from the way they respond to classwork, homework and assignments
9	Do learners enjoy the topic if yes/no why?	Yes, through their involvement in the lessons and participation.	Yes. They really like every aspect and this was evident in the way the learners performed in some of the activities given to them.	Yes. They sometimes make contributions and explain with confidence to their classmates what they do not understand during lessons.	Yes. Through response to oral questions, class work and interaction with fellow learners.	- All four claim that learners enjoy their lesson. -The way they enjoy the lesson was noticeable in the way they interact with their teachers and classmate during class discussion.
15	Have you attended a mathematics workshop or teacher development programme?	Yes. Workshop on NCS for grades 10-12 mathematics, Investec Enrichment Mathematics Programme.	Yes. Workshop was on NCS for Mathematics grades 10-12	Yes. I attended several workshops on mathematics especially data handling which lasted for a week, 3 days, etc.	Yes. I attended many workshops on teachers' development in content knowledge especially in data handling. The duration of the workshop was 7 days.	-all four claim they have attended workshop on professional development programme in maths and data handling in particular.
16	If your answer in (15) is yes, what was the content of the workshop?	Teaching and learning of NCS mathematics and methods for teaching	How to calculate measures of central tendency and spread.	The workshop was on NCS mathematics.	The workshop was on the new topics in mathematics and other challenging topics.	-The workshops were based on: - methods of teaching NCS. -Data handling. New and challenging topics in the new curriculum.
17	What was the duration of the workshop?	Every Saturday and during school holidays for one year.	7 hours workshop on the topic indicated above.	6 hours workshop on the above mentioned topic.	08h00 to 14h00 for four weeks (every Saturday) on data handling.	Durations for the workshops were 6hrs, 7hrs and 8hrs per day for four weeks and 8hrs per day during holidays.

18	Were the workshop facilitators mathematics teachers or mathematics experts?	Yes. Mathematics experts from the universities.	Mathematics teachers.	Yes. Mathematics educators from the university and colleges.	Mathematics educators and experts from the districts.	-The workshop facilitators were mathematics experts from the university, department of education and in-service teachers.
19	As a mathematics teacher, did you benefit from the workshop?	Yes. Very well. How to teach some challenging topics in mathematics such as data handling.	Did not learn new concepts but some changes in the curriculum like data handling that is new.	All about statistics especially lower and upper quartiles ranges etc.	Not as much, I was taught what I already know.	-All four claim that they benefit from the workshops as they gain more confidence in teaching, became abreast with contemporary issues in mathematics education.
20	Would you recommend that similar workshops be held for teachers?	Yes, because the benefits are enormous as it gives confidence in my class practice.	Yes. To provide educators with contemporary issues with regards to teaching and learning but not teaching educators like learners.	Yes. Any time that may be convenient.	Yes. It helps to refresh and reflect on what is already known and be aware of the contemporary issues in the teaching and learning of mathematics.	-all four claim that they will recommend for a similar workshop that can help them to reflect and refreshed their knowledge on the subject.

APPENDIX XVIII

Table 4.7.2: Participants' responses to the interview, questionnaire and written reports about teachers' knowledge of instructional skills and strategies for teaching statistics

Items	Interview Question	Responses				
		Teacher A	Teacher B	Teacher C	Teacher D	Coding
10	In your own opinion and based on your experience in the teaching of statistics, how do you see the topic (statistics) in mathematics?	The topic is good to be integrated into mathematics. It lends support to other areas of mathematics because it is very practical in nature and good in summarising information e.g. frequency table	It looks understandable and helps in understanding other topics too because of the way it helps in organising information in a meaningful way.	It is very important to be integrated into mathematics because of its uses in everyday life and other professions in terms of making information to be understandable to the users.	It is a lively topic and very practical in nature. It can also help to understand other subjects.	-Statistics help to oganise data in meaningful way to the users- -it lends support to understand other subjects. -The way data is represented makes it look practical especially statistical graphs.
11	Do your learners understand your lessons based on the instructional approach for teaching as recommended in the curriculum?	Yes, the approach is OBE learner centred for teaching mathematics but not all topics required it. Learners need the basic background because the topic is new.	Yes. OBE approach is the general teaching method. But one can change depending on feedback from learners.	Yes, they do and I ensure that they participate actively or be actively involved in the lessons.	Yes they do and I encourage them to participate actively in the lesson.	-All four claim that learners understood their lessons based on the instructional strategies used in teaching. -OBE is used. -Learners must be actively involved.
12	If learners have problems in understanding the topic based on the instructional approach, what do you do to help them understand?	I will try to explain the topic with familiar examples and situation as well as solving more problems on that topic. I will try to organised extra-tutoring for them after school hours.	I will conduct remedial lessons with the learners concerned after the normal school hours with familiar examples related to real life.	I have to involve them in the discussion after the lesson and provide more class activities and ensure that they understand the lessons by monitoring how well they are doing the activities.	I have to change my methods of teaching, repeat the lesson and organise extra lesson in the topic in which they are experiencing some difficulties to help the learners.	-Explanation with varieties of example, remedial lessons, problem solving, and monitoring strategies were used to resolve any difficulty that may arose during teaching and based of the instructional approach.

13	What other instructional strategies do you use for teaching and why?	Questioning and answers and demonstration methods. The reason for using these methods is that the teaching of statistics is very practical and most material used are within the environment of the learner (real life)	Using teaching aids because it enhanced understanding and encourages the development of manipulative skills such as graph construction.	Definition of basic terms, explanations and using outcome based approach (OBE) for teaching. Extra tutoring is also important in order to improve learners' understanding of the topic and enhance their participation in the study of statistics.	Explanation of basic concepts with examples and more problem solving activities in real life situations.	-Demonstration method, questioning and answer, use of teaching aids, organizing of extra tutoring and definition of basic terms with examples were other instructional strategies used for teaching statistics. -The reason for using these strategies is to improve learner understanding and achievement in the topic.
Items	**Questionnaire**	**Responses**				
		Teacher A	**Teacher B**	**Teacher C**	**Teacher D**	
1	How long was the lesson?	Duration of the lesson was 45 minutes.	Duration of the lesson was 40 minutes.	45 minutes.	45 minutes.	-Three teachers taught for 45 minutes each. -only one teacher taught for 40 minutes.
2	What was the topic of the lesson?	Statistical graph (histogram).	Data representation by statistical graphs (communicative frequency and ogives).	Scatter diagrams.	Drawing and interpreting of an ogive.	-All four taught statistical graph comprising of histogram, ogive and scatter plots

3	What was the objective / assessment standard of your lesson?	By the end of the lesson, each learner should be able to construct, analyse and interpret a statistical graph (histogram) as well as using them to solve real life problems.	By the end of the lesson, each learner was expected to be able to draw ogives and answer questions related to constructing analysing and interpreting of ogive using the knowledge of measures of central tendency .	By the end of the lesson, each learner should be able to construct, analyse and interpret statistical graph such as the bar graphs, ogive and scatter diagrams.	By the end of the lesson, each learner should be able to draw, analyse and interpret statistical graphs e.g. cumulative frequency curve.	- All four claims that the objective of their lessons was that learners should, at the end of the lesson, be able to construct, analyse, interpret and apply the statistical knowledge to solve everyday real life problems. -
7	Did you think that the learners achieved the objective of the lesson?	Yes. Through their active participation in the lessons and the reaction to the assessment task given afterwards.	They did because they were able to respond positively to the questions asked by the teacher orally, in classwork, home work and assignments.	They did and I confirm through their response to classwork and homework.	Yes. Based on their response to class activities.	-All four participants claimed that the objectives of their lessons were achieve and it was evidence in their responses to classwork, class discussion, homework and assignments
8	How did the learners respond to the class activities, homework and assignments?	Positively and they showed interests in the topic.	The response was quite positive as the learners wrote the homework activities.	Excellent. Their responses were good to indicate that they understood the lesson.	They performed well in the activities given to them as homework or assignments.	-All our teachers reported that learners' responses to classwork, homework and assignments were positive.
9	Were you able to follow the lesson as planned at the end of the lesson?	Yes and it was done as outline in the lesson plans.	Yes, the lesson was a successful one from the beginning to the end.	Yes and it was based on the lesson plan.	Yes and according to the lesson plan.	- All four participants claimed that they were able to follow the planned lessons from the starting point to the end

12	How would you improve / sustain the lesson?	By ensuring (through oral questioning or pre-test) that the necessary background knowledge does exists before introducing new content.	By using more teaching aids like the charts, overhead projector etc.	By giving extra-class activities related to real life and lessons.	By giving more examples on the topic and solving past questions.	-To ensure that learners has adequate background about the topic. -Explain lesson with enough teaching aids. _give enough and variety of class activities. -Solve past questions on the topics.
13	Do you normally evaluate your teaching?	Yes (using class work, test, exams, homework and assignments).	Quite often. Through class work, test, exams and homework.	Yes. Through class work, oral questions, homework.	Yes, I do. I give classwork, homework and sometimes assignments.	-All four participants claimed that they usually evaluate their teaching using classwork, test and examinations.
15	How do you evaluate your teaching performance?	By asking oral questions, during lessons, and giving classwork, homework and assignments.	By observing the difference in my teaching performance through end of year examination.	As mentioned in question 13.	I use same method as in question 13 to determine performance.	-By oral questioning, classwork, homework, assignments and examinations.
16	For what reason do you evaluate your teaching?	To ensure that learners understand what they need to know and to determine which methods of teaching may be more effective than the other through learners' response to class work and homework.	To improve and adjust to the performance of the learners.	For personal professional development and determine how to give learners the best of my capabilities.	To evaluate my teaching performance based on learners' performance in classworks and homework which consequently determines their progress.	-To ensure that learners understand. -To determine progress. -To select a better method of teaching the topic.

Items	**Teachers' Written Reports**	**Responses**				
		Teacher A	**Teacher B**	**Teacher C**	**Teacher D**	
5	How did learners respond to classroom activities as well as homework or assignments?	The learners responded positively and showed much interest in the classroom activities. But a few of them have little problem	Learners were able to write the class activities as well as homework efficiently with exception of few learners..	Their responses to class activities were excellent. But few of them need some help to overcome their little difficulties.	Many of the learners did very well in their classroom activities as well as homework. Only few of them had some problem.	-Learners' responses were positive, excellent and interesting. But a few of them have some difficulties.
6	What changes would you make next with regards to the difficulties you encountered while teaching, either on your part or on the part of the learners?	Try to use different teaching strategies or approach and methods that will best suit the learners.	I shall try to give learners more work on the topic to enhance their understanding of the topic.	No change but more work can be given to the learners for them to understand more.	To adopt a different teaching approach and provide more activities for them to solve.	- Two of them use different teaching methods. - Two of them use more class activities for learners to solve.

APPENDIX XIX

Table 4.7.3: Participants responses to the questionnaire and written reports on teachers' knowledge of learners' preconceptions and misconceptions in statistics teaching

Items	**Questionnaire**	**Responses**				
		Teacher A	**Teacher B**	**Teacher C**	**Teacher D**	**Coding**
4	What prior knowledge does your lesson require?	Measures central tendency and common bar graphs.	Calculation of mean, mode, median, quartiles and simple additions and subtractions.	Measures of central tendency and how to interpret information from simple straight line graphs.	Preparation of frequency table, class interval and boundaries, mid-points in the case of grouped data representation.	-Measures of central tendency -How to prepare frequency table from a given data. - Simple addition and subtraction. How to interpret line graphs.
5	Do the learners have prior knowledge (preconceptions) of the topic?	Yes. Measure of central tendency.	Yes. They could even link the previous knowledge with the new concepts such as histogram and frequency polygon.	Yes but not all especially about grouped data.	Yes. They have been taught how to construct and interpret line graph and quadratic graphs.	-All four claimed that learners have prior knowledge of the topic they teach. -Depending on the topic. -As indicated in question 4
6	How did you identify the prior knowledge (preconceptions) which the learners came with to the class about statistical graphs?	By asking diagnostic oral questioning.	Through the correction of answers to previous questions (Homework) that were given to learners and pre-activities related to the topic I want to teach.	Asking refresher questions involving oral questioning.	By making them to participate in solving some short question at the beginning of the lessons; but sometimes you may ask oral questions.	- Using diagnostic techniques (oral questioning, pre-test Through analysis of learners' responses to class activities (problem solving and discussion)
Items	**Teachers' written reports**	**Responses**				
		Teacher A	**Teacher B**	**Teacher C**	**Teacher D**	
7	How do you identify the preconceptions and	By continually asking	The preconceptions	Through responses to	Oral questioning at the beginning	- Using diagnostic

	misconceptions of the learners during teaching?	diagnostic oral questions at the beginning of the lesson and during the lesson. Misconceptions were identify through the analysis of learners' classwork and homework on histogram.	can be identified through oral questioning or pre-test at the beginning of the lessons. Misconceptions can be identified by going through their classwork or homework. The misconception can be resolved by learners in more practice exercise.	classwork and homework. Misconceptions were identify through the analysis of learners' classwork and homework on scatter plots and ogive.	of the lessons for preconceptions and looking through their responses to classwork and homework on bar graphs in the case of misconceptions.	techniques e.g. Oral questioning, pre-test, classwork and homework. Misconceptions were identify through the analysis of learners' classwork and homework on statistical graphs.
8	What preconceptions and misconceptions do you identify?	Confusing the concept such as mode, median and mean. The preconceptions identified are mode, median and mean. The misconceptions are inability to draw graphs of grouped data, choosing scale, labelling axes and interpreting the graphs especially for grouped data.	Preconceptions: mode, median and mean. Misconception is drawing a bar graph instead of a histogram.	They are familiar with measures of central tendency but develop some misconceptions such as the construction of bar graph instead of histogram during the lesson.	The drawing of the bar graphs. The misconception is that they tend to draw a histogram instead of bar graph.	- Preconceptions identified were measure of central tendency, construction of simple linear graphs and bar graphs. Misconceptions noticed were construction and interpretation of graphs of grouped data e.g. histogram, ogive and scatter plots
9	How would you address the preconceptions and misconceptions, if any, Identified during the teaching and learning process?	By dealing with clear and practical examples dealing with such concepts until learners understand them.	By providing varieties of examples and activities for learners to solve.	Give learners chance to elaborate on their misconceptions in order to correct the misconceptions.	Re-teach and re-explain using a different approach and give them more activities on same topic.	-Explanations with examples, more class activities and re-teaching of the topic.

APPENDIX XX

Table 4.7.4: Participants responses to the teachers' interview, questionnaire and written reports about teachers' knowledge of learners' learning difficulties

Items	**Interview Question**	**Responses**				
		Teacher A	**Teacher B**	**Teacher C**	**Teacher D**	**Coding**
14	What learning difficulties do you remember experiencing as a pupil and as a university / college student or from teaching experience in statistics?	Have problems with plotting of scatter plots, drawing of line of best fit and forming equation from the scatter plot.	Construction of graphs especially choosing an appropriate scale in drawing histograms, frequency polygons, ogives and scatter plots.	Construction and interpreting of graphs especially ogives and scatter diagrams.	Graphical constructions and interpretation especially ogives, scatter plots and regression lines.	-learners' learning difficulties are inability to construct graph of grouped data e.g. ogive, histogram, scatter plots and frequency polygon.
Items	**Questionnaire**	**Responses**				
		Teacher A	**Teacher B**	**Teacher C**	**Teacher D**	
10	What difficulties did the learner experience during teaching?	No major problem and but when it arises, I will deal with it Such as some basic calculations such as the median and mean and mode of group data	Some learners could not choose an appropriate scale on the graph paper to construct graphs of grouped data.	Not much except graphs construction and interpretation of grouped data.	None except determination of mid points and construction of graphs. But any problem occur I will be able to deal with it	- Inability to construct graph of grouped data, calculate median, mid values and interpretations. Anticipated learning difficulty to be dealt with if they arose
11	How did you address these difficulties?	By giving them more exercises to solve on problem areas.	I have to guide them on how to choose a suitable scale for a particular data hence we ended up using the same scale in constructing some of the graphs for the sake of uniformity.	By giving them more exercises to solve on problem areas.	Provide more examples and possibly repeat the lessons	-The difficulties identify were resolved by given learners more activities to solve, guiding and monitoring of learners on how to construct graphs of grouped data and repeating the lesson.

14	What is it about statistics that makes the learning easy or difficult?	Measure of central tendency is easy because it is more practical to teach. Construction and interpretation of graphs of group data are difficulty to teach.	The learning of statistics was quite easy because the learners had the background in grade 10 especially for measures of central tendency except for the construction and interpretation of graphs of grouped data such as histograms, frequency polygons and cumulative frequency curves (ogives).	Example of everyday life makes the lesson lively and interesting. The everyday life example makes learners to easily understand the lessons. But graph of grouped data, especially scatter diagrams are difficult to learn.	It is an interesting subject such that if one has a deeper understanding of it, he/she will be able to present it in a manner that learners can understand it. However, grouped data graphs are more difficult to construct and interpret.	-learning of measures of central tendency is simple to teach and learn. -When lessons are taught by an experience teachers. -Graphs of grouped data are difficult to construct.
Items	**Teachers' Written Reports**	**Responses**				
		Teacher A	**Teacher B**	**Teacher C**	**Teacher D**	**Coding**
1	What learning difficulties did you identify in learners when teaching a topic?	Basic knowledge and background information linking to the new content. They were identified by going through the learners' responses to classwork and homework	1. Choosing a suitable scale. 2. Neatness of axes and title of the graphs. 3. Labelling of axes and title of the graphs of grouped data. All of them were identified by analysis of their classwork, homework, assignments, project, etc.	Some learners are slow in learning of the topic especially the drawing of graphs of grouped data. I observe this while they are doing their classwork. I also use homework and assignments to discover their mistakes	Learners' inability to interpret statistical graphs such as the histogram, the ogive and scatter plots. These difficulties were discovered by analysing learners' classwork, homework and assignments.	- Learning difficulties identify in learners are poor background in the topic, construction of grouped data (labelling of axis), interpretation of graph of grouped data and choosing suitable scales for constructing graph of grouped data. They were identified by analysis of learners' classwork, homework, assignments, etc.

2	What difficulties do you experience in the teaching of statistical graphs?	The construction of graphs of grouped data.	As described in (1) above.	None except that learners struggle to construct graphs of grouped data.	Non availability of graph board which make it to inaccurately display the graphs during teaching.	-Construction and interpretation of graph of grouped data.
3	What do you find interesting in this topic and why?	The practical application of statistical concepts and knowledge in everyday life.	The topic has some practical examples that can be used in day to day life situations and the topic can be used in solving related problems in other subjects such as research projects.	Frequency graphs such as the bar graphs because of easy and smart presentation.	Displaying graphs of the same data using different graphs. This reinforces the uses of statistics in everyday life.	-The way the topic is relatable to everyday real life, graphical representation of data and how it encourages manipulative skills.
4	What do you think you find less difficult to teach in the topic?	Mode, median and mean of all ungrouped data	The topic is less difficult to teach and learners enjoy it especially mode, median and mean of ungrouped data.	The stem-and-leaf diagram, mode, median, mean and range.	Mode, median and mean of ungrouped data and bar graphs.	-Mode, median and mean of ungrouped data. -Stem-and-leaf.
5	How did learners respond to classroom activities as well as homework or assignments?	The learners responded positively and showed much interest in the classroom.	Learners were able to write the class activities as well as homework.	Their responses to class activities were excellent.	Many of the learners did very well in their classroom activities as well as homework.	-Learners' responses to classroom activities such as classwork; homework and other related class activities were positive.
6	What changes would you make next with regards to the difficulties you encountered while teaching, either on your part or on the part of the learners?	Try to use a different approach and methods that will best suit the learners.	I shall try to give learners more work on the graph to enhance their understanding of the topic.	No change but more work can be given to the learners for them to understand more.	To adopt a different approach and provide more activities for them to solve that may relate to real life.	- Changes expected of the teacher are adopting different teaching approach, providing more activities for learners to solve.

APPENDIX XXI

Table 4.8: A Comparison of the documents used by participants in statistics teaching

TEXTS	CASE STUDY 1	CASE STUDY 2	CASE STUDY 3	CASE STUDY 4	CODING
Learner workbooks	The learner workbooks contain written and marked class work and home-work. For example, there was evidence of learners' inability to construct and interpret graphs of grouped data due to wrong scaling of data axis (Learning difficulties) such as histograms, cumulative frequency curves, and the drawing of lines of best fit in a scatter diagram. Learning difficulties were identified by analysis of learners' classwork and homework. Teacher A seem to teach with procedural knowledge (construction of a histogram) and conceptual (Defining and explaining with examples the meaning of mode, median, mean and histogram) approaches However, there were also some instances where learners performed well e.g. construction, analysis and interpretation of bar graphs, stem-and-leaf, histogram and ogives which they did individually and in groups (flexibility in approaches). Detail	The learner workbooks contain written and marked class work and home- work. For example, there was evidence of learners' inability to construct and interpret graphs of grouped data due to wrong scaling of data axis such as histograms (learning difficulties). They were identified by analysis of learners' classwork and homework. In some cases, learners did well in terms of graphical constructions and interpretations in bar (with horizontal and vertical bar graphs) and double bar graphs, histograms and ogives. There was evidence of intervention to resolve learning difficulties. Teacher B seemed to be flexible in his approaches to the teaching of statistics. Learners' were sometimes given extra lessons.	The learner workbooks contain written and marked class work and home- work. There was similar evidence in case study 3 as in case studies 1 and 2. Detail descriptions of statistics concepts and mathematical connections between them were available in which quartiles were described and used to interpret ogive. Learners' misconceptions (drawing a histogram instead of bar graph) and learning difficulties of not being able to label data axis due to wrong scaling were identified by analysis of learners' classwork and homework on graph of grouped data during marking. Scatter plots construction done procedurally and interpretation examples and learners' class activities relatable to real life was available in the learners' workbook. Teacher C seemed to be flexible in his approaches to the teaching of statistics. Learners' were sometimes	The learner workbooks contain written and marked class work and homework. There was similar evidence in case study 4 as in case studies 1, 2, and 3 but the rate at which learners made progress during the lesson was much better. There were details of definition of statistics concepts with examples relatable to real life. Comparative relationship between a bar graph and a histogram. Learners' misconceptions (drawing a histogram instead of bar graph and vice versa) and learning difficulties of not being able to label data axis due to wrong scaling were identified by analysis of learners' classwork and homework of graph of grouped data. Teacher D seemed to be flexible in his approaches to the teaching of statistics where he uses both procedural and conceptual knowledge to teach statistical	-Learners' workbook contains written and marked classwork but the rate at which learners make progress differ in each case. -Analysis of learners' classwork, homework and assignments were used to identify learners' misconceptions and learning difficulties. -There was evidence of learning difficulties of not being able to label data axis due to wrong scaling, and misconception of drawing a histogram instead of a bar graph and vice versa. Teachers taught with both procedural and conceptual knowledge in their statistics lessons.

TEXTS	CASE STUDY 1	CASE STUDY 2	CASE STUDY 3	CASE STUDY 4	CODING
	descriptions of concepts. etc Learners' were sometimes given extra lessons.		given extra lessons.	graphs. Learners' were sometimes given extra lessons.	
Learner portfolios	The learner portfolios contain written and marked tasks such as assignments, projects and investigations, informal and formal tests and examinations done individually and in groups. These assessment instruments with feedback from the learners contain similar evidence of where the learners perform well and where their misconceptions and learning difficulties lie as shown in the learner workbooks.	The learner portfolios contain written and marked tasks such as assignments, projects and investigations, informal and formal tests and examinations. Constructions and interpretations were observed as two of the areas were learners had difficulties. There was also evidence of teaching intervention.	The learner portfolios contain written and marked tasks such as assignments, projects and investigations, informal and formal tests and examinations. There was also evidence of intervention in learners' learning difficulties in constructing and interpreting graphs of grouped data such as scatter plots, histogram, ogive, etc.	The learner portfolios contain written and marked tasks such as assignments, projects and investigations, informal and formal tests and examinations. Similar evidence of learner difficulties in statistical graphs was observed. Evidences of interventions to address the difficulties were also observed.	-Contains written and marked tasks, tests, examinations -Learners' performances in the various tasks in statistical graph given to them were indicated showing whether they perform well or not and what difficulties they may have encountered - learners had difficulties with the construction and interpretation of graph of grouped data.
Teacher portfolios	The teacher's portfolios contain policy documents such as the National Curriculum Statement (NCS), SBA and other related assessment instruments. Other documents are lesson plans showing method used for teaching, how preconception were identified using oral questioning,, checking and marking of learners' homework, work schedules and records of assessment areas, how learners misconceptions (drawing bar graph instead of histogram) and learning difficulties (construction of graphs (labelling of	Teacher Bs' portfolio contains similar documents to that of teacher A. Intervention strategies similar to the ones used in case study 1 were used to address the misconceptions (e.g. drawing a histogram instead of bar graph) and learning difficulties about labelling the horizontal axis, observed by teacher B in case study 2 by analysing learners classwork, homework, and assignment. Oral probing questioning, pre-activities and checking and marking of learners' homework were used to identify learners' prior knowledge in histogram	Teacher Cs' portfolio contains similar documents as those of teachers A and B. Similar intervention strategies used in case studies 1 and 2 were used to address the misconceptions (drawing bar graph instead of histogram) and learning difficulties in graph constructions of graph of grouped data (eg give and scatter plots) as observed by teacher C in case study 3. Oral probing questioning, pre-activities and checking and marking	There were similar documents and records in teacher Ds' portfolio as seen in teacher A, B and C's portfolios. Oral probing questioning, pre-activities and checking and marking of learners' homework were used to identify learners' prior knowledge. Similar intervention strategies used in case studies 1, 2 and 3 were used to address the misconception ((drawing bar graph instead of histogram) and learning difficulties	-Contains policy documents, tasks, tests, examinations with their memoranda in. -Marks of learners in the tasks and test already completed were available. -Intervention strategies used to identify learning difficulties such as more activities days for afternoon lessons were indicated. Learning difficulties and misconceptions were addressed by re-explanation of the concept, extra tutoring and class

TEXTS	CASE STUDY 1	CASE STUDY 2	CASE STUDY 3	CASE STUDY 4	CODING
	data axis)of grouped data such as histogram, ogive, scatter plots, etc.) were identify by analysing learners classwork, homework during marking, and the intervention strategies such as extra tutoring and class activities were put in place to address them. There were also invitation letters to mathematics workshops.	construction. There were also invitation letters to mathematics workshops.	of learners' homework were used to identify learners' prior knowledge. Learning difficulties and misconceptions were addressed by re-explanation of the concept and as Teacher A and C did. There were also invitation letters to mathematics workshops.	of labelling data axis of grouped data observed by teacher D in case study 4. Learning difficulties and misconceptions were addressed by re-explanation of the concept and as Teacher A, B and C did using extra tutoring and class activities in statistics. There were also invitation letters to mathematics workshops.	activities in statistics. The teachers had invitation letters to several workshops in mathematics teaching.
School based assessment (SBA)	The SBA of teacher A contains topics to be taught, assessment tasks, and memoranda for the tasks and formats for grading and recording learners' performance in the tasks.	The SBA of teacher B contains content to taught assessment tasks, memoranda for the tasks and formats for grading and recording of learners' performance in the tasks.	The SBA of teacher C contains contents to be taught, assessment tasks, memoranda for the tasks and formats for grading and recording of learners' performance in the tasks.	The SBA of teacher D contains topics to be taught assessment tasks, memoranda for the tasks and formats for grading and recording of learners' performance in the tasks.	- contains contents of statistics curriculum, assessment tasks, memoranda for the tasks and formats for grading and recording of learners' performance in the tasks.
Textbooks	Recommended	Recommended	Recommended	Recommended	

APPENDIX XXII

An exercise in statistics for mathematics teachers

INSTRUCTION: This exercise is to get an insight into the basic knowledge that you have about statistics teaching in school mathematics. Choose the option that best represent the correct answer to each of the question and write it against the number of the question. Do not write your name or the name of your school.

Duration: 40mins

Example

Find the mode of the following set of data: 4,3,5,4,5,6,4,6,5,4.?

A 4
B 3
C 5
D 6
E 4 and 3

ANSWER: A (The most occurring number in the set of data)

1 What would be the angle of sector representing the interval 10-20 in a pie chart in the following frequency distribution table?

Interval	0-10	10-20	20-30	30-40	40-50
Frequency	10	30	20	8	7

A. 48^0
B. 72^0
C. 96^0
D. 120^0
E. 144^0

Use the frequency distribution table below to answer question

Interval	0-4	5-9	10-14	15-19	20-24
Frequency	3	5	7	4	1

2 Estimate the mode of the distribution.

A. 11.3

B. 11.5

C. 11.6

D. 12.0

E. 12.1

3 Calculate the mean of the distribution.

A 10.08

B 10.75

C 10.93

D 10.93

E. 11.79

4 The mean height of three groups of students consisting of 20, 16 and 14 students is 1.67m, 1.50m and 1.40m respectively. Find the mean height of all the students

A. 1,52m

B. 1.53m

C. 1.54m

D. 1.55m

E. 1.56m

5 The table below gives the frequency distribution of marks obtained by a group of students in a test

Marks	3	4	5	6	7	8
Frequency	5	x-1	x	9	4	1

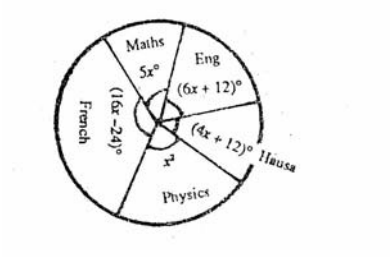
If the mean mark is 5, calculate the value of x.

A. 12
B. 13
C. 11
D. 9
E. 5

6 What is the median mark in question 4

A. 5
B. 4
C. 10
D. 5.5
E. 4.5

In a class, there are 80 students. The statistical distribution of the number of students offering Physics, English, Mathematics, Hausa, and French is shown in a pie chart below.



Use this diagram to answer question 6.

7 How many students offer Mathematics?

A. 12
B. 13
C. 36
D. 10
E. 25

8 Calculate the percentage of student that offer English in the class.

A. 18.7%
B. 18.5%
C. 18.4%
D. 18.2%
E. 18.3%

The number of learners that were absent from a school in a class in a week were 2, 5, 6, 3 and 4. Use this information to answer question 9 and 10.

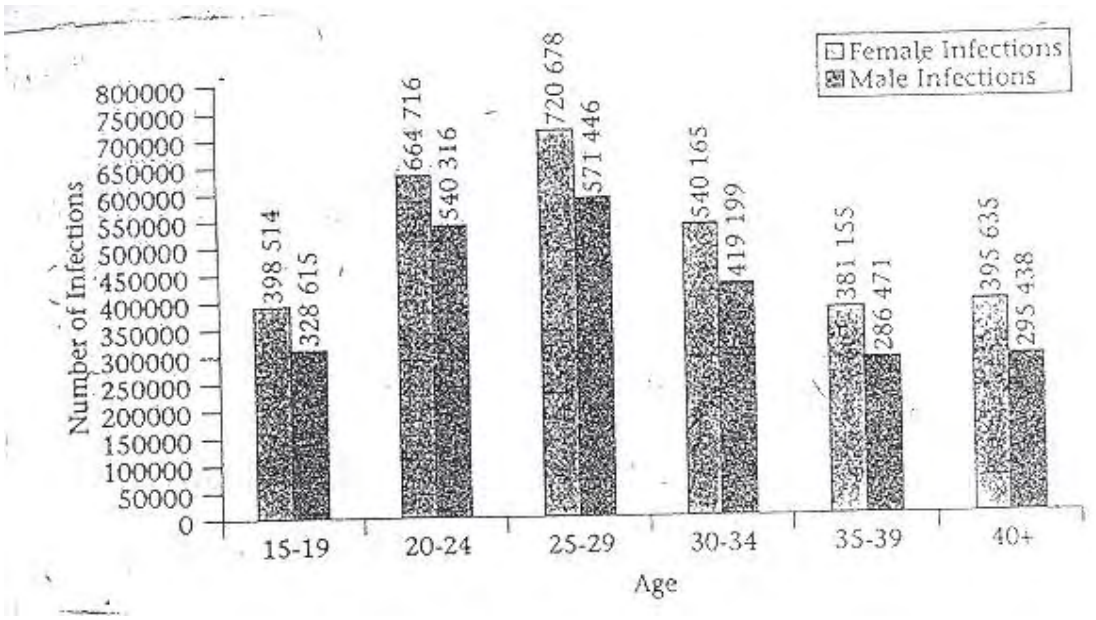
9 What is the variance of the data?

A. 3.0
B. 2.5
C. 5.0
D. 4.0
E. 2.0

10 Calculate the standard deviation of the distribution.

A. 2.4
B. 1.4
C. 3.4
D. 4.4
E. 5.0

The diagram below shows the number of HIV+ males and Females per age group in South Africa in 2003. Use this information to answer questions 7 and 8.



11 How many South Africans were HIV+ in 2003?

A. 5542348

B. 5543248

C. 5554238

D. 5542384

E. 5524348

12 What percentage of male and HIV+ South Africans are in all the groups in 2003.

A. 44.50%

B. 4 4.19%

C. 44, 05%

D. 42.40%

E. 4.40%

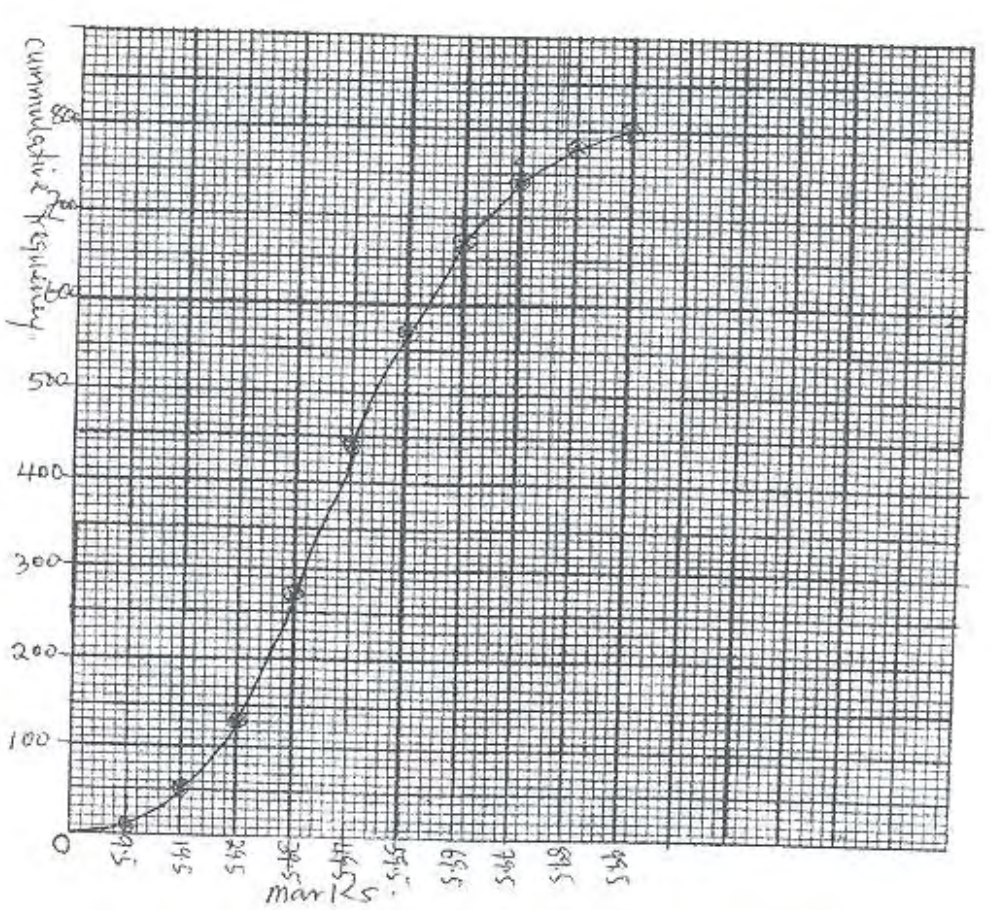
13 If the population of South Africa is 46560400, how many South Africans are not HIV+?

A. 41018052
B. 441018052
C. 41036052
D. 14018052
E. 5542348

14 Which age group is most infected with HIV/AIDS in 2003?

A. (20-24) years
B. 40+ years
C. (30-34) years
D. (25-29) years
E. (15-19) years

The frequency distribution of marks of 800 students in an examination is display in a cumulative frequency curve as shown below. Use the diagram to answer questions9 -11.



15 Use your ogive to determine the 50th percentile.

A. 47.5

B. 43.5

C. 37.5

D. 57.5

E. 67.5

The candidates who score less than 25% are to be withdrawn from the institution, while those that score more than 75% are to be awarded scholarship. Estimate:

16 The number of candidates that will be withdrawn from the institution.

A. 100

B. 80

C. 180

D. 200

E. 70

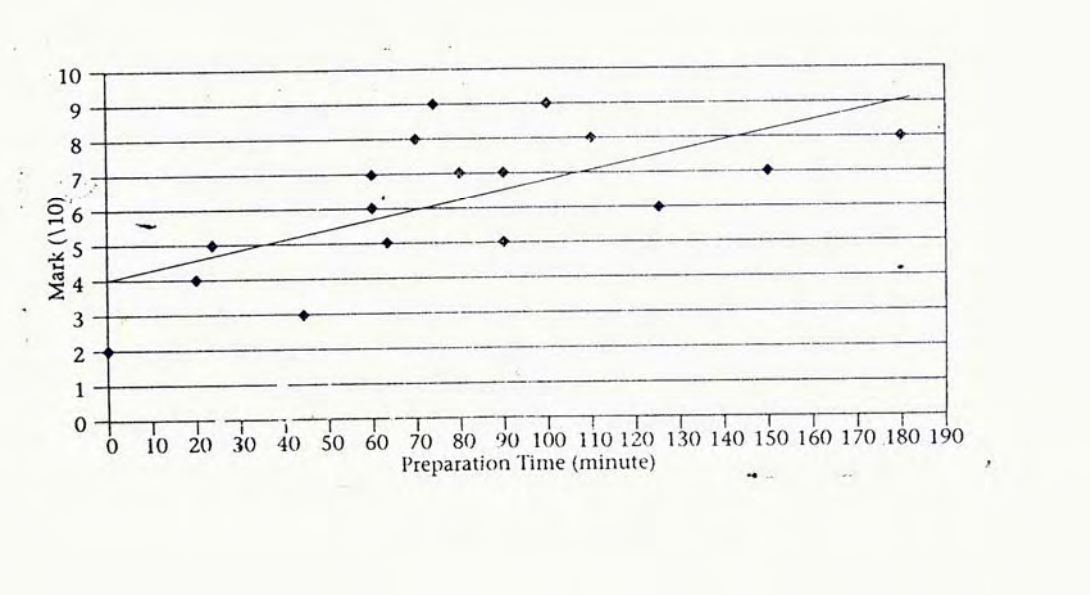
17 How many candidates will be retained in the institution but will not enjoy the scholarship award?

A. 640
B. 560
C. 300
D. 440
E. 540

18 How many candidates will be retained in the institution but will not enjoy the scholarship award?

A. 640
B. 560
C. 300
D. 440
E. 540

The graph below display the amount of time that a group of students spent in preparation for a test and the marks that they scored in the test. The line of best fit has been included on the scatter plot. Use this diagram to answer questions 12.



19 The graph shows a ---------- correlation between the amount of time the students spent in preparing the examinations and the marks scored.

A. Strong

B. No

C. Weak

D. Strong and weak

E. None of the above

20 Determine the equation of the line of best fit for the scatter plot.

A ` Y = 0.22x + 40

B Y = 0.50x + 40

C Y = 0.70x + 40

D Y = 22x + 40

E Y = 2.2x + 40

Total marks: 100

APPENDIX XXIII

Memo for final conceptual knowledge exercise, march 2010

QUESTION	ANSWER
1	E
2	C
3	B
4	C
5	C
6	A
7	D
8	E
9	E
10	B
11	A
12	B
13	A
14	D
15	A
16	B
17	C
18	A
19	A
20	A

APPENDIX XXIV

Examining the content knowledge of mathematics teachers in statistics teaching

Duration: 30mins

The following are the topics to be taught in statistics under data handling in the new National Curriculum Statements for grades 10-12: stem-and-leaf; mode, median and mean of ungroup data; frequency table of group data; range, percentiles, quartiles; inter-quartiles and semi-quartile range; bar and compound bar graphs; histogram; frequency polygons; pie charts; line and broken line graphs; box and whisker plot; variance, mean deviation; standard deviation; Ogives; five number summary; scatter plots; line of best fit.

a) Arrange the topics in each grade on how you think they should be taught in grades 10, 11 and 12.
b) With an arrow, show how you can teach these topics sequentially in each grade. For example, you observe morning before afternoon and before evening. Therefore; Morning ⟶ afternoon ⟶ evening

A)

GRADE 10	GRADE 11	GRADE 12

GRADE 10	GRADE 11	GRADE 12

APPENDIX XXV

Examining the content knowledge of mathematics teachers in statistics teaching

Duration: 30mins

The following are the topics to be taught in statistics under data handling in the new National Curriculum Statements for grades 10-12: stem and leave; mode, median and mean of group data; frequency table of group data; range, percentiles, quartiles; inter-quartiles and semi-quartile range; bar and compound bar graphs; histogram; frequency polygons; pie charts; line and broken line graphs; box and whisker plot; variance, mean deviation; standard deviation; Ogives; five number summary; scatter plots; line of best fit.

c) Arrange the topics in each grade on how you think they should be taught in grades 10, 11 and 12.

d) With an arrow, show how you can teach these topics sequentially in each grade. For example, you observe morning before afternoon and before evening. Therefore; Morning ⟶ afternoon ⟶ evening

SOLUTION

A)

GRADE 10	GRADE 11	GRADE 12
Mode, Median, Mean, Ranges, (ungrouped data), Frequency table, Bar and Compound bar graphs, Histogram, Frequency polygons, Pie charts, Line and broken line graphs. Mode, median and mean (grouped data), Quartiles, Inter-quartiles and semi-inter-quartile range	Five number summary, Box and whisker diagrams, Ogives, Variance and Standard deviation, Scatter diagrams, Lines of best fit	N/A

	GRADE 10
	Mode → Median → Mean → Ranges (Ungrouped data) Frequency table → Bar and Compound bar graphs → Histogram → Frequency Polygon → Pie Charts Line and broken line graphs. Mode → Median → Mean (Grouped data) Quartiles → Inter-quartile and semi-inter-quartile ranges
	GRADE 11
	Five number summary → Box and whisker diagrams → Box and whisker diagrams → Ogives → Variance and Standard deviation → Scatter diagrams → Scatter diagrams → Lines of best fit

1	**A(1)**	**Grade 10 topics (25%)**	**Marks deducted**	**Marks obtained**
	a	Missing one topic in the arrangement.	2	23
	b	Missing two topics in the arrangement.	4	21
	c	Missing three topics in the arrangement.	6	19
	d	Missing four topics in the arrangement.	8	17
	e	Missing five topics or more in the arrangement.	10	15
	A2	**Grade 11 topics (25%)**	**Marks deducted**	**Marks obtained**
	a	Missing one topic in the arrangement.	2	23
	b	Missing two topics in the arrangement.	4	21
	c	Missing three topics in the arrangement.	6	19
	d	Missing four topics in the arrangement.	8	17
	e	Missing five or more topics in the arrangement.	10	15

2	**B1**	**Grade 10 with links (25%)**	**Marks Deducted**	**Marks obtain**
	a	Missing one topic in the arrangement.	2	23
	b	Missing two topics in the arrangement.	4	21
	c	Missing three topics in the arrangement.	6	19
	d	Missing four topics in the arrangement.	8	17
	e	Missing five or more topics in the arrangement.	10	15
	B2	**Grade 11 with links (25%)**	**Marks Deducted**	**Marks obtain**
	a	Missing one topic in the arrangement.	2	23
	b	Missing two topics in the arrangement.	4	21
	c	Missing three topics in the arrangement.	6	19
	d	Missing four topics in the arrangement.	8	17
	e	Missing five or more topics in the arrangement.	10	15
	B3	Grade 12 (N/A)	**Marks Deducted**	**Marks obtain**
		N/A	Deduct 10 marks from total marks if any topic is written in grade 1 2. But if the same topic in grade 11 is written in grade 12, no mark should be deducted. It should be regarded as a revision in grade 12.	Balance after deduction

APPENDIX XXVI

The interview schedule for mathematics teachers.

This interview probes the content knowledge in statistics and educational background that may have enabled the teachers to develop their topic-specific PCK in statistics.

Time : 30 minutes

1) Which university / college did you attend?

_____

_____

_____

2) What qualifications did you obtain?

_____

_____

_____

3) What course/subject/module did you study at the university/ college?

_____

_____

_____

4) How long did you study this course/subject?

_____

_____

_____

5a) If one of the courses in (3) is mathematics methodology, how did it help you to prepare lessons for teaching?

5b) How do you know that your teaching is effective?

6) Do you have an interest in the teaching of mathematics? If yes/no, why?

7) What is your understanding of the nature of the statistics you are teaching?

8) Do learners understand the topic?

9) Do learners enjoy the topic? If yes/no, why?

10) In your own opinion and based on your experience in the teaching of statistics, how do you see the topic (statistics) in mathematics?

11) Do your learners understand your lessons based on the instructional approach for teaching as recommended in the curriculum?

12) If the learners have any problems in understanding the topic based on the instructional approach, what do you do to help them to understand?

13) What other instructional strategies do you use for teaching and why?

14) What learning difficulties do you remember experiencing as a pupil and as a university student or from teaching experience in statistics?

15) Have you ever been to a mathematics workshop or teachers' development programme?

16) If your answer in (15) is yes, what was the content of the workshop?

17) What was the duration of the workshop?

18) Were the workshop facilitators mathematics teachers or mathematics expert?

19) As a mathematics teacher, what did you benefit from the workshop?

20) Would you recommend that similar workshops be held for teachers in subsequent time?

APPENDIX XXVII

Report on the teaching of statistics.

This schedule is to guide the mathematics teachers in written report during the four weeks of teaching statistical graphs in grade 11. Any other relevant information may be added by the teacher during the course of teaching.

Duration: 4 weeks

1) What learning difficulties do you identify in learners when teaching a topic?

2) What difficulties do you experience in the teaching of statistical graphs?

3) What do you find interesting in this topic and why?

4) What do you think you find less difficult to teach in the topic?

5) How did the learners respond to classroom activities as well as homework or assignments?

6) What changes would you make next time with regard to the difficulties you encountered while teaching, either on your part or on the part of the learners?

7) How do you identify the preconception and misconceptions of the learners during teaching?

8) What preconceptions or misconceptions do you identify?

9) How would you address the preconceptions and misconceptions, if any, identified during the teaching and learning process?

APPENDIX XXVIII

The questionnaire for mathematics teachers.

This questionnaire aimed at investigating what the teacher did while teaching statistical graphs in grade 11.

Duration: 15 mins

1. How long was the lesson?

_____

_____

_____

2. What was the topic of your lesson?

_____

_____

_____

3. What were the objectives of your lesson?

_____

_____

_____

4. What prior knowledge does your lesson require?

_____

_____

_____

5. Did the learners have the prior knowledge (preconceptions) of the topic?

6. How did you identify the prior knowledge (preconceptions) which the learners bring to the class about statistical graphs?

7. Did you think the learners achieved the objective of the lesson?

8. How did the learners respond to class activities, homework and assignments?

9. Were you able to follow the lesson as planned to the end of the lesson?

10 What difficulties did the learners experience?

11 How did you address these difficulties?

12 How would you improve the lesson?

13 Do you normally evaluate your teaching?

14 What is it about statistics that makes the learning easy or difficult?

15 How do you evaluate your teaching performance?

16 For what reasons do you evaluate your teaching?

17 Were the students able to use the knowledge acquired to solve other problems?

APPENDIX XXIX

Instrument validation form for the conceptual knowledge exercise

Pedagogical content knowledge which is topic specific is conceptualised to include content specific knowledge, content specific instructional strategies, conceptions and learners' learning difficulties. The study participants (competent mathematics teachers) have developed PCK and used it to assist learners to perform well in mathematics as evidence at the senior certificate examination result for some period of years. This instrument is meant to measure the content of a chosen topic (statistics) according to the National Curriculum Statements (NCS) in mathematics, which the competent mathematics teachers have and demonstrate in statistics teaching.

I therefore solicit few moment of your time to help me to validate the instrument using **SURENESS** and **RELEVANCE**. By indicating **sureness,** one has no doubt that the instrument measures the content of the chosen topic. By indicating relevance, one has no doubt that the instrument is valuable and useful in measuring the content knowledge of the chosen topic.

The rating levels for SURENESS are: 1 = not very sure; 2 = fairly sure; and 3 = very sure.

The rating levels for RELEVANCE are: 1 = low/not relevant; 2 = fairly relevant; and 3 = highly relevant.

QUESTION NUMBER	SURENESS	RELEVANCE	DO NOT WRITE ON THIS COLUMN
1			
2			
3			
4			
5			

6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Comments:

_____

_____

_____

_____

_____

_____ _____

Signature of Reviewer and qualification Date

APPENDIX XXX

Ethical clearance certificate

UNIVERSITY OF PRETORIA

FACULTY OF EDUCATION

RESEARCH ETHICS COMMITTEE

CLEARANCE CERTIFICATE	**CLEARANCE NUMBER :** SM 09/08/02
DEGREE AND PROJECT	PhD How competent mathematics teachers devleop pedagogical content knowledge in statistics teaching
INVESTIGATOR(S)	Sunday Bomboi Ijeh
DEPARTMENT	Department of Science, Mathematics and Technology Education
DATE CONSIDERED	1 December 2011
DECISION OF THE COMMITTEE	APPROVED

Please note:

For Masters applications, ethical clearance is valid for 2 years

For PhD applications, ethical clearnace is valid for 3 years.

CHAIRPERSON OF ETHICS COMMITTEE Prof L Ebersohn

DATE 1 December 2011

CC Jeannie Beukes
Prof G.O.M Onwu

This ethical clearance certificate is issued subject to the following conditions:

1. A signed personal declaration of responsibility
2. If the research question changes significantly so as to alter the nature of the study, a new application for ethical clearance must be submitted
3. It remains the students' responsibility to ensure that all the necessary forms for informed consent are kept for future queries.

Please quote the clearance number in all enquiries.

APPENDIX XXXI

A sample of teachers' response to concept mapping exercise

THE MATHEMATICS TEACHERS' KNOWLEDGE-BASE IN STATISTICS TEACHING

DURATION: 30mins

The following are the topics to be taught in statistics under data handling in the new National Curriculum Statements for grades 10-12: stem and leave; mode, median and mean of group data; frequency table of group data; range, percentiles, quartiles; inter-quartiles and semi-quartile range; bar and compound bar graphs; histogram; frequency polygons; pie charts; line and broken line graphs; box and whisker plot; variance, mean deviation; standard deviation; Ogives; five number summary; scatter plots; line of best fit.

a) Arrange the topics in each grades on how you think they should be taught in grades 10, 11 and 12.
b) With an arrow, show how you can teach these topics sequentially in each grade. For example, you observe morning before afternoon and before evening. Therefore; Morning afternoon ⟶ evening ⟶

A)

GRADE 10	GRADE 11	GRADE 12
MODE, MEDIAN, MEAN RANGES OF UNGROUPED DATA. FREQUENCY TABLE, SINGLE AND COMPOUND BAR GRAPHS, HISTOGRAM FREQUENCY POLYGON PIE CHART, LINES AND BROKEN LINE GRAPHS MODE, MEDIAN, & MEAN OF GROUPED DATA QUARTILES	INTER QUARTILE RANGES, SEMI - INTERQUARTILE RANGE, FIVE NUMBER SUMMARY BOX & WHISKER DIAGRAMS, OGIVES VARIANCE AND STANDARD DEVIATION SCATTER DIAGRAMS LINES OF BEST FIT.	REVISSION OF GRADE 10 & 11 WORKS.

Omission of two topics (21) (25) =46

GRADE 10	GRADE 11	GRADE 12
MODE → MEDIAN → MEAN → RANGE (UNGROUPED DATA) FREQ. TABLE → SINGLE & COMPOUND BAR GRAPHS → HISTOGRAM → FREQ POLYGON → PIE CHART → LINE AND BROKEN LINE GRAPHS → MODE → MEDIAN → MEAN (GROUPED DATA → QUARTILES.	INTER QUARTILE → SEMI-INTERQUARTILE RANGES → FIVE NUMBER SUMMARY → BOX & WHISKER DIAGRAM → OGIVES → VARIANCE AND STANDARD DEVIATION → SCATTER DIAGRAMS → LINES OF BEST FIT.	REVISSION

(21) (25) 46

Omissions of Two topics

92

APPENDIX XXXII

LESSON OBSERVATION SHEET

DATE: .....

DURATION OF THE LESSON: .....

The practical investigation lesson will be observed against the following attributes:

1) PLANNING
   - 1.1 Lesson topic
   - 1.2 Learning outcomes
   - 1.3 Assessment Standards
   - 1.4 Resources used

2) PEDAGOGICAL ISSUES
   - 2.1 Introduction of the lesson
   - 2.2 General class handling
   - 2.2.1 Class organization
   - 2.2.2 Discipline
   - 2.2.3 Interactions
   - 2.2.4 Movement
   - 2.2.5 Learning climate
   - 2.2.6 The involvement of the lesson

2,3 Lesson Development (Progression)

2.4 Consolidation of the lesson

2.5 Description of teaching and learning
   - 2.5.1 Language
   - 2.5.2 Questioning techniques
   - 2.5.3 Assessments
   - 2.5.4 The use of resources
   - 2.5.5 Knowledge of the teacher

a) How did the teacher identify learners' preconceptions, if any, in a topic as indicated in the lesson plan? Did he or she demonstrate knowledge of learners' anticipated learning difficulties in the topic during the lesson and in the lesson plan?

b) Did the teacher demonstrate his or her subject matter content knowledge of the topic he or she was teaching?

c) What instructional skills and strategies did he or she use in teaching the topic (statistics)?

2.5.6 Errors and misconceptions

d) How did he or she identify the learners' misconceptions and learning difficulties in the topic he or she was teaching?

e) How did he or she address the identified misconceptions and learning difficulties?

3) LEARNER RELATED ACTIVITIES

4) TEACHER RELATED ACTIVITIES

5) EVALUATION / CONCLUSIONS