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SECONDARY SCHOOL TEACHERS' AND PUPILS' VIEWS ON THE USE OF MATHEMATICS TEXTBOOKS WITH ANSWERS ONE DISTRICT OF ZIMBABWE

Maregedze Lawrence, Mazowe High School, Chinamasa Emmanuel, Chinhoyi University of Technology, Newton Hlenga, Gaza High School

Abstract

This study sought secondary school teachers' and pupils' views on the use of mathematics textbooks with answers. It was motivated by the observation that the majority of secondary school pupils in Mazowe district are not using mathematics textbooks with answers although they need instant feedback. Data were collected from a cluster sample of 40 mathematics teachers and 120 secondary school pupils. These responded to a self-reporting questionnaire and interviews. The study found that the majority (75%) of pupils wished to use textbooks with answers but their teachers (48%) were against it. Teachers argued that mathematics teaching is much more than looking for an answer to a problem hence no need for stretching the limited funds to buy mathematics textbooks with answers. Form 4 pupils tended to use answer books more than forms 1, 2 and 3. Some of participants reported that the average performer in mathematics could benefit more by using a mathematics textbook with answers. Teachers prefer to use answer books with the high performing pupils. Those participants in support of textbooks with answers expect pupils to use them to check for accuracy while those against them complain of pupils being motivated to cheat on answers and laziness. Study recommends the increased use of mathematics textbooks with answers by teachers and pupils. Teachers can use textbooks with answers as guides for selecting examples and grading assignments, while pupils can benefit by solving one problem in more than one method to get the same answer and evaluating it. Further research can be done to establish why form three pupils are not keen to use mathematics textbooks with answers.

Key words: mathematics teaching, answer books, O-level pupils

Introduction

The mathematics sections of bookshelves in bookshops show mathematics textbooks with and without answers. Model answer books and Red-spot books for physics and chemistry are also displayed. This phenomenon is a response by the commercial world to pupils' and teachers' need for textbooks with answers. Unfortunately some school classrooms have more mathematics textbooks without answers than those with answers.

In fact, the number of students not writing mathematics at 'O'-level in Zimbabwe is increasing even though most of higher learning courses make mathematics an entry requirement (Nziramasanga' commission 1999). One of the main factors contributing to pupils' dropping mathematics before writing examinations is the mathematics teacher and how the teaching is done. Of particular interest is the debate on the use of mathematics textbooks with answers which motivated the researchers to establish teachers' and pupils' views on using mathematics textbooks with answers in Mazowe district.

Although the Ministry of Education policy includes mathematics as a compulsory subject up to 'O' level many pupils prefer not to be examined in it. There is need for providing effective teaching through student feedback, learning experience and adequate resources like textbooks with answers to motivate students. Unfortunately Munetsi (1996:113) reports that "most schools have few resources of mathematics hence the textbook is often perceived as their only resource material." The acute shortage of resources is more pronounced for mathematics textbooks with answers. Their absence limits the need for students to actively participate in their own learning process so that observation and reflection of learnt material can be conceptualized. According to Miller (2003) using a mathematics textbook where solutions can be easily found motivates the student. The motivation can only be realized when the teacher and pupils know how to use textbooks with answers.

Chinhanu (1997) suggests that teaching is the creation of situations where mathematics concepts and structure can be discovered by the learner. This is a child centered approach in which the teacher's role is to enable students to discover the structure of their learning and verify solutions. Provision of solutions by the teacher or textbook with answers can improve students' study habits in mathematics. In addition students can be responsible for managing their own learning. According to Gay (1979) feedback for the teacher through students' getting or failing to get the suggested answer in

their textbook is necessary for decisions about objectives, strategies and activities that work or those that require improvement.

Statement of the Problem

This study was motivated by the observation that some schools are not purchasing mathematics textbooks with answers for their pupils. Some mathematics teachers withdraw pupils' personal mathematics textbooks with answers from their pupils. In other schools teachers have gone to the extent of cutting out pages with answers from mathematics textbooks bought by the schools. Denying pupils answers contradicts practices in countries such as America where websites such as <http://www.hotmath.com> and Cramster.com/math-solutions, provide step-by-step solutions to mathematics homework problems from pupils' textbooks on line. Removal of answers from textbooks also violates the need to provide student feedback against which they can evaluate their solutions. Indirectly such teachers are teaching their pupils to tear out pages from textbooks.

Research questions

The debate on the use of mathematics textbooks with answers motivated these questions:

1. *What are teachers' and pupils' views on the use of mathematics textbooks with answers?*
2. *What are the advantages of using textbooks with answers?*
3. *How can mathematics textbooks with answers be better used for teaching and learning?*

Answers to these questions can contribute to the understanding of the use of mathematics textbooks in schools. It provides a basis for school policies on mathematics textbook use. The study is encouraged by Mtetwa (2000:95) who said "teaching mathematics well in Zimbabwe, requires significant adjustment in some technical, methodological and cultural aspects of current instructional repertoires." In this case, it contributes to teachers' methods for using mathematics textbooks with answers.

Literature Review

People find it difficult to separate the need for an answer and mathematics when mathematics is a unique subject in that problems have solutions with exact answers (Boley, 1999). In fact the answer that one gets is either wrong or correct calling for students to have a guiding answer from the textbook they are using. The need for working is supported by Hammersley in Graham, Knuth and Patashnik (2004: v) who suggested that in mathematics, "we look for deeds not words."

Perspectives on Mathematics Teaching and Motivation

Pupil motivation to do mathematics can be from the subject itself, the pupil's desire for a pass in mathematics or pupil's ability to solve mathematical problems. According to Kyriacou (2001:60) "motivation towards learning is undoubtedly one of the key aspects of pupil learning and is also a source of important differences between pupils." This is critical in mathematics which is considered by many as a difficult subject.

Fitts and Posner (1973) uphold the role of feedback when they pointed out that human motivation is based on achievement that is marked by getting the answer suggested in the textbook's answers. Hamackek (1985) suggested that reinforcement from teachers, success in mastery of worthwhile concepts and instant feedback are crucial elements motivating students to carry on with their learning of mathematics. Fernald (2005:257) concurs with Hamackek (ibid) by asserting that "motivation is the most important aspect of successful memory." These sentiments imply that instant feedback in the form of answers in the answer books should be provided for motivational purposes.

Marlowe and Canestari (2006:9) observed that once students get confirmation of success by getting correct answers with minimal amount of error, difficulty or confusion, they are ready to develop fluency along with increased accuracy by practicing without supervisor and guidance of the teacher. This observation shifts the centre of learning from the teacher to the student. Minnesota (2001) advised teachers to provide or encourage extension activities once mastery, as rejected by correct answers, is demonstrated.

A teacher needs to be tactful when using answers as pupil motivators in mathematics. According to Hamachek (1985), low performers tend to be highly motivated by success experience rather than failure. They can be assigned graded exercises whose answers they can get from drill and following provided procedures. High achieving students on the other hand are motivated by a mixture of failure and success (Hamachek, 1985:210). They require assignments composed of questions with different difficulty levels. They can be challenged to provide alternative solutions towards the answer in the answer book. Low performers require more teacher guidance when they fail to get the answers. Teachers can provide leading hints, with assistance being provided before pupils give up trying to avoid experiencing more failure.

Advantages of Mathematics Textbooks with Answers

In literature the debate on the use of mathematics textbooks with answers raises advantages and disadvantages. Goodaire and Parmenter (2004) justified the need for answers in mathematics by pointing out that mathematics is a subject based on logical reasoning in which specific rules and sequences are followed. This suggests the need for answers which show procedures. One of the requirements of ZIMSEC mathematics syllabus 4008 / 4028 is for students to be taught to check and criticise their own work and that of other students. This is possible when teachers and pupils have answer keys to use.

Stroud (1995: xiii) suggests the following benefits of using mathematics textbooks with answers: “pupils can work at their own pace, pupil involvement is intensified, there is immediate assessment of responses and pupils have a greater responsibility for their progress.” Mathematics textbooks with answers also help in reducing the problem of lack of teaching material suitable for study and revision as cited by Macfarlane (1990).

Chinamasa (2008:226) regards a marking scheme as an answer that has both method(s) and final answer. He suggested that pupils should be given the marking scheme for three benefits: (1) to improve the teacher's preparedness and enhance his/her expert power.

(2) to encourage a logical representation of solutions with clear connected and organised sequence and (3) to share an objective criteria for marking their work.

Latif (1990) noted that there were three main advantages for providing model answers

1. Model answers focus the student on salient topic concepts to be applied in a particular solution
2. They show the depth required for each topic and topic concept linkages
3. Compel students to search for the correct solution
4. Discussion of model answer in small groups improves cooperative learning

Disadvantages of Mathematics Textbooks with Answers

Literature discourages the use of mathematics textbooks with answers from different angles. Graham et al (2004) from a moral point noted that a cheating student may pass mathematics exercises by just copying the answers. Removing answers reduces the temptation to cheat. Goodaire et al (2004: xi) supports this idea by affirming that, “it is easy to cheat by just turning over the page and looking at the answer ...”

Macfarlone (1990:37), focusing on the human factor, identified a teaching force with inadequate skill to cope with the problem facing it as the main factor contributing to pupils under performance in mathematics. The human factor may include teachers with inadequate skills to use mathematics textbooks with answers, for example marking skills in which marks are given for procedures as well as answers (Mukombo, 1994). Unfortunately not much is said on how textbooks with answers can be used by both teachers and pupils during mathematics learning.

METHODOLOGY

Research design

The study used a descriptive survey research design to identify teachers' and pupils' views on the use of mathematics textbooks with answers, their distribution and factors contributing to them. Chikoko and Mhloyi (1995:62) support this by defining a descriptive survey as "a method of research which describes what we see." In addition Cohen and Manion (1989) justifies the use of descriptive surveys from the application view when they suggested that, surveys gather data at a particular point in time with the intention of describing the nature of existing variables. In this research a descriptive survey was considered ideal since the study aimed to identify and describe the distribution of teachers' and pupils' views on the use of mathematics textbooks with answers in Mazowe district.

Population

This study's target group consisted of secondary school mathematics teachers and secondary school pupils in Mazowe district. The district has sixty-five mathematics teachers and about eleven thousand secondary school students. Teachers have knowledge about the use of mathematics textbooks with and without answers which they are using and have discovered their benefits and shortfalls. A child centered teaching regards students as important contributors to their learning hence an important stakeholder for this study. These stakeholders are clustered around schools in Mazowe district.

Sampling

The sample consisted of forty mathematics teachers, hundred and twenty students from seven secondary schools. Since the total number of schools is known, researchers applied simple random sampling to select four day rural schools, one rural boarding school and two from growth points. Random numbers generated by a computer were matched to a school's last four digits

Instruments

Two questionnaires were used, one for the mathematics teachers and the other one for students. The questionnaire was considered as ideal since all the respondents are literate, able to understand the questions and express their views in writing. The study required individual views collected within a short time. The questionnaires collected respondent demographic data, views on the use mathematics textbooks with answers and their availability in their respective schools. Teachers were also asked to suggest ways in which mathematics textbooks with answers can be used to improve mathematics instruction. Another instrument used is an open ended interview guide.

Data collection and Analysis

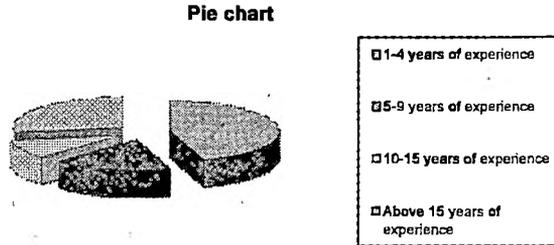
Researchers sought permission from the Ministry of Education and school heads to gather data for the study from their schools. A pilot study was done in two secondary schools not participating in this study. Assistance from colleagues who taught at sampled school was also sought for hand delivery of questionnaires to the respondents in those schools. Researchers also carried out interviews with pupils in each of the forms to confirm what was reported on questionnaires. Interviews were also carried out with teachers to extract advantages and disadvantages of using textbooks with answers.

Completed questionnaires were screened for completeness and answering of key questions first. Frequency tables were generated from different views raised and presented on bar graphs, line graphs and pie chart to show the distribution of respondents on each variable. Qualitative answers were presented verbatim to maintain originality.

Findings and Discussion

Findings presented in this study are based on responses from forty mathematics teachers and one hundred and twenty students from seven secondary schools.

Fig 1, Pie Chart representing teachers mathematics teaching experiences



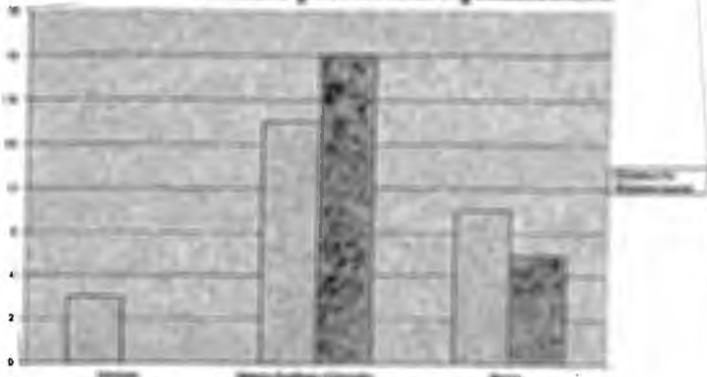
The pie chart shows that the majority of teachers (45%) in the sample have limited experience. They have taught mathematics for (1-4) years. Study findings can be dominated by views from inexperienced teachers who are the majority. Those with experience, above five years (55%) provide a pool from which greater experience of the strengths and limitations of using mathematics textbooks with answers can be derived.

Table2, Teachers' views and Teacher professional qualification N=40

Professional qualification	For	Against
Untrained	3	0
Diploma /Certificate of Education	11	14
Degree	7	5
Total	21	19

The table shows that the majority 21(52,5%) of teachers in the sample are for the use of mathematics textbooks with answers. Since the majority 37(93%) of the teachers are trained, there was not reason to doubt their assessment of the merits and demerits of mathematics textbooks with answers.

2, Teachers' views and Teacher professional qualification

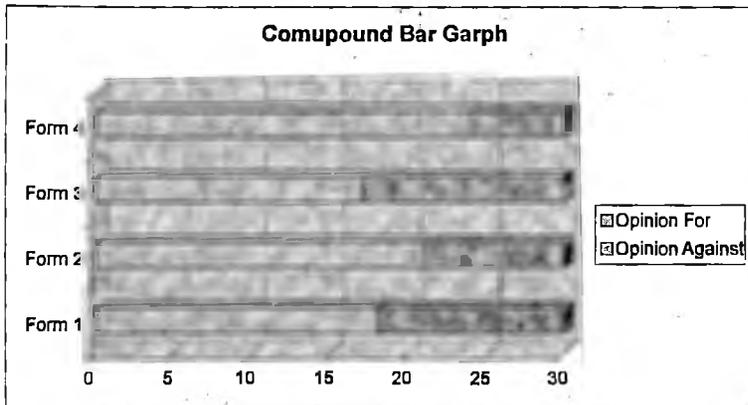


The graph shows that the majority of teachers against the use of mathematics textbooks with answers are Diploma or Certificate of Education holders. There is a higher preference to use mathematics textbooks with answers by degreed and untrained teachers. Interviews revealed that untrained teachers needed textbooks with answers for their own personal development. Findings seem to suggest that teacher qualification is a factor influencing teacher's decision to use textbooks with answers.

Students' Class	For	Against
Form 1	18	12
Form 2	21	9
Form 3	17	13
Form 4	24	6
Total	90(75%)	30(25%)

The table shows that the majority of students want to use mathematics textbooks with answers.

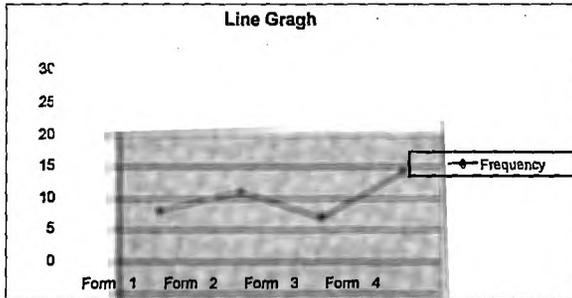
Fig 3, Students' views by form Compound bar graph



The trends of students wanting to use mathematics textbooks with answers increased from form one to form two but declined in form three while there is a sudden increase in form four. The decline in form three pupils' low preference for textbook with answers can be accounted for by the consideration that pupils at this stage construe use of answers as a confirmation of their inability and need for assistance from answers. The increase of pupils' preference for textbooks with answers at form four be attributed to students wanting to use the answer books when preparing for their examinations

Table 4, Trend for students preference of textbooks with answers

Students' Class	Frequency
Form 1	18
Form 2	21
Form 3	17
Form 4	24

Figure 4, Trend for students' preference of textbooks with answers

The above trend shows that there is an increase in the need for mathematics textbooks with answers from form one to two. The trend drops at form three and then peak at form four. This might be due to increase in the need to study and revise and pass. It is at form three where the decision to drop mathematics is nurtured hence availability of answers is considered a direct threat to ability. Form four pupils who would have decided to write mathematics require textbooks with answers for examinations by engaging into more study and revision work.

Table 5, Present use of mathematics textbooks with answers.

Stakeholders	Using answer books	Not Using answer books
Teachers	89 %	11 %
Students	22 %	78 %

Table 6, Stakeholders' views on pupils who can benefit from use of answer books

Pupil ability group	Number of Teachers	Number of Pupils	Totals
Low performers (0-39%)	4	17	21(13%)
Average performers (40-60%)	9	42	51(32%)
High performers (61-100%)	16	22	38(24%)
All	3	0	3(2%)
None	8	39	47(29%)
Totals	40	120	160

The table shows differences between teachers' and pupils' views. The majority of teachers 16 (40%) prefer to use mathematics text books with answers with the high ability group of pupils. This finding concurs with that by Chisaka (2001) who reported that teachers allocated more resources to high ability classes. The majority of pupils 42 (35%) preferred answer books to be used by those whose performance is average. Some pupils 39 (33%) object to the use of answer books by pupils. Pupils' views could have been influenced by the prevailing situation where no answer books are supposed to be used by pupils.

Teachers' and pupils' views: Advantages of using mathematics textbooks with answers

Those teachers and pupils for the use of mathematics textbooks with answers raised the following benefits:

Table 6, Advantages of using textbooks with answers N = 111

Perceived benefit	Freq
-selfassessment during study or examinations preparations;	72
-checking solutions in order to see whether they are correct or wrong;	95
-encouraging students to study alone by providing instant feedback;	68
-reducing mathematical anxiety on students;	53
-reduce teachers' work by allowing students to be able to mark their own work	61
-reduces quarrels with the teachers on chalkboard solutions which are not correct	52

The majority of participants 95(86 %) emphasize that checking of solutions to see whether they are correct or wrong is the main use of a mathematics answer book. The result can be attributed to the general view of mathematics as a unique subject in which an answer is correct or wrong (Boley, 1999).

Some students highlighted that some teachers are not competent enough to produce correct answers to the problems hence the need to check their answers. This shows lack of trust in teachers' competence by their pupils. Those who regard answer books as a source of teacher-pupil disagreement were supported by one teacher X during the interview who said "*Oh-oo this topic on symmetry, I'm having problems nekamwe kamukomana kemusform two neanswer book rako. Dai kasingaratidzi hako vamwe!*". In this case the availability of an answer book was a source of teacher frustration, particularly when the boy shows others to gain support in criticizing the

teacher's competence. We deduced that if answer books are to be used some teachers' expertise may be threatened by the existence of mathematics textbooks with answers which students will use as a base for detecting teachers' errors.

Teachers and pupils perceived disadvantages of using textbooks with answers

Table 6, Disadvantages of using textbooks with answers N=94

Disadvantage	Freq
-students cheating by copying answers from the answer books;	79
-students will concentrate on answers instead of working;	53
-it promotes laziness;	71
-students will refer to incorrect answers in some answer books;	13
-lack of resources (answer books are more expensive);	62
-students are frustrated by failing to get answers in answer books	58
-examinations do not provide answers	44
- for students to show working as evidence of concept mastery	37
-teachers being afraid that students will not consult them;	18

Students and teachers agree that students will copy answers for exercises from the answer books. This may be a problem with teachers who mark the answer only. If procedural marking in which method marks are awarded then a pupil cannot get the correct answer from a wrong working.

Researchers would like to assist the 44 respondents who think that examinations do not provide answers by referring them to these questions from past examinations papers:

- a) Given that $2^{2(2-3)} \times 2^{3x} = 16$, show that $2^{x^2} + 3x - 10 = 0$ (15 November 2002, 4008/2 question 9(b) (i), page 11)
- b) VABC is a right pyramid whose base ABC is an equilateral triangle of side 8cm. The height of the pyramid is 10cm, D is the centre of the triangle ABC and M is the midpoint of AC. (a) show that $DM = 2,309\text{cm}$ (June 2009, 4008/2 question 12, page 12)

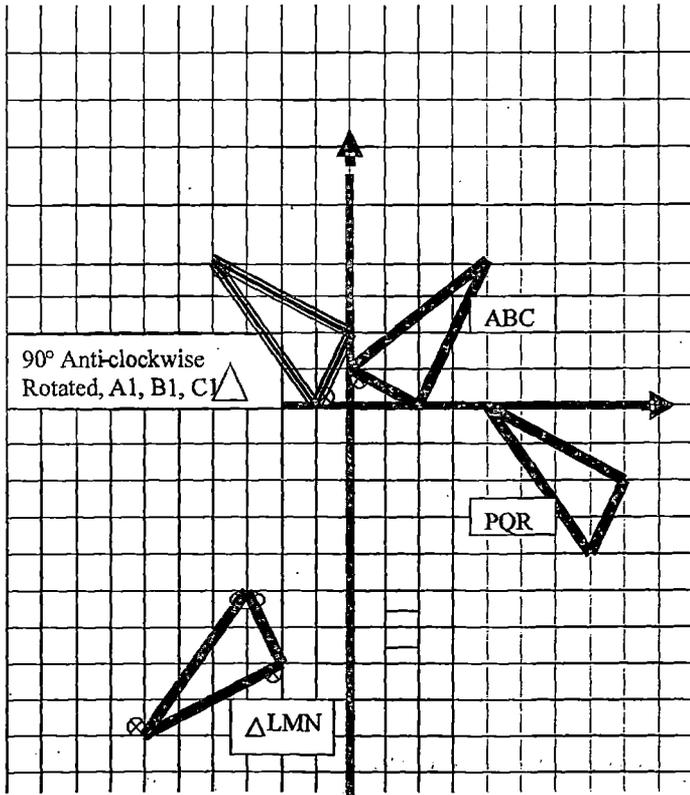
In these questions, answers were given and the examiner asked for the working. Therefore examinations provide answers.

Although the 13 participants are in the minority, they provided the following as evidence for the fact that some of the solutions and answers in textbooks are not correct:

* Channon, Mcleish, Head, Macrae and Chasakara (1997:246) who suggest that, the answer for a translation vector to the exercise 27b number 10c for a triangle ABC with vertices A (2;0), B (4; 4), C (0; 1) which was mapped onto triangle PQR with vertices P (8; -2), Q (4;0), R (7; -4) by a 90 anti-clockwise rotation about the origin and then by a translation and asked the learners to draw the triangles is $\begin{bmatrix} -4 & -8 \end{bmatrix}$

The center of rotation to this problem is point (0;0) the matrix is not correct but the correct translation vector is $= \begin{bmatrix} 8 & -4 \end{bmatrix}$

Graphical Solution



The translation can also be found by multiplying the coordinates of each point by the 90 anticlockwise rotation matrix then subtract one point's coordinates from its corresponding coordinates after mapping.

$$\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 2 \\ 4 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} \quad \text{thus} \quad \begin{bmatrix} 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 0+0 \\ 0+0 \end{bmatrix} + \begin{bmatrix} 0+(-4) \\ 0+(-1) \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \end{bmatrix} = \begin{bmatrix} -4 \\ -1 \end{bmatrix}$$

then subtract the mapping coordinates from its mapped coordinates to find the translation vector, for example coordinates of P (8;-2) – of A rotated to A1 (0;2) thus

$$8 \begin{bmatrix} 0 \\ -2 \end{bmatrix} - \begin{bmatrix} 0 \\ 2 \end{bmatrix} = \begin{bmatrix} -4 \end{bmatrix} \quad \text{which is the translation vector.}$$

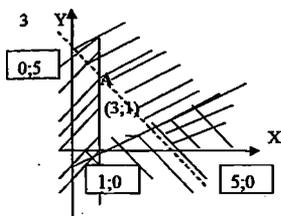
* The same authors made errors on ranges for exercise 16c on number 13a

when they gave that 135-144, 144-154, 155-1,, 155-164 and 165-174 are the ranges on the given data on heights of 30 students which is follows:

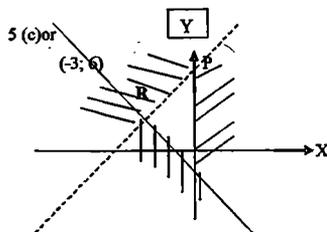
145	163	149	152	166	156	159	139	145	141
150	158	150	149	143	159	154	167	146	147
152	162	144	169	162	150	173	160	167	171

(a) Take the class intervals 135-144, 145-154, ..., and construct the table of frequencies. Though the frequencies were correct such errors of overlapping classes can really mislead low performers. A similar error was done on question 14a.

* Other incorrect answers are in Channon et al (1994:144) on exercise 17a questions 3 and 5(c) in Fig 17.3 and Fig 17.4 with diagrams being represented bellow. The correct answers are as follows: $x > 1, x + y < 5$ and $3y > x$ for number 3 and $x < 0, 2x + y > 0$ and $2y < x + 8$ for number 5(c) but *their answers are as follows: $x > 1, x + y < 5$ and $3y > x$ for number 3 and $x < 0, 2x + y > 0$ and $2y < x + 8$ for number 5(c), there are errors in the use of dotted lines for strict inequalities ($<$ $>$) and bold line for (\geq) so four of the six inequalities required are incorrect.*



$$2y = x + 8$$



However, the incorrect answers are like a drop of water in the sea since most of the answers are correct and this book covers the mathematics content very well, hence it is mostly the main textbook in most schools.

Recommendations on Strategies for using mathematics textbooks with answers

1. Teachers can use answer books during lesson planning to select questions to work as examples and grading exercises for different ability groups in their classes.
2. Teachers can use problems whose answers they have checked as examples and ask pupils to check in the answer book. The technique cultivates trust between teacher and pupils.
3. Teacher can assign problems whose answers are known and ask pupils to solve the problem in different ways getting the same answer. For example, *solve the following quadratic equation : $2x^2 - 3x - 2 = 0$. Answers are $x = 2$ or $-\frac{1}{2}$, by (a) factorization (b) completing the square (c) the quadratic formula and (d) graphical method. Which of the methods can result in errors, why?*
4. Teachers apply procedural marking where method marks are awarded and correct answer deduced from correct method scoring full marks.
5. Teachers can allow students to demonstrate how they got specific answers to show concept mastery

6. For slow learners, teachers can leave blanks in the working or provide leading hints in the form of notes. Pupils will start by completing them, leading to the given answer as shown here: $2x^2 - 3x - 2 = 0$

$$a = 2, \quad b = (\quad), \quad c = -2$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-3) \pm \sqrt{(-3)^2 - 4(2)(\quad)}}{2(2)}$$

$$x = \frac{3 \pm \sqrt{(\quad) - 4(-4)}}{4}$$

$$x = \frac{3 \pm \sqrt{25}}{4}$$

$$x = \frac{3 \pm (\quad)}{4}$$

$$x = 2 \quad \text{or} \quad -\frac{1}{2}$$

7. Pupils should be taught how to use answer books;

- to provide instant feedback by checking on the answer;
- to assess and evaluate their own work or other students' work during learning
- to provide motivation by instant feedback on supplementary work given
- to mark group work and games where group leaders give scores to each group;
- when preparing for examinations by focusing on the critical concepts

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