THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

STUDENTS' ITEM RESPONSE ANALYSIS REPORT ON THE FORM TWO NATIONAL ASSESSMENT (FTNA) 2022

MECHANICAL ENGINEERING

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090 MECHANICAL ENGINEERING

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FOREWORD

This report presents Students' Items Response Analysis (SIRA) on Form Two National Assessment in Mechanical Engineering subjectwhich was conducted in November 2022. The report aims to provide feedback to all educational stakeholders on the factors that contributed to the students' performance in Mechanical Engineering.

The Form Two National Assessment (FTNA) is a formative evaluation which intends to monitor students' learning and to provide feedback that teachers, students and other educational stakeholders can use to improve teaching and learning processes. This analysis shows justification for the students' performance in the Mechanical Engineering subject. It reveals that students had good performance in the topic of workshop management and safety rules. However, when it comes to engineering materials, their performance is poor. Factors that affected the students' responses include the students' failure to understand the demands of the questions, insufficient knowledge on some tested subject matters and a lack of mechanical skills.

The analysis shows that most of the students who scored high marks were able to identify the demands of each question, had enough knowledge of the assessed subject matter, and were proficient in the English language. However, the students who scored low marks lacked such attributes. Furthermore, the report explains the reasons why some students provided either good or poor responses. Extracts from each case are attached to justify the students' performance.

The Council believes that the report will be used by stakeholders especially teachers who in turn will maximise the teaching and learning processes so as to attain the required instructional objectives. The Council appreciates the efforts made by all who, in one way or another, contributed to the preparation of this report.

Dr. Said A. Mohammed
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report analyses the students' performance on the Form Two National Assessment (FTNA) in Mechanical Engineering, which was administered in November 2022. The assessment measured the competencies that the Form Two students had attained in accordance to Mechanical Engineering Secondary Education Syllabus which was issued in 2019.

The Mechanical Engineering assessment paper had three sections: A, B and C, all of which comprised of 10 questions. Section A had two (2) objective questions(1 and 2). Question 1 consisted of ten multiple-choice items constructed from seven topics.Each item carried 1 mark. Question 2 consisted of five homogeneous matching-itemsconstructed from the topic of Workshop Management and Safety Rules. Each item carried 1 mark, making a total of 15 marks. Section B had seven short-answer questions, each carrying 10 marks. Section C had one question weighing15 marks. The students were required to answer all questions.

A total of 424 (100%) students sat for the assessment where, 297 (70.05%) passed. Further analysis showing the pass grade basing on sexis presented in Table1.

Table1:Students'Performancein Mechanical Engineering Subject

Sex	Grades					Passed	
	A	B	C	D	F	Number	Per cents
M	1	6	119	135	88	261	74.79
F	0	0	11	10	39	36	48.00
Total	**1**	**6**	**130**	**110**	**127**	**297**	**70.05**

Table 1 shows that there was a large number of students who scored grades C,D and F and only a small number scored grades A and B.

However, the students' performance was interpreted based on the typical ranges of marks earned by students. If the scores ranged from 0 to 29 marks, the performance is regarded as weak. Moreover, if the scores ranged from 30 to 64 marks and from 65 to 100 marks, the performance was considered average and good, respectively. For illustration in figures and tables, red, yellow, and green colors are used to represent weak, average, and good performance, respectively.

The report also analyzes the students' responses to each question by explaining the requirement of the question, the percentage of the students who attempted the question, their scores, and the reasons for such performances. Extracts from

the students' scripts, graphs, charts, and tables are inserted to illustrate the reported information. Lastly, the report provides appendices I, II, III, IV, and V showing the students' performance questionwise, general performance, description of performance in each question, overall performance, and comparison of performance gradewise for the years 2021 and 2022.

2.0 ANALYSIS OF THE STUDENTS' PERFORMANCE IN EACH QUESTION

This part covers the type of questions; topic from which the questions was constructed, competencies test, the requirements of each question and the percentages of the students who had weak, average or good performance based on their responses.

2.1 Section A: Objective Questions

This section is comprised of two (2) questions carrying a total of 15 marks. Question 1 consisted of 10 multiple-choice items constructed from various topics, each item carrying 1 mark. Question 2 included five (5) matching items from the topic of workshop management and safety rules, each worth one mark.

2.1.1 Question1: Multiple Choice Items

This question consisted of ten multiple-choice items (i-x) which were from the following topics:*Engineering Materials, Workshop Tools and Equipment, Workshop Management and Safety Rules, Mechanical Engineering Jobs and Occupations, Introduction to Science, Engineering and Technology,* and *Metal Work Technology.*Students were instructed to choose the correct answer from among the given alternatives by writing its letter in the box provided. Each item carries 1 mark.

The question was attempted by 424 (100%) students,whose scores were as follows: 7 (1.65%) students scored from 0 to 2 marks, 243 (57.31%) scored from 3 to 6 marks and 174 (41.03%) scored from 7 to 10 marks. Generally, students' performance in this question was good since 417 (98.35%) students scored from 3 to 10 marks. This performance is summarized in Figure 1.

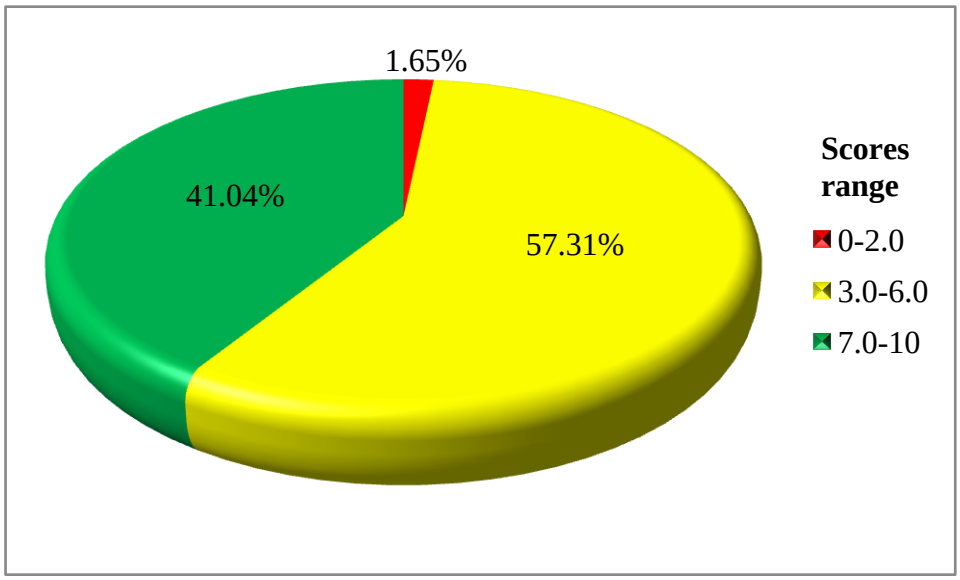


Figure 1:*Students Performance in Question 1*

Despite of the students' good performance in this question, 1.65 percent of the performance isweak due to number of reasons.The following is the analysis of students' responses for each item:

Item (i), was set from the topic of Engineering materials.Students were required to apply their knowledge of engineering materials to identify various types of raw materials used for the production of pig iron in the blast furnace. The item measures the students' ability to analyse different engineering materials and their applications. The question was:

Which materials are used to charge the blast furnace during the production of pig iron?

A Coke, limestone and iron ore *B Coke, limestone and slag*
C Steel scraps, limestone and coke *D Limestone, air and pig iron*

The correct response was *A: coke, limestone, and iron ore*. Students with knowledge of the materials charged in the blast furnace, as well as those with knowledge of the various metalurgical items and their applications, chose this correct response.However,those who opted Alternative B were confused with the term "slag." They strayed by thinking that slag is the byproduct of the smelting process in the blast furnace. Those who chose distractor C, *Steel scraps, limestone and coke*whereby misled *"Steel scraps"* which was the raw material used in the production of steel and other iron alloys. Those who selected distractor D, *Lime stone, air and pig iron* did not understand that air

is an additional source that helps alter reactions but is not a core material for the production of pig iron. Hence, they lacked knowledge of pig iron production and its resources.

Item (ii) was extracted from the topic of *workshop tool and equipment*. It assessed students' skills in using a hacksaw blade with the appropriate number of teeth per inch. In order to select the appropriate kinds of tools for the task at hand, the students must apply the bench shop skills they have mastered. The question was:

You are required to cut a thin metal using hacksaw. Suggest which hacksaw blade is appropriate to use.

A Blades with tough teeth *B Blades with elastic teeth*
C Blades with small pitch *D Blades with large pitch*

The correct response for this item was *C, Blades with small pitch.* Students who chose the correct response had knowledge of the type of blade that can be used to cut thin materials. They were able to identify the types of blades with close teeth as those used to cut hard and thin materials. For those who chose alternative A, *Blades with tough teeth* were comfused by the hacksaw blade specification because toughness was not one of the appropriate properties of the materials used to manufacture them. Similarly, the students opted for an alternative B-*blade with elasitic teeth*, they didn't know that elesiticity is not one of the properties of metal cutting blade teeth. Those who opted for distratcor D, *Blade with a larger pitch* were unaware that when blades have fewer teeth per specified space (teeth per inch), they have deeper spaces between teeth, resulting in a more aggressive chiseling action. Therefore, when this type of blade is used for cutting thin material, it tends to break off. This incorrect response from the students suggests that they lacked sufficient knowledge of the blades and their intended applications.

Item (iii) was set from the topic of *Workshop Management and Safety Rules*. It tested the students' knowledge on how they practiced the safety of machines and other equipment in the workshop. The question was:

Fixed, interlocking, automatics and trip guards are machine guards used to ensure safe work environment. Why most of the manufactures prefer to use an interlocking safety guards than others?

A *It provides a tripping device inside the guard.*
B *It is operated by the moving part of the machine in which it is fitted.*

C *It forms an integral part of the machine a cannot be removed.*
D *It forms an integral part of the machine a can be removed.*

The correct response was C, *It forms an integral part of the machine and cannot be removed.* Students who got the answer right were knowledgeable about workshop management, safety regulations, and the roles that machine guards play in maintaining a secure working environment and were able to select the appropriate answer. However, those who lack enough background on the subject matter choose options A, B, or D. These students were unaware that an interlocking guard is a safety measure intended to instantly shut down a machine's moving parts if the guard is removed or opened while it is in use. Normally, unless the guard is put back in place, the machine won't be able to start up again. Also, they didn't know how successful this type of guard can be in enhancing operator safety and significantly lowering risks, accidents, and injuries at work, which is why the majority of manufacturers to utilize it.

Item (iv) tested the students' knowledge in the topic of *Mechanical Engineering Jobs and Occupation*. The question was:
Who is responsible to measure, analyze and interpret data for performance of mechanical components, device and engines in engineering field?

A Technician *B Technologist*
C Engineer *D Artisan*

The correct answer was "C, *Engineer."* Students who chose the correct alternative C understood properly the functions of engineers as specialists who create, design, analyze, construct, test, and evaluate machines, complex systems, buildings, gadgets, and materials to satisfy functional objectives and criteria while taking into account practicality, regulation, safety, and cost constraints. In contrast, those who selected option B, *Technologist* misrepresented a technologist's role as a specialist in contemporary technology, particularly technology related to a specific activity or sector. For those who selectedalternative D, *Artisan*were unable to distinguish between a mechanical engineer's and an artisan's responsibilities. In fact, an artisan is a skilled manual worker who employs tools and machinery in a particular speciality.

Item (v) was set from the topic of *Introduction to Science, Engineering and Technology*and it tested students' knowledge on the relationship between

science and technology in daily life. It assessed students' understanding of how these two words are related. The question was:

What is the relationship between science and technology?
A Technology is the application of science
B Science is the application of science
C Science is a major application of technology
D Technology is the major application of science

The correct answer was A: *Technology is the application of science*. The students who chose the correct alternative showed a greater understanding of the relationship between science and technology. Their knowledge aided them in distinguishing between science and technology, as well as how the two terms are related. On the other hand, those who selected C, "*Science is a major application of technology,"* did not comprehend that there is no connection between science and technology, proving that they merely failed to distinguish the terms "science" and "technology" as requirements of the topic. Those who selected options C and D also lacked comprehension of the connection between science and technology. The term "major," which was used to falsify the entire phrase, lured these students. Failure to choose the correct answer indicates that they had insufficient knowledge on the topic.

Item (vi) was developed from the topic of*Metal technology*require the students to use knowledge on gas welding plant to give out the purpose of the gauges installed on it. The question was:

In gas welding, pressure regulators used has two gauges, what are the function of the gauges?
A To indicate working and gas content in the cylinder
B To vary regulator pressure and cylinder pressure
C To balance regulator pressure and cylinder pressure
D To vary regulator pressure and maintain cylinder pressure

The correct alternative was A, *To indicate working and gas content in the cylinder.* Students who chose the correct response understood that the purpose of installing gauges in gas plants is to indicate the pressures before and after the regulators. However, those who chose alternative B, *To vary regulator pressure and cylinder pressure*failed to understand that adjustment screws, open and close valves are tools used to vary the pressure in gas regulators and cylinders. Students who chose C, *To balance regulator pressure and cylinder pressure*lacked knowledge that only inlet and outlet

gases are required to be balanced, and the tools used are absorbent filler and gas regulator.Moreover, those who chose alternative D, *To vary regulator pressure and cylinder pressure* did not understand that there are no tools used for this kind of work in the welding gas plant.

Item (vii) was set from the topic of *Engineering Materials*. It tested students' ability on indentifying various types of elements used for alloying ferrous metals. The question was:
Steel and cast iron are known as ferrous metal which are used in making different type of metallic components. What them?

A Sulphur content *B Carbon content*
C Tungsten content *D Oxygen content*

The correct alternative was B *Carbon contents*. Students who chose the correct alternative had sufficient knowledge of ferrous alloys. They understood that the amount of carbon in ferrous metal is the onethat produces iron products. Thus the higher the carbon content, the more ferrous alloy is called cast iron, and the lower the carbon content, the ferrous alloy is called steel. Those who chose the incorrect response A, *sulphur content* did not understand that the presence of sulphur in the ferrous metal will increase brittleness and reduce weldability but will not make both steel and cast iron differ. Students who chose altenative C, *Tungsten content* failed to understand that tungsten will increase the strength of cast iron and form carbide in steel, which is suitable for making special metallic components.Similarly, those who chose alternative D, *Oxygen content* did not understand that additional oxygen in ferrous metal make it easyto corrode and reduce the machineability of cast iron.

Item (viii) was extracted from the topic of *Workshop tools and equipment*. It require the students to identify the measuring tools, which include a try square. The item tested the students' knowledge of workshop tools and equipment used in the workshop. The question was:

Which measuring instrument has features of try-square, bevel protractor, rule and scriber?

A Depth gauge micrometer *B Height gauge micrometer*
C Combination set *D Inside micrometer*

The correct answer was altenative *C, Combination set.* The students who chose the correct response had knowledge of measuring tool which combines various tools. On the contrary, students who opted for alternative A, *Depth*

gauge micrometer were unaware that this kind of micrometer is used to determine the depth of slots, holes, and recesses such that it can't be connectedthe other measuring device. Those who selected alternative B, *Height gauge micrometer*did not understand that this tool serves the same purpose but in addition italso measures heights and mark items that need to be worked on, with the pointer being sharpened to serve as a scriber which help to mark out the work parts. A few students who chose alternative D, *Inside micrometer*missed the concept that the inner micrometer's components cannot be paired with any other gadget. Generally these students lacked knowledge of workshop tools and equipments.

Item (ix) was set from the topic of *Workshop Management and Safety Rules*. It required the students to identify the components that are found in the first-aid kit. It tested students' knowledge of safety devices and their components. The question asked:

Which items are found in workshop first aid kit?

A Pain killer tables, ARVS, Bandage, Scissors and Tincture
B Spirt, Syringe, TB tablets, Gloves and Bandages
C Bandages, Scissors, Pain killer tablets, Tincture and Spirit
D Condom, ARVs, TB tablets, Gloves and Spirit

The correct answer was alternative C, *Bandages, Scissors, Pain killer tablets, Tincture and Spirit.* The students with enough knowledge and familiar with safety skills chose this altenative. They knew that first aid kit is a collection of materials and equipment used to provide rapid medical treatment, primarily to treat accidents and other mild or moderate medical issues. Likewise, students who opted for the incorrect response A, *Pain killer tables, ARVS, Bandage, Scissors and Tincture* were not aware that an ARVS acronym for antiretroviral medications tablets which are used to treat HIV patients and stop the virus from replicating in the body hence, it requires an expert to administer to pertinent. Simiraly, who opted for B and D were wrong because TIB tablets are for the treatment of tuberculosis, which also requires special care in preservation and distribution. While condoms are used to prevent virus transmission during sexual interactions, As a result, it couldn't be kept in the first-aid kit. These incorrect responses are an indication of students' inadequate knowledge of the subject matter.

Item (x) was set from the topic of *Mechanical Engineering Jobs and Occupation*.It requires the students' to identify the personnel who have duties

of doing various activities in the production processes. The purpose of this item was to assess the student's knowledge of job titles and descriptions. The question asked:

The growth of industrial sector in Tanzania depends on the level of qualification to the workers. Who is responsible to perform routine product development and coordination of workforce, material and equipment?

A An artisan *B Craft person*
C Engineer technologist *D Technician*

The correct answer was alternative *C, Engineer technologist.* The students who chose the correct response had sufficient knowledge of various engineering personnel. Those who chose alternatives A, B, and D failed to differentiate the responsibilities of an engineer-technologist with those of other occupations. They failed to understand that among the duties of engineering technologists is to analyze, modify, test, and apply new and existing engineering technologies to solve complex issues in consultation with engineers. Similarly, they didn't know that in the training aspect, they have similar training to engineers but with a focus on practical applications; hence, engineers design things and then engineering technologists build them. Their choice indicates that these students lacked sufficient knowledge of engineering job descriptions.

2.1.2 Question 2: Matching Items

This question consisted of five matching items derived from the topic of *Workshop Management and Safety Rules.* This question required the students to match the descriptions in List A with their corresponding responses in List B by writing the letter of the correct response below the corresponding item number in the table provided. The question was as follows:

2. Match the descriptions in **List A** with the corresponding response in **List B** by writing the letter of the correct response below the item number in the table provided.

List A	List B
(i) A thing or situation which may cause injury.	A Accident
(ii) An exposure to risk or chance to accident.	B Safe guard
(iii) A quality or condition of being safe from danger, injury or damage.	C Safety
(iv) State of sense or defense against attack.	D Danger
(v) An unexpected happening that results in injury.	E Caution
	F Security
	G Hazard
	H Precaution

Answers

List A	(i)	(ii)	(iii)	(iv)	(v)
List B					

Atotal of 424 (100%) students attempted the question and their scores were as follows: 60 (14.15%) students scored from 0 to 1 mark, 245 (57.78%) students scored from 2 to 3 marks, and 119 (28.07%) scored from 4 to 5 marks. Generally the students' performance on this question was good since 364 (85.85%) scored above average. Figure 2 illustrates this data.

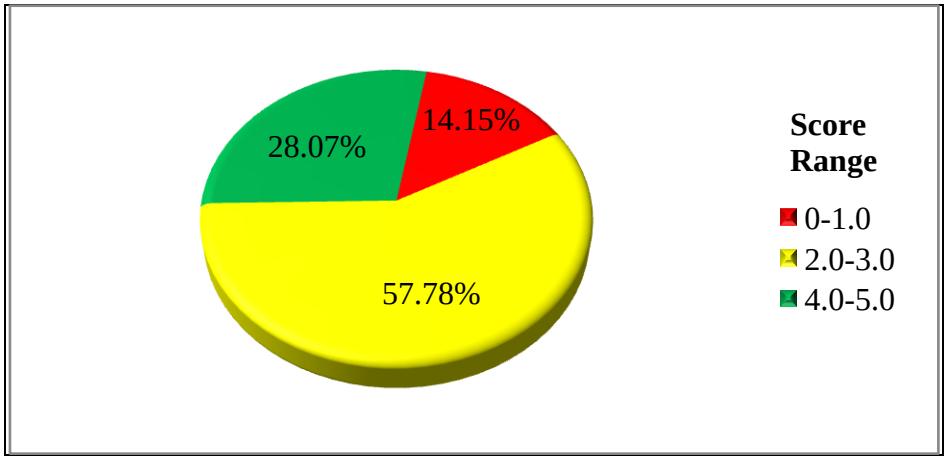


Figure 2:*Students' Performance in Question 2*

Further analysis on the students' performance in each item is as follows:

Item (i), required the student to identify the situation which may cause injury. The correct response was *D, Danger*. Students who correctly matched understood that danger is created by actions that raise the possibility of contracting a disease or suffering an injury, which can then result in disability, death, or societal issues. A few students selected G. *Hazard.* These students failed to understand that a hazard is a source or scenario that has the

potential to cause harm to people or the environment, as well as damage to their property or health.

In item (ii), the students were required toidentify the term which represents the possible situation which causes an accident. The correct response was *G. Hazard.* The students who correctly matched the item understood that "hazard" is a condition that presents a risk or threat to the environment as well as an individual's life, property, or health. However, a few students who mismatched the item with D, *Danger*, were unable to distinguish between *danger* and *hazards*. A hazard is something that does not actually exist but could nevertheless result in an individual suffering harm or infection. It is an unforeseen and unanticipated encounter or occurrence that could cause suffering, illness, loss, or harm. On the contrary, danger refers to a situation in which a person has no guarantee that it will be anything that is obvious or well-known.

Item (iii) required the students to provide a suitable response that matched correcly with the phrase "*A quality or condition of being safe from danger, injury, or damage."* The correct response was "C," *"safety*." Students who managed to match correctly had a clear understanding that "safety" refers to a situation in which risks and conditions that can cause physical, psychological, or material harm are under control. A few students who matchedit with*F, Security*, failed to distinguish the term "security" as the actions taken to make people or places safe. However, those who matched with letters A, B, D, E, G, and H had insufficient knowledge of the subject matter.

In item (iv), required the students to identify a match to the name which represents the resiponsibility of taking care andprotection. The correct response was *F, Security*. Students who managed to match correctly had a clear understanding that security is about protecting organizations and people against threats or danger. However, few students who matched the item incorrectly with *C, "safety,"*did not realise that safety is the perception of being shielded from dangers. It's also important to emphasize how safe a person feels when they have control over risk factors.

Item (iv) required the students to identify the situation whereby if it happens the results are injury and damage.The students who chose the correct response*A, Accident* had adequate knowledge of workshop safety and rules matters. Conversely, the students who made the incorrect selections were

unaware that an accident is an abrupt, unanticipated occurrence that frequently causes harm, loss, or injury. They didn't know that an accident is an unfortunate, unforeseen, and unplanned event or circumstance, usually resulting in an unfavorable outcome, and is frequently the result of carelessness or ignorance.A hazard is typically defined as a condition or changing set of circumstances that poses a risk of injury, illness, or property damage.

2.2 Section B: Short Answers Question

This section comprised of seven (7) short-answer questions constructed from the following topics; *Engineering Materials, Workshop Tools and Equipment, Metal Work Technology* and *Workshop Management and Safety Rules.* Each question carried 10 marks, making a total of 70 marks.

2.2.1 Question 3 : Engineering Materials

This question had three parts (a), (b) and (c). In part (a), the students were required to list five different components that, when added to white, malleable cast iron, would cause a rise in the ferrite phase, a drop in strength, a reduction in toughness, and an increase in yield strength.Part (b) required the students to use a few words to explain the properties of malleable cast iron.In part (c), students were required to demonstrate the application of white cast iron.

The analysis indicates that the question was attempted by 424 (100%) students and their scores were as follows: 298 (70.28%) scored from 0 to 2.5 marks, 118 (27.83%) scored from 3.0 to 6.0 marks, and 8 (1.89%) scored from 6.5 to 10 marks. These data are summrised in Figure 3.

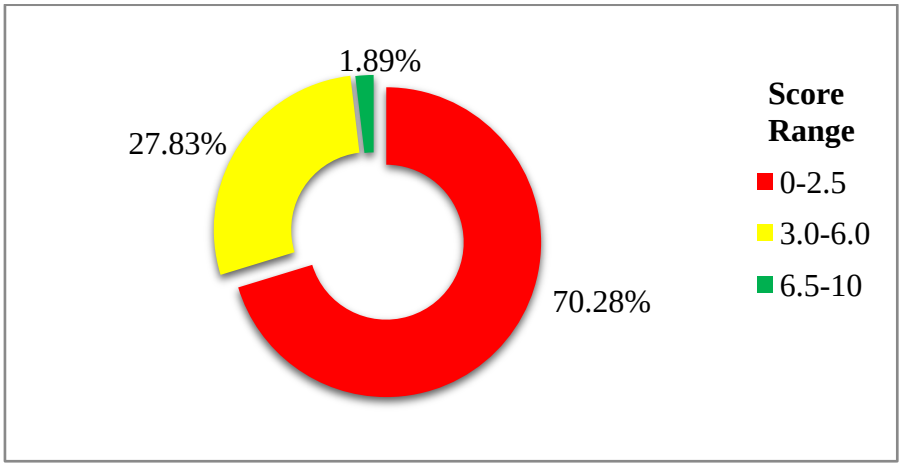


Figure 3:*Students' Performance in Question 3*

Figure 3 shows that the general students' performance on this question was weak because 70.28 percent scored from 0 to 2.9 marks while 29.72 percent scored from 3 to 10 marks. The students who scored low marks (0–2.9) failed to explain the properties of malleable and white cast irons, their applications, and effects when combined with other elements. For example, one student in Part (a), instead of identifying the elements such as iron, carbon, sulphur, silcon, manganese, and phosphorous and their percentage composition present in white cast iron, copied the question by writing, "*increase of ferrite phase, decrease of strength, toughness lowered, yield of strength, and copper."* This shows that she/he had insufficient knowledge about engineering materials, specifically the properties of iron and its alloys.

Similary, most of the students faced difficulties in providing the correct answer in part (b).Their responses show that some were guessing the answers. For example, one student wrote; *that malleable cast iron should be harder, tough, malleable, smooth and have a melting point that enables it to change from a solid to a liquid.* Such student failed to understand that malleable cast iron has mechanical strength characteristics that are in between those of *ductile* or gray cast irons. It has qualities that make it perfect for applications where *toughness* and *machinability* are needed.In addition, malleable cast iron is less prone to cracking and has a variety of characteristics, including *better tensile, rupture,* and *elongation* values as well as a *high resistance to wear* and a *powerful shock resistance*.

In part (c), some of the students mixed up the functions of cast iron from white cast iron. They provided their responses in a broad manner instead of being focused on what was asked. For example, one student wrote: "*It is used in making pipes to carry suitable fluids; it is used in making different machines; it is used in making automotive parts; it is used in making pots, pans, and utensils; and it is used in making anchors for ships.*" In their responses students were required to mention the items such as tractor spring manufacturing, rail road brake pedals, automotive crankshafts, hangers and differentials, gearboxes, and steering gear housings, etc. Others students omitted this part, indicating that the students had insufficient knowledge of the tested concept. Extract 3.1 is a sample of the incorrect responses.

3. You have been assigned to do laboratory analysis on White and Malleable cast iron. The results observations were: increase of ferrite phase, decrease of strength, toughness lowered and yield of strength.

(a) Which elements and their compositions were obtained in white cast iron? Give five elements.

(i) It have have high conductivity.

(ii) It have high conductor of electrich.

(iii) It have thomarl conductivity

(iv) It have chemical properties

(v) It mechanical properties.

(b) Briefly explain five properties of malleable cast iron.

(i) thomarla properties. It used in thomarl practas.

(ii) Hadrical properteas - It used in electrical propectas

(iii) chemical properties - It used in chemical reaction properteas

(iv) mechanical properties - It used in me chanical properes

(v) civil properteas - Is used in civil properteas

(c) Where can white cast iron be used according to the properties of white cast iron found in analysis? Mention five uses.

(i) Used in manufacturing machine.

(ii) Used in fabrication

(iii) Used in manufacturing industries.

(iv) Used in construction

(v) Used in mantaines materials.

Extract 3.1: *A sample of a Student's Poor Response in Question 3*

In Extract 3.1, the student in part (a) bases his/her hypothesis on physical properties such as chemical, electrical, thermal, and mechanical instead of identifying the elements and their percentage in composition. In part (b), she/he bases her/his decision on the metallic properties, which are general instead of specific to the white cast iron. For part (c), she/he gives out the general application of engineering materials, which is outside the scope of the question. This shows that she or he lacked knowledge of cast iron and its products.

On the other hand, students who performed averagely understood the question, but they had little knowledge of engineering materials. The majority were able to give a few correct elements with their compositions in white cast iron while others missed some parts. In Part (b), most of the students were able to briefly explain one or two properties of malleable cast iron; as a result they scores few marks in this part. Some of them managed to list the general application of cast iron instead of specifically white cast iron as a requirement of part (c). Consequantly, they failed to score all the marks allocated.

However, very few (1.89%) correctly identified the elements found in white cast iron, but they misread when indicating the compositions' percentages as requested in Part (a). One student, for instance, erroneously mentioned the correct composition of carbon and sulphur. Contrarily, some students were able to address the requirements in parts (b) and (c) by describing the characteristics of malleable cast iron and mentioning a few applications for white cast iron, but their efforts received little marks. This demonstrates that despite having knowledge of engineering materials, the students were unable to recollect all the responses. Extract 3.2 is a sample of good responses from the a script of one of the students.

3. You have been assigned to do laboratory analysis on White and Malleable cast iron. The results observations were: increase of ferrite phase, decrease of strength, toughness lowered and yield of strength.

(a) Which elements and their compositions were obtained in white cast iron? Give five elements.

(i) Iron:..White cast iron contain about 90% of iron in composition

(ii) Carbon is in form of cementite that chemically combined about 4

(iii) Sulphur:..is an impurity which compare about 4.5% comparing

(iv) Silicon:..is an impurity which compose about 0.5% comparing

(v) Phosphorus:..is an impurity which compose about 1% in comparing

(b) Briefly explain five properties of malleable cast iron.

(i) Malleable cast iron can be easily casted, forged and be Machined well.

(ii) Malleable cast iron is strong and hard

(iii) Malleable cast iron is less brittle

(iv) Malleable cast iron can be rolled, extruded or hammered without breaking

(v) Malleable cast iron has high tensile strength and it is ductile.

(c) Where can white cast iron be used according to the properties of white cast iron found in analysis? Mention five uses.

(i) It is used for Manufacturing horticultural equipment

(ii) It is used for Manufacturing car bodies.

(iii) It is used for fabrication of engine blocks

(iv) It is used for Making leaf springs

(v) It is used in fabrication of Metal sheets

Extract 3.2: *A Sample of a Student's Good Response in Question 3*

Extract 3.2 shows a sample of the correct responses by a student who managed to address some parts of the question correctly. However, she/he stayed in a few points about the specific application of white cast iron. This indicates that she/he had sufficient knowledge about cast iron and its products.

2.2.2 Question 4: Workshop Tools and Equipment

This question was constructed from the topic of *Workshop Tools and Equpment*under the subtopic of *Use of Mechanical Tools and Equipment*. The question measures the ability of the students to know the application,

materials, and securement of the various tools and equipment used in the workshop. The students were required to study the figure given, then (a) give the name and function of the given device, (b) provide part names marked with provided letters, and (c) mention, explain, and state the parts labeled based on the material, profile, and protection.

The question was attempted by 424 (100%) students out of whom, 37.03 percent scored from 0 to 2.5 marks, 41.75 percent scored from 3.0 to 6.0 marks, and 21.23 percent scored from 6.5 to 10 marks. This analysis shows that the performance in this question was average, as 62.97 percent scored from 3.0 to 10 marks. Figure 4 portrays the students' performance in this question.

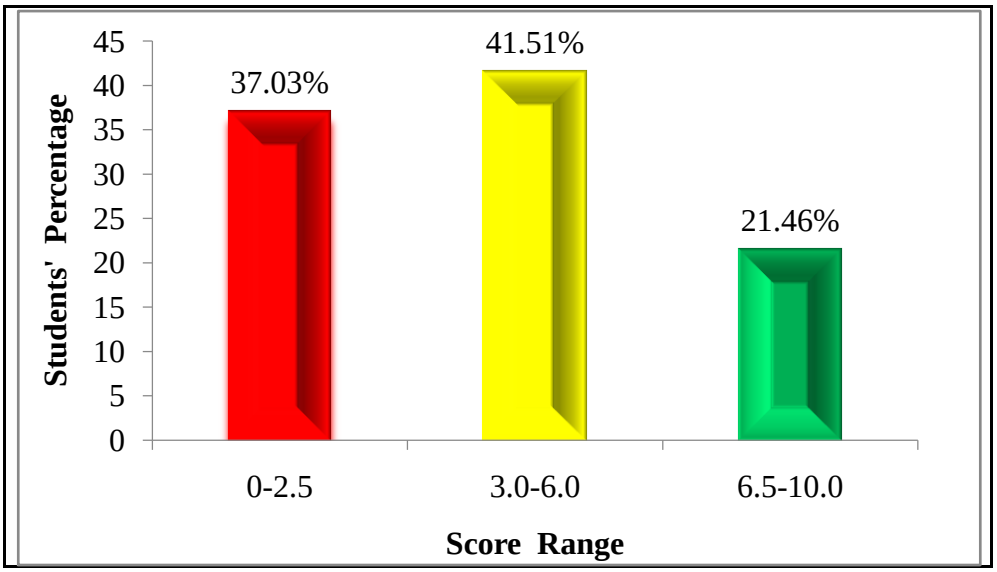


Figure 4:*Students' Performance in Question 4*

The analysis in Figure 4 indicates that the students who scored average marks (3 to 6.0) failed to respond correctly to all parts of the question. Some were able to name, list, and identify the types of materials used to manufacture the labeled parts but failed to provide the reasons why they are knurled and covered with soft plate lines. For example, one student respondedto part (c) as the (i) *material used to manufacture parts labeled D and F is* pig iron instead of carbon steel and mild steel. Also, another student in part (c) (iii) wrote, "*The part D must be covered with soft liners so as to maintain the balance of the material during the cutting process, like spare pipe,*" instead of avoiding the *sliding or slipping of the workpiece, increasing friction, and increasing the holding ability of the workpiece.* The variations observed in

the students' scores depended on the students' ability to give the appropriate responses.

On the other hand, those who scored from 3 to 10 marks in this question managed to give the correct name and function of the device as asked in parts (a) and (b), as well as the types of materials used to manufacture the device as asked in part (c) (i). These students were also able to explain the reason why the part labeled "D" is knurled and covered with soft plate lines, which are: *to help with gripping the workpiece, avoid sliding or slipping of the workpiece, increase friction, and increase the holding ability of the workpiece.* Extract 4.1 illustrates the responses given by one of the students who attempted well the question.

4. Figure 1 shows mechanical device commonly used in the workshop. Study it carefully and then answer the questions that follow:

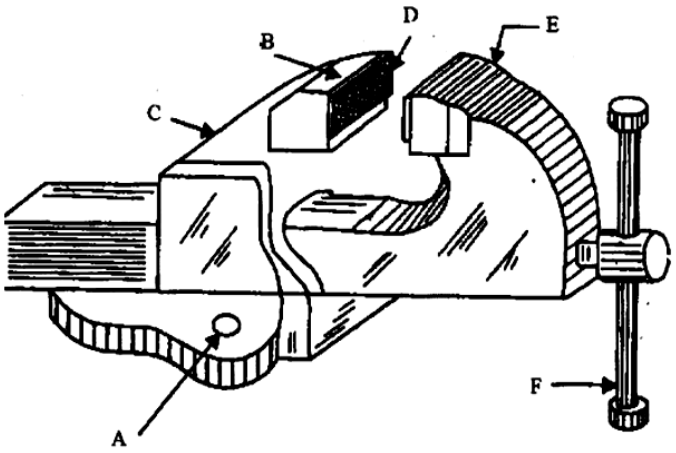


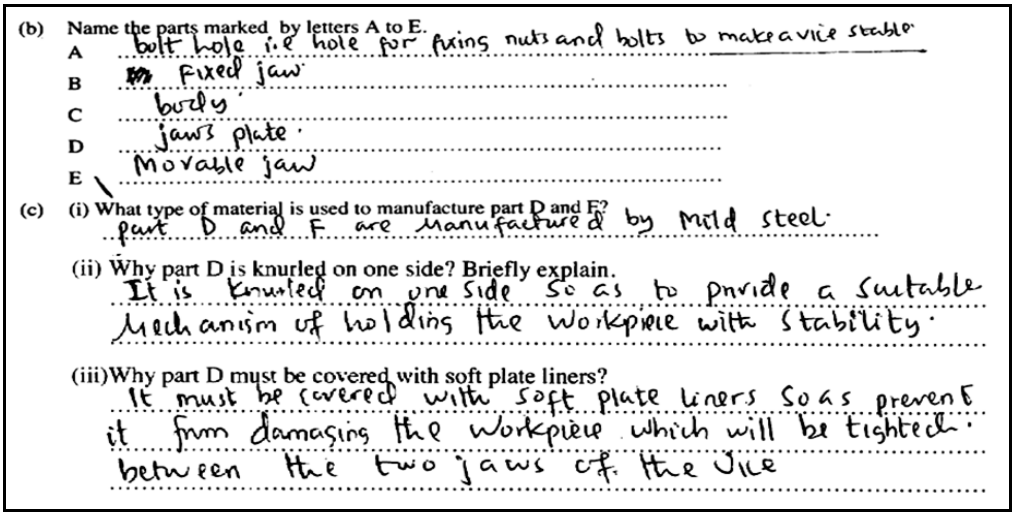
Figure 1

(a) (i) Identify the component shown in Figure 1.

The Componet above is called "Vice"

(ii) What is the main function of the component?

Its function is to hold different materials during certain operations in the workshop for example holding workpiece of a drilling machi


(b) Name the parts marked by letters A to E.
A bolt hole i.e hole for fixing nuts and bolts to make a vice stable
B Fixed jaw
C body
D jaws plate
E Movable jaw
(c) (i) What type of material is used to manufacture part D and F?
part D and F are manufactured by Mild steel
(ii) Why part D is knurled on one side? Briefly explain.
It is knurled on one side so as to provide a suitable mechanism of holding the workpiece with stability.
(iii) Why part D must be covered with soft plate liners?
It must be covered with soft plate liners so as prevent it from damaging the workpiece which will be tightech between the two jaws of the vice

Extract 4.1:*A Sample of Student's Good Response in Question 4*

Extract 4.1 shows that the student managed to give the correct type and function of the components as asked in part (a). However, she/he failed to name exactly the parts marked with the letter D and the materials used to make them. This shows that he/she was familiar with the tool, the materials used in its manufacture, its application, and the reasoning behind the device's surface finishing.

Nonethless, 157 (37.03%) students had poor performance because their scores ranged from 0 to 1.2 marks. Students who received zero points did not correctly answer all questions. For example, one student mentioned the name and function of the device in parts (a) (i and ii) as "*grinding machine and provide the output of a cutting tool*" instead of "*bench vice*" and uses it to hold the work in the workshop. Another student in part (b) named the marked parts as "*A for nuts, B for plates, C for surface grinding, and E for strength"* instead of "A for hole, B for fixed jaws, C for jaw plate, and E for movable jaw. Students who received 0.5 to 2.5 marks, on the other hand, were able to correctly respond to a few parts by naming and identifying the part but failed to identify the material used to make the component and in providing the reason for knurling and covered the knurled part. Extract 4.2 shows a sample of an incorrect response from the student who scored low marks.

4. Figure 1 shows mechanical device commonly used in the workshop. Study it carefully and then answer the questions that follow:

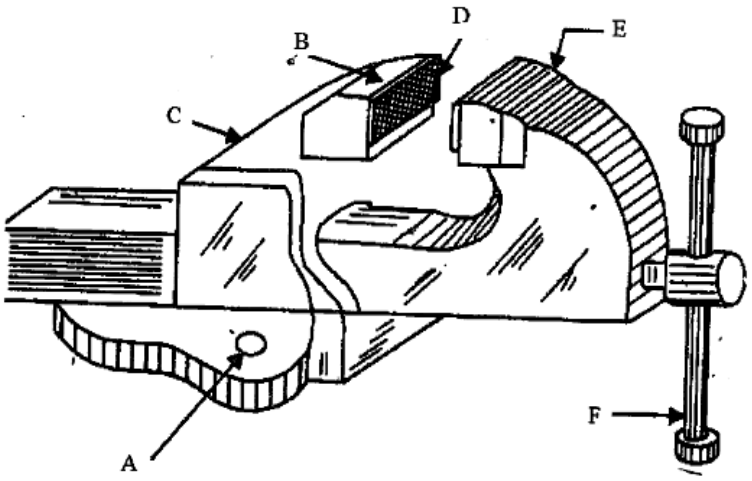


Figure 1

(a) (i) Identify the component shown in Figure 1.

Is the tools used to cutting the soft word in the mechanical workshop.

(ii) What is the main function of the component?

To cutting the metal example wood in the process of bulding and manufacture of material

(b) Name the parts marked by letters A to E.

A Valve

B Motor

C table work

D Wives

E Column

(c) (i) What type of material is used to manufacture part D and F?

Iron material is used to manufacture

(ii) Why part D is knurled on one side? Briefly explain.

Because to supply the soft materials and removed another side in machine.

(iii) Why part D must be covered with soft plate liners?

Part D must be covered with soft plate liners because the part D can movered the small soft plate metal

Extract 4.2:*A Sample of Student's Poor Response in Question 4*

Extract 4.2 shows a sample responses from a student who failed to correctly respond to allparts of this question. This implies that, the student lacked knowledge abouttheconcepts tested.

2.2.3 Question 5: Metal Work Technology

This question was derived from the sub-topic of *Electrical Arc Welding*. It had two parts, (a) and (b). Part (a) required the students to explain briefly the terms (i) arc crater, (ii) arc blow, (iii) welding polarity, (iv) flux, and (v) arc length as used in the arc welding process. Part (b) required the students to analyze five safety precautions taken into consideration in the welding workshop. The question is designed to assess students' knowledge of the welding process and its safety precautions.

The question was attempted by 424 (100%) students, out of whom 134 (31.60%) scored from 0 to 2.0 marks, 252 (59.44%) scored from 3.0 to 6.0 marks, and 38 (8.96%) scored from 7 to 10 marks. Generally, the students' performance in this question was good, since 290 (68.40%) of the students scored from 3.0 to 10 of the allocated marks. This performance is summarized in Figure 5.

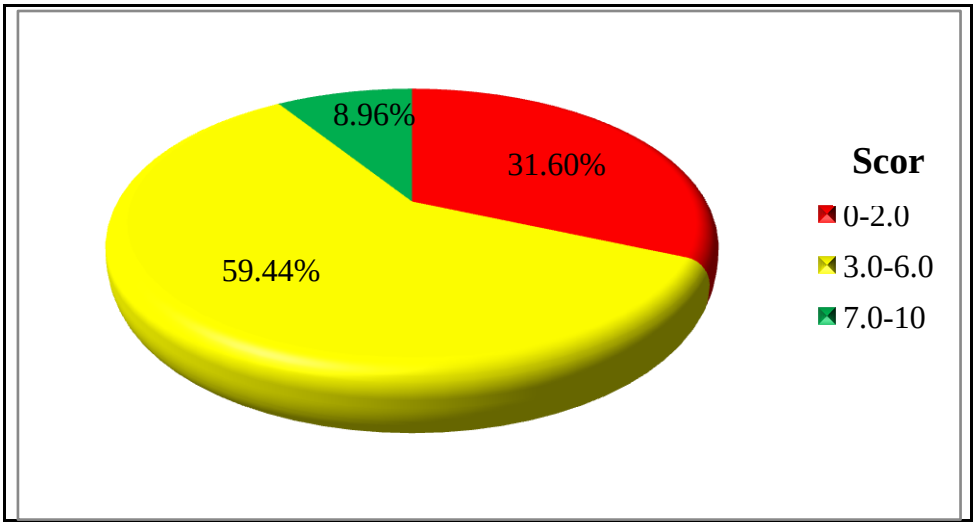
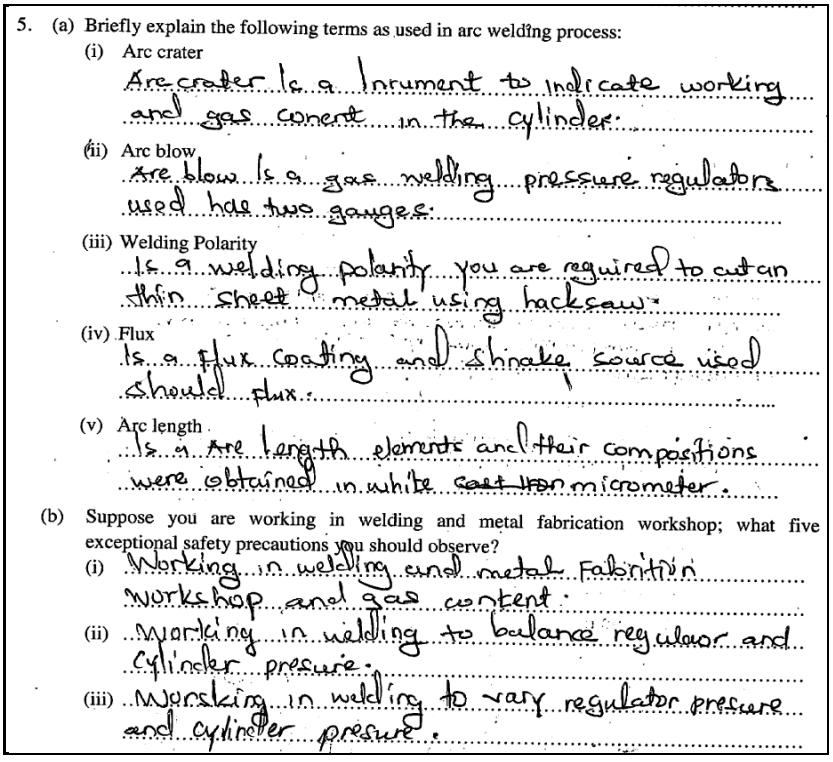


Figure 5:*Students' Performance in Question 5*

The performance trend in Figure 5 shows that students' performance was good since 68.40 percent scored above 3.0 marks. The students' response analysis reveals that students (31.60%) who performed poorly had inadequate knowledge of the arc welding process and its terminology. Some of these students provided irrelevant answers. For example, in part (a) (i), one of the

students gave the definition of "arc crater" as *the situation that occurs when you travel at high speed.* Other students in parts (ii), (iii), (iv), and (v) explained the terms "arc blow,welding polarity, flux, and arc length" as *the amount of current that is being supplied from the welding sources; the quantity of current that is to be used in the welding process from its electric sources; the material that is used to remove dust; and the length between two or more metals that are going to be joined.* These are incorrect explanations. These were unaware that an arc crater and an arc blow are both welding defects that can occur during the welding process if proper procedures are not followed.

On the other hand, those who failed to explain the terms flux and arc length did not know that those were the material used to coat the electrode and the distance from the electrode to the attachment point on the workpiece, respectively.Extract 5.1 is an example of a poor response from one of the students' scripts.


5. (a) Briefly explain the following terms as used in arc welding process:

(i) Arc crater

Arc crater is a Inrument to indicate working and gas conent in the cylinder.

(ii) Arc blow

Arc blow is a gas welding pressure regulators used has two gauges.

(iii) Welding Polarity

Is a welding polarity you are reguired to cut an thin sheet metal using hacksaw.

(iv) Flux

Is a flux coating and shielg source used should flux.

(v) Arc length

Is a Arc length elements and their compositions were obtained in white cast iron micrometer.

(b) Suppose you are working in welding and metal fabrication workshop; what five exceptional safety precautions you should observe?

(i) Working in welding and metal Fabrition workshop and gas content.

(ii) Working in welding to balance regulator and cylinder pressure.

(iii) Working in welding to vary regulator pressure and cylinder pressure.

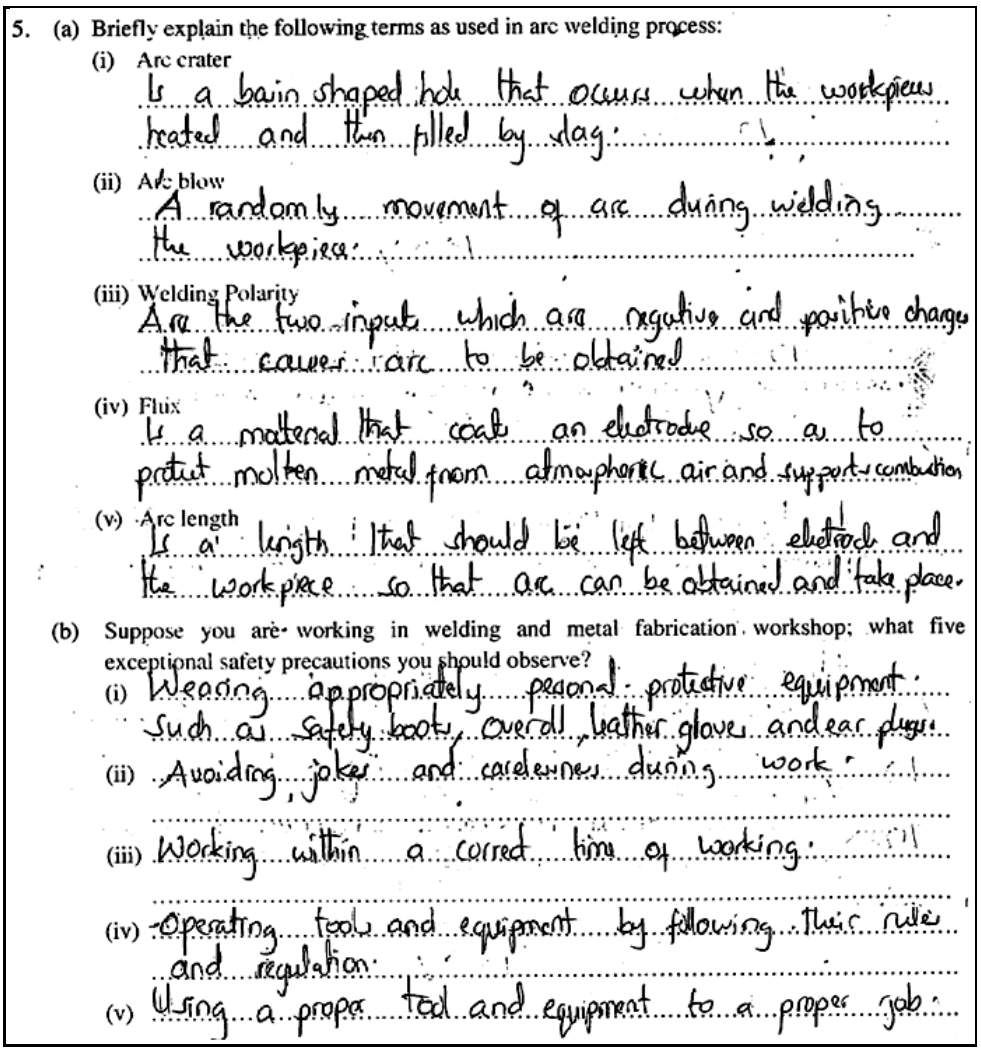
Extract 5.1:*A Sample of Student's Poor Response in Question 5*

In Extract 5.1, the student provided incorrect terms used in arc welding processes. For example, she/he described an arc blow as the gas welding pressure regulator having two gauges, which is incorrect. She/he failed to

understand that the question was based on the arc welding process and not the gas welding process. Additionally, she/he did not distinguish between the terms "arc blow" and "pressure regulator," as "arc blow" is a welding phenomenon that can happen when unstable arcs wander or oscillation away from the place of welding which caused by external magnetic fields, such as those produced by nearby equipment or materials. Whereas "pressure regulator" refers to the device used to control the pressure of the gases in oxyfuel welding. This indicates that she/he lacked sufficient knowledge of the arc welding processes.

Beside that, 59.43 percent of the students who scored average performance (4 to 6 marks) were able to give a correct response to some part of the question or mixed correct and incorrect responses for both parts. For example, one student managed to answer correctly in part (b) but failed the whole part (a). This indicates that she/he is competent in the area of safety precautions but not in the arc welding defects and techniques requested. Furthermore, other students provided correct responses in part (a) but made reflections on points about exceptional safety precautions that are required to be taken in the welding workshop. These responses prove that the students had adequate knowledge of safety precautions but only partial knowledge of the terminologies used in various welding processes.

On top of that, 8.96 percent of students with a good performance were the ones who provided relevant responses and met most of the requirements of the question. These students proved to have a clear understanding of the demands of the question, thus providing appropriate answers to most of the parts asked. Extract 5.2 is an example of responses from a student who performed well.



5. (a) Briefly explain the following terms as used in arc welding process:

(i) Arc crater

Is a bain shaped hole that occurs when the workpiece heated and then filled by slag.

(ii) Arc blow

A randomly movement of arc during wedding the workpiece.

(iii) Welding Polarity

Are the two inputs which are negative and positive charge that cause arc to be obtained

(iv) Flux

Is a material that coats an electrode so as to protect molten metal from atmospheric air and support combustion

(v) Arc length

Is a length that should be left between electrode and the workpiece so that arc can be obtained and take place.

(b) Suppose you are working in welding and metal fabrication workshop; what five exceptional safety precautions you should observe?

(i) Wearing appropriately personal protective equipment such as safety boots, overall, leather gloves and ear plugs.

(ii) Avoiding jokes and carelessness during work.

(iii) Working within a correct time of working.

(iv) Operating tools and equipment by following their rules and regulation.

(v) Using a proper tool and equipment to a proper job.

Extract 5.2:*A Sample of Student's Good Response in Question 5*

In Extract 5.2 the student was able to explain correctly the terms arc crater, arc blow, welding polarity, flux and arc length as applied in arc welding processes. She/he also provided the standard safety precautions that should be followed in a welding workshop. She/he realized that there were usually fires and other sparks from grinding and cutting machines in a welding workshop now. As a result, the presence of oil and other explosive materials may cause burning, resulting in property and infrastructure damage.

2.2.4 Question 6: Workshop Management and Safety Rules

This question was composed from the topic of *Workshop Management and Safety Rules*. The students were required to explain reasons of making

infrastructure for fire preventive or fire break out. The question intended to assess the student's knowledge on the importance of fere preventive in the workshop.

The statistics show that 424 (100%) students attempted this question, out of whom 220 (51.89%) scored from 0 to 2.0 marks, 143 (33.73%) scored from 3 to 6 marks, and 61 (14.49%) scored from 6.5 to 10 marks out of the 10 marks allocated. Figure 6 presents the students' performance on this question.

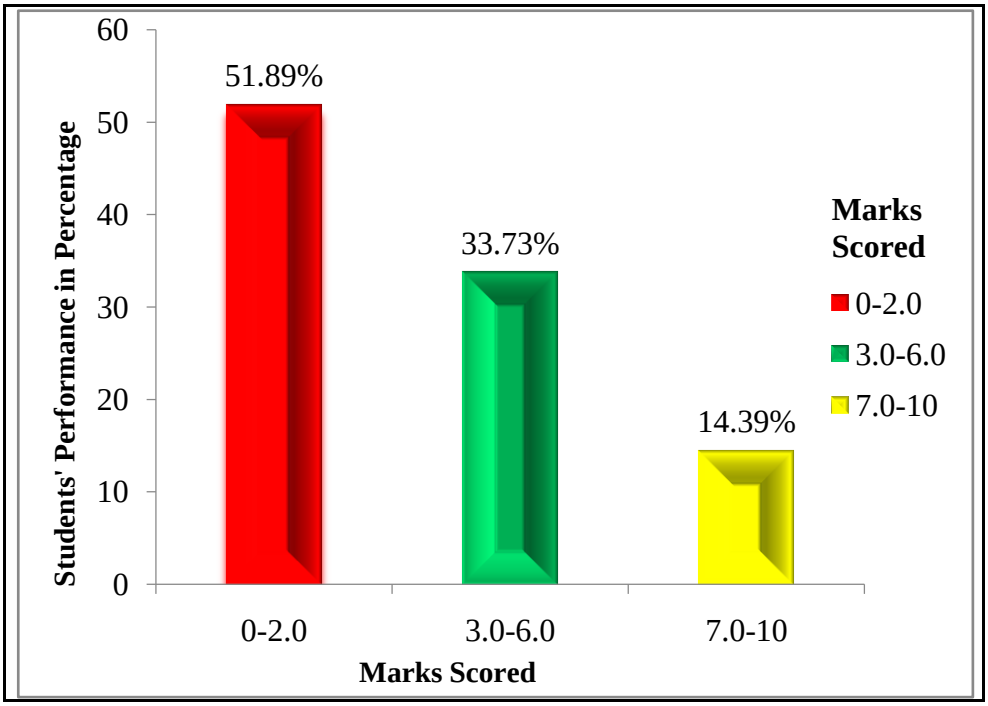
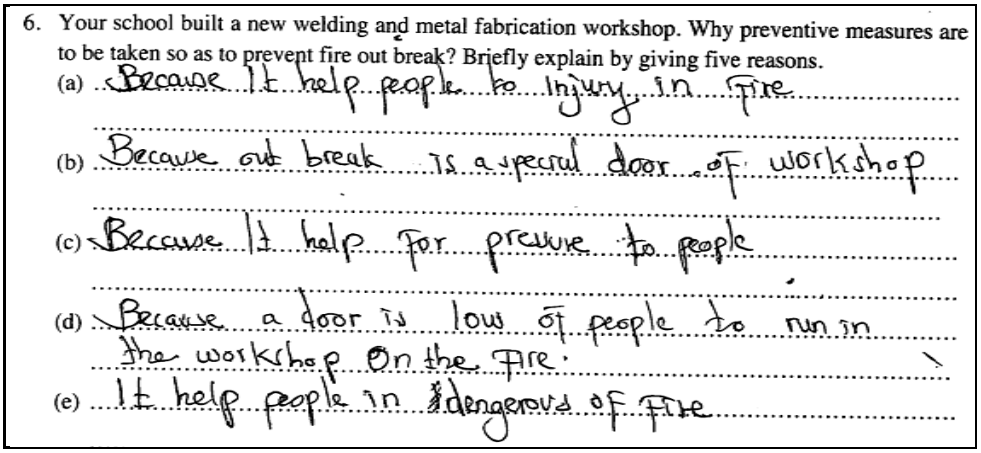


Figure 6:*Students' Performance in Question 6*

Figure 6 shows that the general performance on this question was average because 48.11 percent of the students scored from 3 to 10 marks. This shows that the students had sufficient knowledge of safety precautions and measures to be taken to prevent accidents and hazards.

The observation made on the responses of the 51.89 percent of the students who performed poorly revealed that most of them confused the safety precautions taken for machine shops with those taken to prevent fire outbreaks. For example, one student wrote: *"Turning off machines after use, avoiding overheating of machines, not playing in the workshop, and avoiding working on the high voltage heat"* He/she should have written; *"avoiding damage to equipment, minimizing accidents and injuries, ensuring the safety of fuel and explosive materials, equipping workers with skills in firefighting,*

and creating a safe working environment. These responses demonstrate that the students were unable to distinguish between the safety precautions that should be taken when operating machines and those that should be taken when making fire breaks. Most of them were not aware that a fire requires heat, oxygen, and fuel in order to start and spread. A fire won't start or spread if there isn't heat, oxygen, and fuel. Therefore, one must eliminate heat, oxygen, or fuel in order to put out a fire.Extract 6.1 is a sample of a poor response from one of the students.


6. Your school built a new welding and metal fabrication workshop. Why preventive measures are to be taken so as to prevent fire out break? Briefly explain by giving five reasons.

(a) Because It help people to injury in fire

(b) Because out break is a special door of workshop

(c) Because It help for presure to people

(d) Because a door is low of people to run in the workshop On the fire.

(e) It help people in dengerous of fire

Extract 6.1:*A Sample of Student's incorrect Response in Question 6*

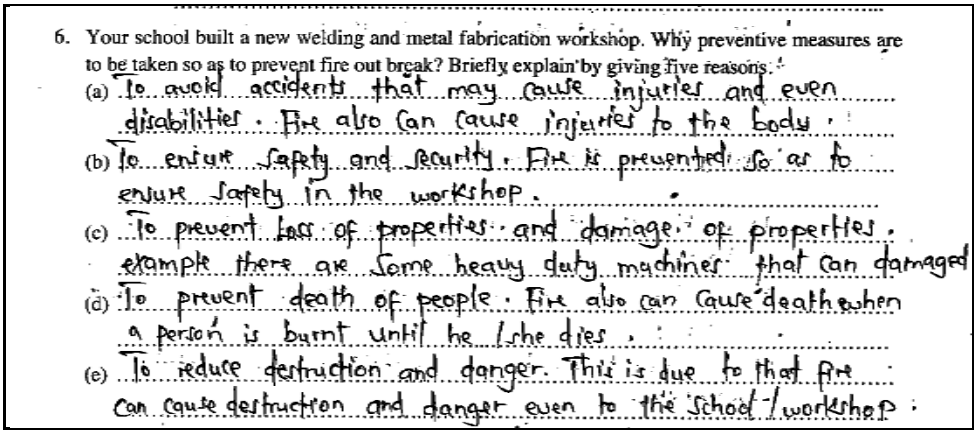
In Extract 6.1, the student provided incorrect responses to all parts of the question. She/he outlined the safety measures to be performed when carrying out tasks in the welding workshop rather than why fire outbreaks in the workshop. This demonstrates that she/he did not understand that a fire outbreak is an abrupt eruption, an outburst of flame, light, and heat created when anything burns.

On other hand, the students who scored average (33.73%) managed to provide few reason of necessity of making fire out breaks in the welding workshop, but mixed with other general safety reasons of machine shop. For example, one student wrote: *wear safety equipments in the workshop; It may caurse distruction of the workshop;* another wrote: *to protect the machine and the workshop as well as to make school safe*. These responses show that, the students were knowledgeable in the safety but misunderstood the requirement of the question.

However, the students who received an average score (33.73%) partially understood the reasons for making *fire* breaks in the welding workshop. Hence they provideed few reasons or mixed the correct responses with other

general safety reasons for the machine shop. For example, one student wrote: "*Wear safety gear in the workshop; it may lead to workshop destruction*." Another wrote: "*To make the school safe as well as to protect the machine and the workshop*." These responses demonstrate the students familiarity with safety but also their confusion on the question's requirements.

Additionally, 14.39% of the students with higher marks were able to correctly demonstrate why a fire outbreak in welding workplaces should be taken into account. They were aware that in order to reduce risks and accidents, the proper precautions should be taken in every welding workshop. These can entail getting rid of the fire risk, shifting the welding project, or covering the risk using nonflammable materials. Before and during welding, welding environments and their surroundings must be kept clean and free of flammable materials. Most of the time, only places that have been specifically created to reduce possible fires should be used for welding activities.. Extract 6.2 shows a sample of response from a candidate who provided relevant answer to this question.


6. Your school built a new welding and metal fabrication workshop. Why preventive measures are to be taken so as to prevent fire out break? Briefly explain by giving five reasons.
(a) To avoid accidents that may cause injuries and even disabilities. Fire also can cause injuries to the body.
(b) To ensure safety and security. Fire is prevented so as to ensure safety in the workshop.
(c) To prevent loss of properties and damage of properties. example there are some heavy duty machines that can damaged
(d) To prevent death of people. Fire also can cause death when a person is burnt until he/she dies.
(e) To reduce destruction and danger. This is due to that fire can cause destruction and danger even to the school/workshop.

Extract 6.2: *A Sample of a Student's Good Response in Question 6*

In Extract 6.2 the student managed to explain the importance of making a fire outbreak during construction of a welding workshop. This indicate that she/he demonstrated adequate knowledge of workshop safety precautions and its measures to be taken, hence scored higher marks.

2.2.5 Question 7: Workshop Tools and Equipment

This question had two parts (a) and (c) extracted from the sub-topic called *Use of Mechanical Tools and Equipment*. The students were required to use their knowledge of using a handsaw to respond to the two parts of this question. Part (a) required students to identify two causes of tooth breakage:

excessive tooth wear and blade breakage. In part (b), the students were required to analyze four precautions that should be taken to avoid the faults stated in part (a). The purpose of the question was to assess how well the students could demonstrate the use of tools in a bench workshop, utilizing the knowledge they had learned in theoretical terms.

The question was attempted by all 424 (100%) students who sat for this paper. Data analysis shows that 310 (73.11%) students scored from 0 to 2.5 marks, 90 (21.23%) scored from 3 to 6.5 marks, and 24 (5.66%) scored from 7 to 10 marks. This performance is summarized in Figure 7.

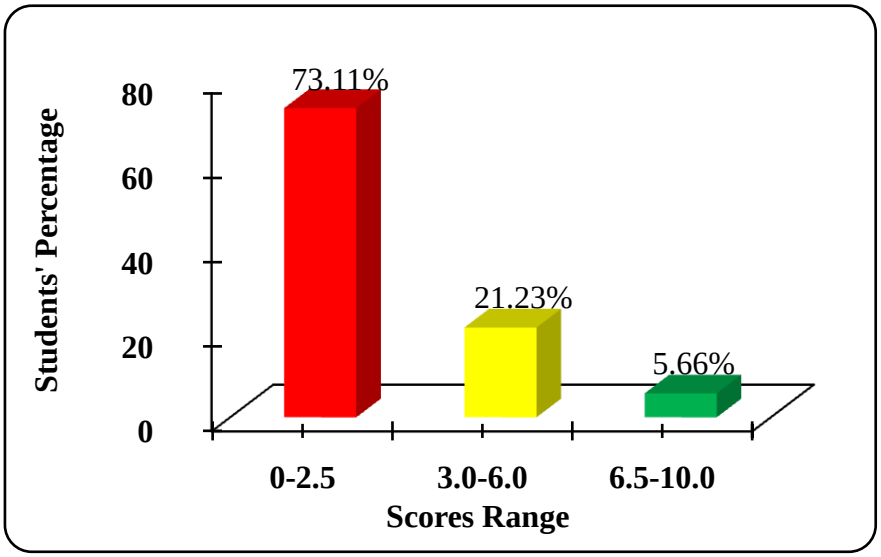


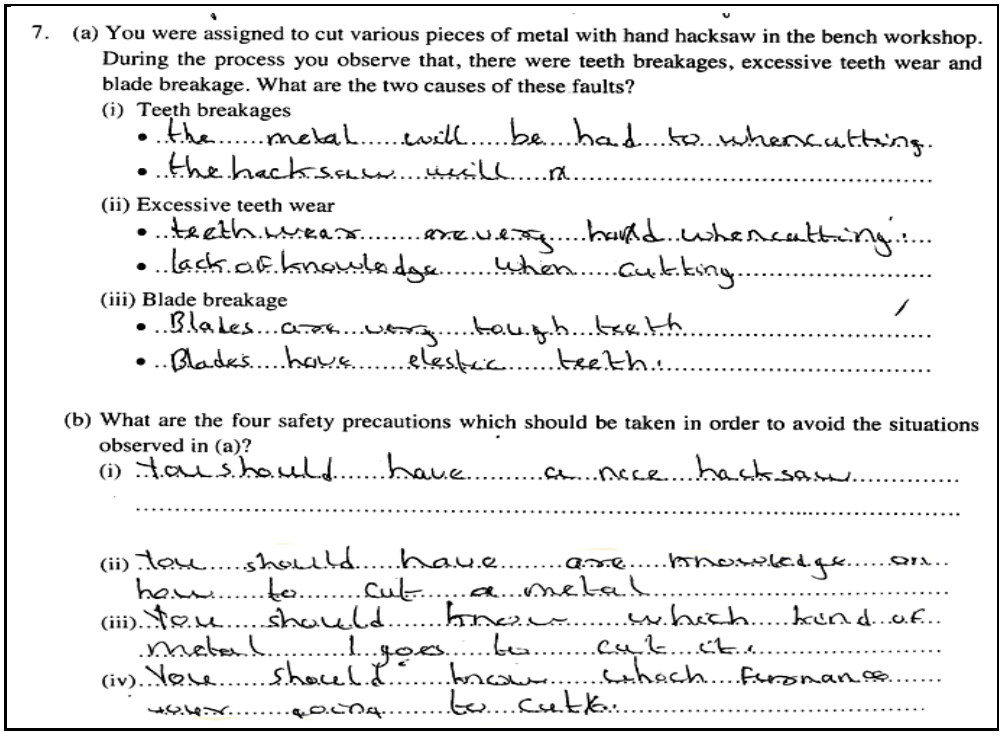
Figure 7:*Students' Performance in Question 7*

Figure 7 shows that the general performance on this question was poor because 73.11 percent of the students achieved weak performance. These students lacked sufficient understanding of tools, equipment, and their uses. Because of this, they were unable to determine the most likely reasons on the problem and the appropriate safety measures to be implemented to guard against tool damage.

In part (a), analysis indicates that the students had insufficient knowledge of faults that may happen in a hand hacksaw and their causes, as well as the safety precautions to be taken to prevent these faults. Also, other students did not understand the requirement of the question, as evidenced by the incorrect answers they provided. For example, in part A, one student wrote the causes of teeth breakage are: (i) *throwing down objects and* (ii) *falling; for causes of excessive tooth wear, she/he wrote that it is due to;* (i) *the drilling process*

and (ii) *doing experiments; and for blade breakage*.She/he also wrote that it is caused when there is no magnetism. Such students did not understand that hand hack saw blade faults can be caused by: incorrect tooth size, incorrect saw blade rotation, not securely fixing the workpiece, sawing against corners, excessive speed and pressure, excessive tensioning, out-of-line strokes, and so on.

In part (b), most students failed to identify the safety precautions to be taken to overcome the faults stated in part (a). Some of the students provided irrelevant responses in this part, either because they did not know the required factors or because they lacked the capability to answer the question. For example, one student wrote that she/he *shouldwear proper workshop uniforms; not use the tools without instructions*; and *not turn on the machine without permission,* etc. while others skipped the part. This indicates that the students lacked knowledge of the various faults of the tool and its proper applications. Extract 7.1 is a sample of the incorrect responses to this question.



7. (a) You were assigned to cut various pieces of metal with hand hacksaw in the bench workshop. During the process you observe that, there were teeth breakages, excessive teeth wear and blade breakage. What are the two causes of these faults?

(i) Teeth breakages

- the metal will be had to when cutting.
- the hack saw will n

(ii) Excessive teeth wear

- teeth wear are very hard when cutting.
- lack of knowledge when cutting

(iii) Blade breakage

- Blades are very tough teeth
- Blades have elastic teeth.

(b) What are the four safety precautions which should be taken in order to avoid the situations observed in (a)?

(i) You should have a nice hacksaw

(ii) You should have are knowledge on how to cut a metal

(iii) You should know which kind of metal I goes to cut it.

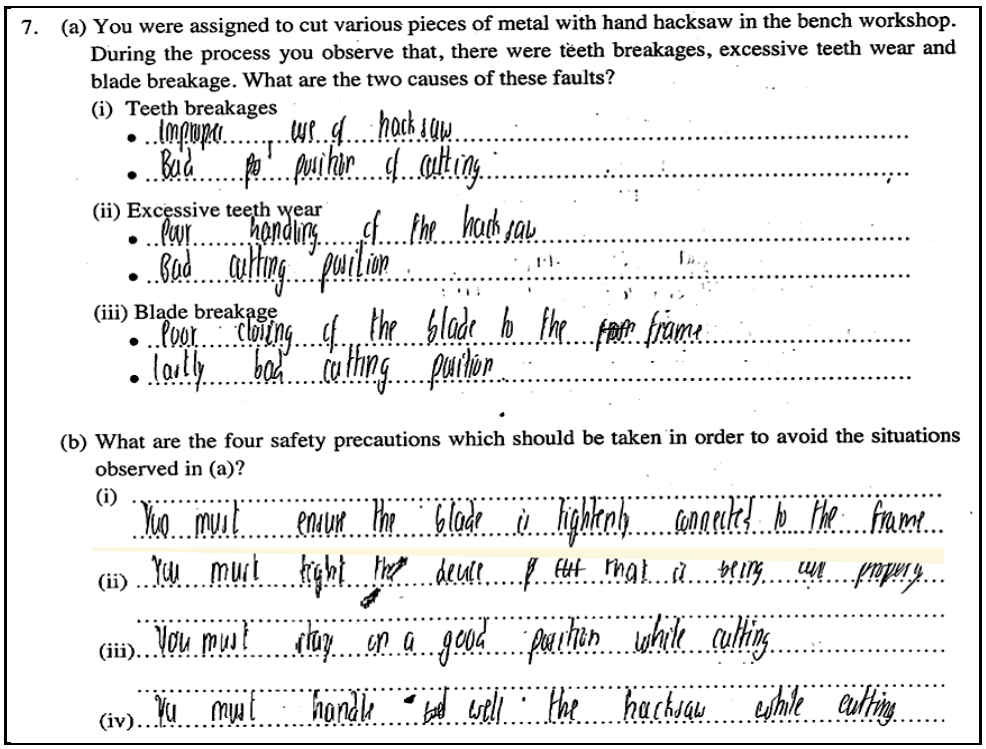
(iv) You should know which firmness wear going to cutte.

Extract 7.1:*A Sample of Student's Poor Response in Question 7*

Extract 7.1 demonstrates that the student's responses to both parts were irrelevant since they were uninformed about probable hand tool faults. There are also numerous problems in the wording utilized.

In contrast, 114 (26.89%) students achieved good performance. In part (a), the students understood that the causes of some faults in using a hand hacksaw blade include: too many teeth on the saw blade for the application; excessive feed rate; material movement caused by clamping problems; an incorrect (reversed); and choice of cutting parameters for the application (reversed) as well as material advancement when the saw blade is in the down position.

In part (b), the students also knew that the following safety measures would be implemented in an effort to prevent and rectify the flaws mentioned in item (a): With the teeth pointing away from the handle, insert the blade into the frame. Make sure the piece is firmly secured; select the appropriate blade type for the material to be sliced; Pick a blade that has the right number of teeth for the material you're cutting; After installing the blade, turn the wing nut three times to apply the proper tension to the blade; if at all feasible, arrange the work in the vice so that the cutting is vertical. Releasing pressure on the back stroke will help you avoid excessive workpiece overhang.Extract 7.2 is an example of a response from a student who performed well.


7. (a) You were assigned to cut various pieces of metal with hand hacksaw in the bench workshop. During the process you observe that, there were teeth breakages, excessive teeth wear and blade breakage. What are the two causes of these faults?

(i) Teeth breakages
- Improper use of hacksaw
- Bad position of cutting

(ii) Excessive teeth wear
- Poor handling of the hacksaw
- Bad cutting position

(iii) Blade breakage
- Poor closing of the blade to the frame
- Lastly bad cutting position

(b) What are the four safety precautions which should be taken in order to avoid the situations observed in (a)?

(i) You must ensure the blade is tightenly connected to the frame

(ii) You must tight the screw of nut that is being use properly

(iii) You must stay on a good position while cutting

(iv) You must handle and well the hacksaw while cutting

Extract 7.2:*A Sample of Student's Good Response in Question 7*

Extract 7.2 shows the responses by a student who managed to analyze the causes of faults and identify the safety precautions to overcome those faults.

This shows that the student really comprehended the topic, which contributed to their high mark.

2.2.6 Question 8: Metal Work Technology

This question had two parts (a) and (b) extracted from the sub-topic *Gas Welding*. The students were required to use their knowledge of the process and operation being done with gas welding to analyze the advantages and disadvantages of the process. Part (a) required students to identify five advantages that make the process more useful than other types of metal joining. In part (b), the students were required to list five disadvantages that make the process not useful. The key objective of the question was to assess students' abilities to choose the proper kinds of metal joints in comparison to other methods.

The question was attempted by 424 (100%) students. Among them, 229 (54.01%) scored from 0 to 2 marks; 181 (42.69%) scored from 3 to 6 marks; and 14 (3.3%) scored from 7 to 10 marks. Figure 8 summarizes this performance.

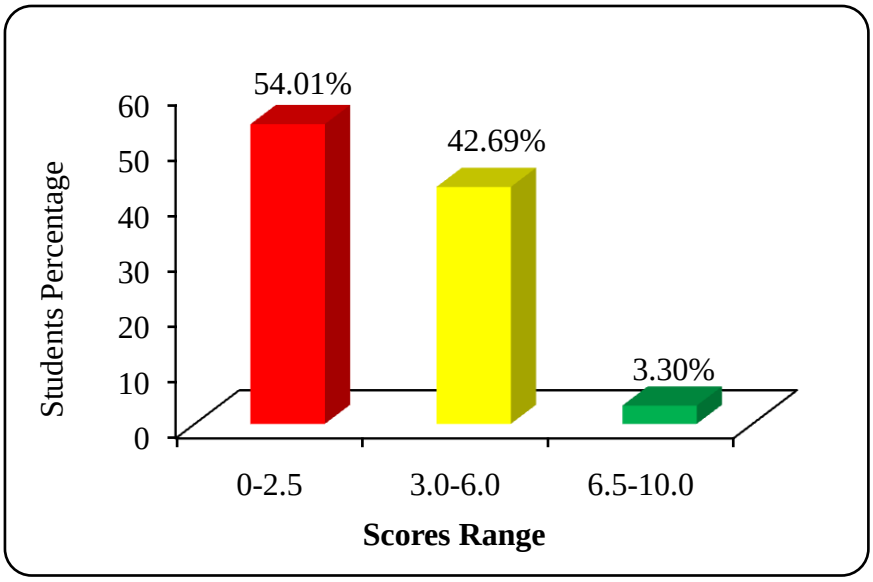


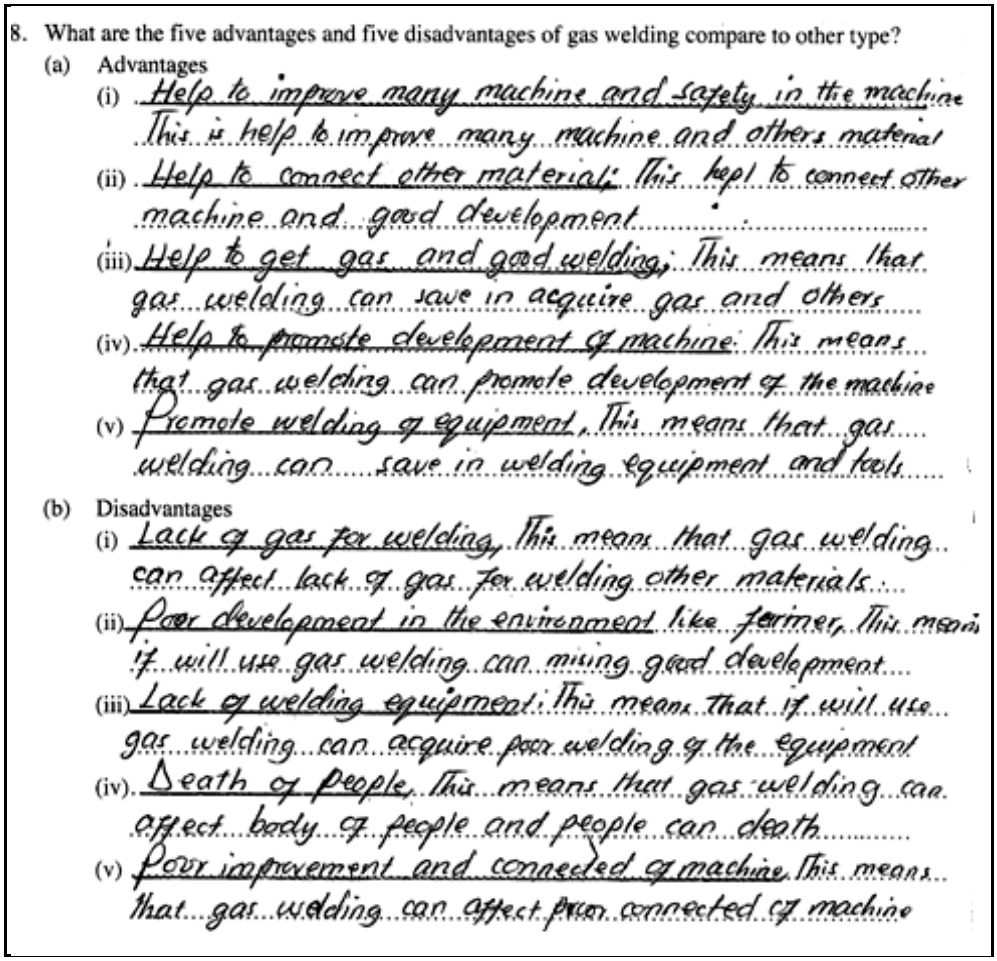
Figure 8:*Students' Performance in Question 8*

Figure 8 shows that the general performance on this question was average since 195 (45.99%) students scored from 3 to 10. This signifies that the students had adequate knowledge of gas welding processes and their benefits.

Part (a) required students to identify the advantages that make gas welding superior to other processes.The results of the analysis show that 54.01 percent of the students who scored from 0 to 4 marks (81.7%) had the following weaknesses in tackling the question: lack of knowledge of the subject matter, failure to address the demands of the question, inadequate gas welding skills, and failure to adhere to the identification of benefits of the processes that distinguish them from other metal joining processes. For example, one of the students lists the function instead of the reason that led them to the benefits. She/he wrote: *used for ferrous, used for automobile air crafts, used for field work,* etc. The students did not know that both joining processes are applied in those areas that she/he mentioned. However, the question required the student to identify what makes this joining process unique. Another student wrote: *"to make the work stronger and more malleable."* Those who provided an incorrect answer were unaware that, among other things, gas welding has numerous advantages over other metal joining methods. These including: Gas welding can be used to join ferrous and nonferrous metals due to its superior strength over other welding processes.When we compare gas welding to the other popular weld methods like arc welding and other types of welding,gas welding is a versatile process that can be performed outside or in remote locations without specialized equipment, but it requires skill and knowledge and safety precautions must be taken.In addition, the initial capital required for gas welding is very low. For some applications, this is very beneficial; another benefit of gas welding is that it doesn't require highly specialized labour. This makes it easier to find gas welders as well as keeping the labor charge low. The other advantage is that its plant is relatively easy to pick up and move around, unlike some other forms of welding, etc.According to the results of the analysis, the majority of the students lacked sufficient knowledge and skills in the gas welding process.

In part (b), the majority of students failed to list the disadvantages that make the process unfit for certain circumstances. The majority of them failed to identify that the process is appropriate for thinner sheets but not for thicker sections. Another disadvantage is that the heating rate is quite slow, which slows down the entire process. Also, the process does not reach the same temperatures as arc welding. Therefore, it isn't the ideal type of welding for high-strength steels. In another case, the process is missing a dedicated flux shielding system, so it might not meet someone's requirement if that is what they are looking for.

Additionally, the students were unaware that the procedure calls for stringent safety precautions to avoid accidents like explosions or flames brought on by sparks igniting flammable objects close to the work area. Another disadvantage of gas welding is that it can be difficult to utilize it in confined spaces or places with limited access since it creates heat that could harm neighboring components or start fires if not adequately controlled. However, the procedure necessitates a certain level of talent, and effective welders need both in order to master this sort of weld and consistently create high-quality results on various metals and alloys.Extract 8.1 is a sample of a poor response from the script of one of the students.



8. What are the five advantages and five disadvantages of gas welding compare to other type?

(a) Advantages

(i) Help to improve many machine and safety in the machine This is help to improve many machine and others material

(ii) Help to connect other material: This kepl to connect other machine and good development

(iii) Help to get gas and good welding: This means that gas welding can save in acquire gas and others

(iv) Help to promote development of machine: This means that gas welding can promote development of the machine

(v) Promote welding of equipment, This means that gas welding can save in welding equipment and tools

(b) Disadvantages

(i) Lack of gas for welding, This means that gas welding can affect lack of gas for welding other materials

(ii) Poor development in the enviroment like farmer, This means if will use gas welding can mising good development

(iii) Lack of welding equipment: This means that if will use gas welding can acquire poor welding of the equipment

(iv) Death of people, This means that gas welding can affect body of people and people can death

(v) Poor improvement and connected of machine This means that gas welding can affect poor connected of machine

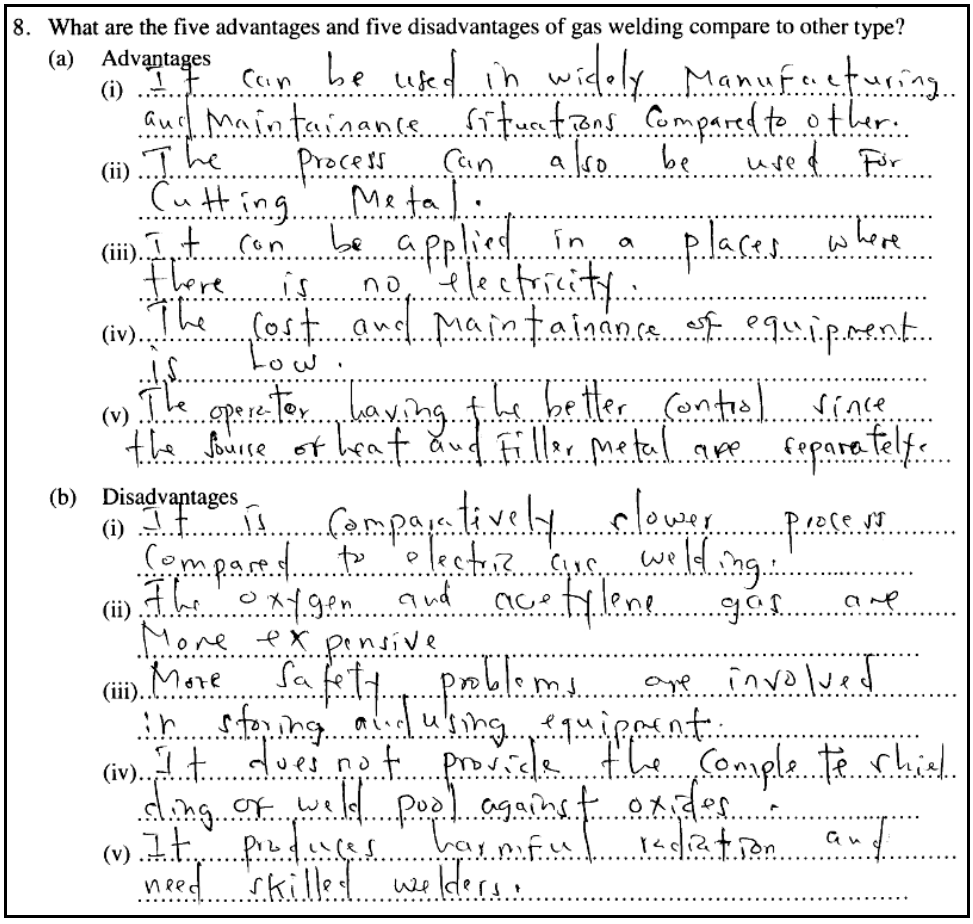
Extract 8.1: A Sample of Student's Irrelevant Response to Question 8

In Extract 8.1, the student wrote responses that showed that he/she did not understand the requirements of the question. Instead of identifying which reason makes the gas weld most useful compared to others, as asked in part

(a), she/he provides the functions of the welding process. Again instead of listing disadvantages that make the process unprofitable, the student mentioned some precautions and the safety of the gas and equipment used in the plant in part (b). This demonstrates that she/he lacked knowledge of the gas welding process.

Furthermore, 42.69 percent of students who received 3 to 6 marks were able to address the question's demands and had adequate mastery of the subject matter, as well as a relatively good skill in gas welding, but provided insufficient points. Some students repeated some points and, due to this, were unable to exhaust all the required points. This reduced their potential to score higher marks.

On the other hand, marks ranging from 10 to 15 were scored by only 3.3 percent of the students who were able to comprehend the demands of the question. They offered relevant points with comparative examples of other types of welding and joining of metal. This implies that the students had adequate knowledge of the gas welding process and its benefits. Extract 8.2 is a sample of the correct responses of a student with good performance.


8. What are the five advantages and five disadvantages of gas welding compare to other type?

(a) Advantages

(i) It can be used in widely Manufacturing and Maintainance situations Compared to other.

(ii) The process can also be used For Cutting Metal.

(iii) It can be applied in a places where there is no electricity.

(iv) The cost and maintainance of equipment is low.

(v) The operator having the better control since the source of heat and Filler metal are separatelfe.

(b) Disadvantages

(i) It is Comparatively slower process Compared to electric arc welding.

(ii) The oxygen and acetylene gas are More expensive

(iii) More safety problems are involved in storing and using equipment.

(iv) It does not provide the Comple te shiel ding of weld pool against oxides.

(v) It produces harmful radiation and need skilled welders.

Extract 8.2: *ASample of Student's Good Response in Question 8*

Extract 8.2 shows a student's response in which she/he identified the types of benefits and drawbacks that distinguish gas welding from other types of metal joints. This indicates that she/he had adequate knowledge of gas welding and hence deserved higher marks.

2.2.7 Question 9: Workshop Management and Safety Rules

This question was derived from the topic of *workshop management and safety rules.* It had two parts, (a) and (b). In part (a), the studentswere required to describe the types of fire for which the stated media will be used as an extinguisher. Part (b) required the students to identify five preparations to be done during the handling of mechanical equipment.The question was:

(a) Water, Foarm and Carbon Dioxide (CO_2) are media used for fire extinguishers.Under which circumstance is it appropriate to use each media?

(i) *Water*

(ii) *Form type*

(iii) *Carbon dioxide (CO_2)*

(b) Suppose you are working in a mechanical workshop and you are required to arrange the materials using materials handling equipment such as forklift. Briefly explain four precautions you will take when handling mechnaical equipment.

The analysis of the students' performance shows that 136 (32.08%) students scored from 0 to 2 marks, 204 (48.11%) scored from 3 to 6 marks and 84 (19.81%) scored from 7 to 10 marks. Figure 9 represents the performance of the students in question 9.

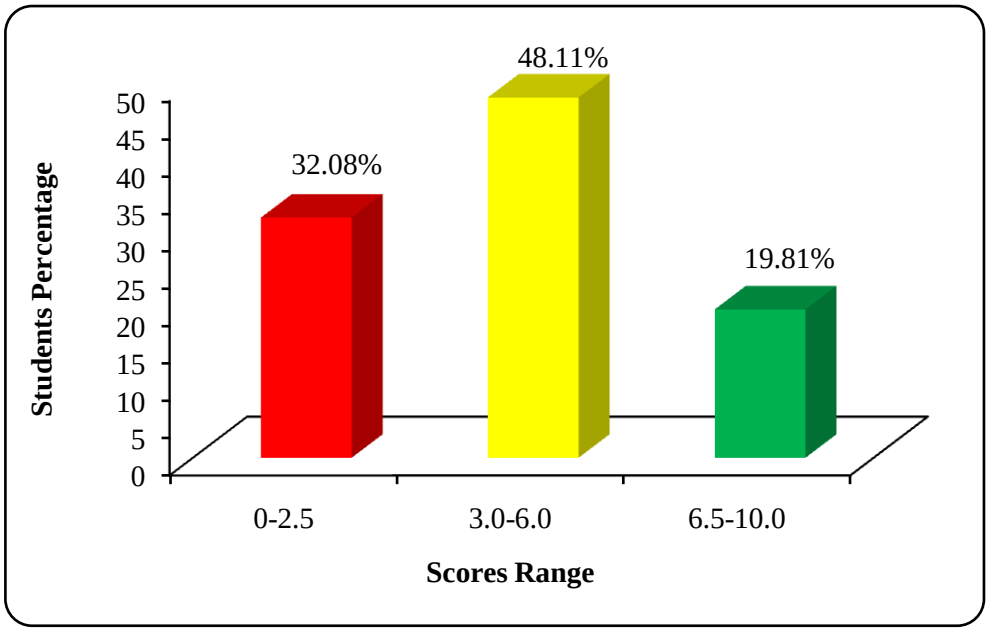


Figure 9:*Students' Performance in Question 9*

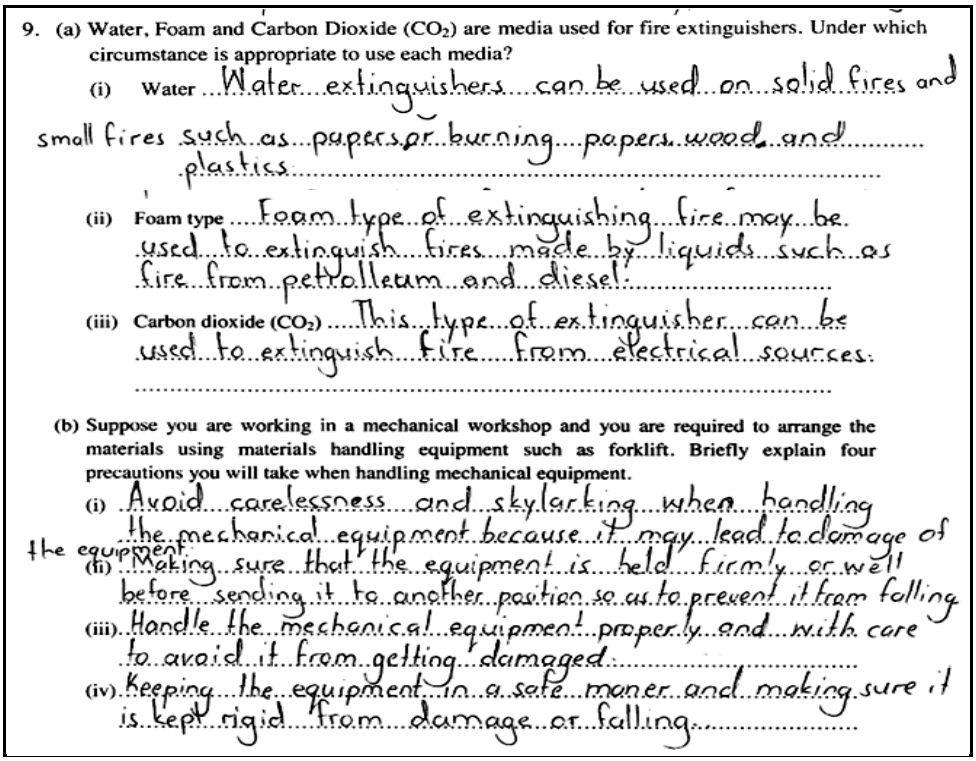
Figure 9 shows that the general performance on this question was good, as 67.92 percent of the students performed above average. This indicates that majority of the students had sufficient knowledge about the topic of workshop management and safety, specifically the concept of safety accidents and their causes and prevention.

Analysis further indicates that students with good performance were 33 (7.78%). These students had adequate knowledge of fire extinguishers and media used for various forms of fire and their effects, as well as the precautions to be taken when handling mechanical equipment.

Part (a) required them to explain the types of fires that the provided media will put out. The analysis of the students' scripts reveals that the majority of

them were able to provide the correct responses in part (a). They knew that fire is grouped into five categories, which are: Class A: freely burning, combustible solid materials such as wood or paper; Class B: flammable liquid or gas; Class C: energized electrical fire (an energized electrical source serves as the ignitor of a class A or B fire; if the electrical source is removed, it is no longer a class C fire); Class D: metallic fire (titanium, zirconium, magnesium, sodium), and Class K: Animal or vegetable oils or fats are used in cooking. Consequently, they understood that, regardless of the types of fire, there will always be the same four elements present, which are: fuel, heat, oxygen, and a chain reaction.

In part (b), the students managed to provide the precautions that should be taken when handling materials. Hence, they provided the correct safety precaution required to be taken during material handling. This indicates that they had sufficient knowledge of material handling and its precautions. Extract 9.1 is a sample of the correct responses of a student with good performance.



9. (a) Water, Foam and Carbon Dioxide (CO_2) are media used for fire extinguishers. Under which circumstance is appropriate to use each media?

(i) Water Water extinguishers can be used on solid fires and small fires such as papers or burning papers, wood and plastics

(ii) Foam type Foam type of extinguishing fire may be used to extinguish fires made by liquids such as fire from petrolleum and diesel.

(iii) Carbon dioxide (CO_2) This type of extinguisher can be used to extinguish fire from electrical sources.

(b) Suppose you are working in a mechanical workshop and you are required to arrange the materials using materials handling equipment such as forklift. Briefly explain four precautions you will take when handling mechanical equipment.

(i) Avoid carelessness and skylarking when handling the mechanical equipment because it may lead to damage of the equipment.

(ii) Making sure that the equipment is held firmly or well before sending it to another position so as to prevent it from falling

(iii) Handle the mechanical equipment properly and with care to avoid it from getting damaged.

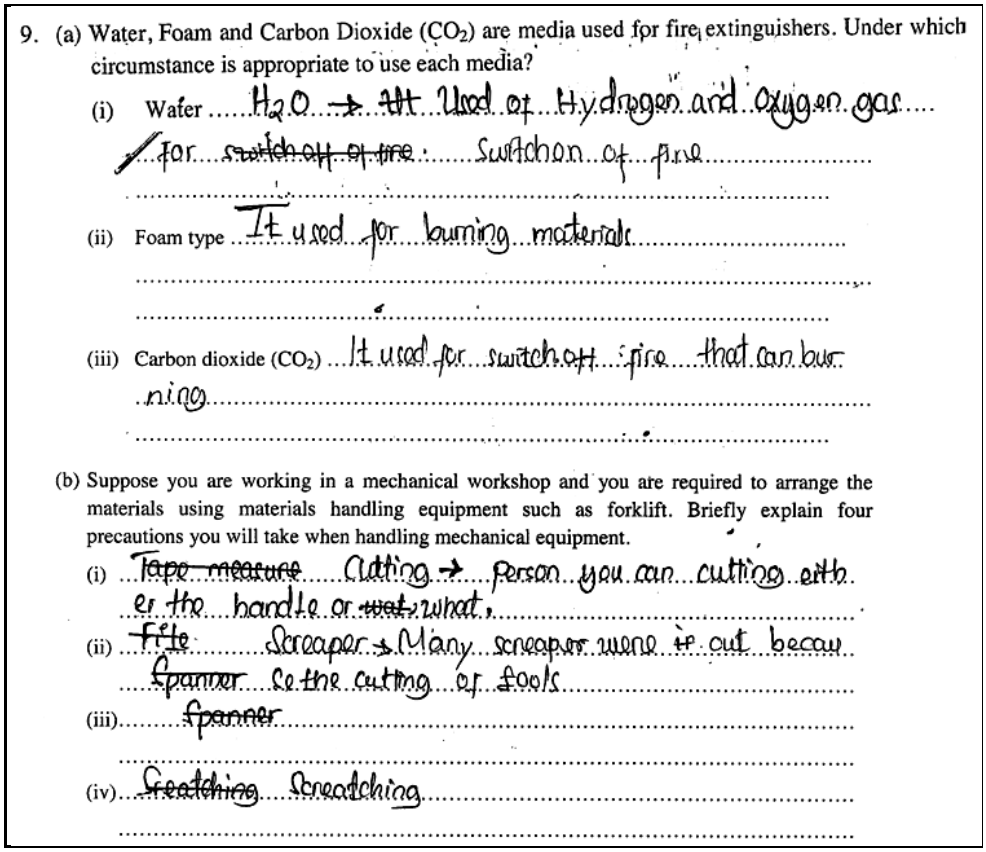
(iv) Keeping the equipment in a safe maner and making sure it is kept rigid from damage or falling.

Extract 9.1: *A Sample of Student'sGoodResponse in Question 9*

In Extract 9.1, the student was able to explain the types of fires that will be extinguished with their respective types of media, as well as precautions to be taken when handling material with mechanical equipment.

However, 204 students corresponding to 48.11 percent, scored from 3 to 6 marks. Most of them identified the correct safety precautions but missed the types of fire and the recommended media and therefore scored average marks.

Apart from the students' whose performance was average in this question, there was 32.08 percent who scored low marks (0-2.0). These students lacked knowledge of accidents' causes and preventions, especially the type of fire, the media used to extinguish it, and safety measures to be taken in material handling. For example, in part (a) (ii), one student wrote, "*The uses of carbon dioxide to extinguish fire in class A, which was caused by materials such as paper and wood.*" The student did not understand that fires of class A could be extinguished with water, while carbon dioxide would be used for fires of class C. Extract 9.2 is a sample of weak responses from one of the students.



9. (a) Water, Foam and Carbon Dioxide (CO_2) are media used for fire extinguishers. Under which circumstance is appropriate to use each media?

(i) Wafer ...H_2O → ~~It~~ Used of Hydrogen and Oxygen gas... ~~for switch off fire~~ : Switchon of fire

(ii) Foam type ...It used for burning materials...

(iii) Carbon dioxide (CO_2) ...It used for switch off fire that can burning...

(b) Suppose you are working in a mechanical workshop and you are required to arrange the materials using materials handling equipment such as forklift. Briefly explain four precautions you will take when handling mechanical equipment.

(i) ~~Tape measure~~ Cutting → person you can cutting either the handle or ~~wet~~ what,

(ii) ~~File~~ Screaper → Many screaper were it out becau ~~Spanner~~ se the cutting of tools

(iii) ~~Spanner~~

(iv) ~~Greatching~~ Screatching

Extract 9.2: *A Sample of Student's Weak Response in Question 9*

In Extract 6.2, the student provided the incorrect responses to all parts of the questions showing that he/she had insufficient knowledge of workshop management and safety rules.

2.3 Section C: Structured Questions

This section consisted of one compasory structured question composed from the topic of *Engineering Materials*. The question had 15 marks.

2.3.1 Question 10: Engineering Materials

This question had three parts, (a), (b), and (c). In part (a), the students were required to mention the type of furnace that can be used for the production of iron from its ores. For part (b), the students were to provide the advantages of that furnace mentioned in part (a) compared with other types. In part (c), the students were asked to provide the explanation and chemical reactions that were undergone in the pig iron. The question was:*Acertain company decided to install a plant for Iron and its product smelting from iron ores. They found out that there are Open hearth furnaces, Cupola furnace an Electric furnace.*

(i) *Giving a reason, advice the company management the type of furnace to install.*

(ii) *What are the advantages of the furnace chosen in (a) when compared to others?*

(iii) *Pig iron production using cupola furnace may involve three main zone namely, combustion or oxidizing zone, reducing zone and melting zone. With the help of chemical reactions, describe the processes undergone in those zone.*

A total of 424 (100%) students attempted the question, whose scores wereas follows: 357 (84.20%) scored from 0 to 4 marks, 62 (14.62%) scored from 5 to 9 marks, and 5 (1.18%) scored from 10 to 15 marks. These scores are presented in Figure 10.

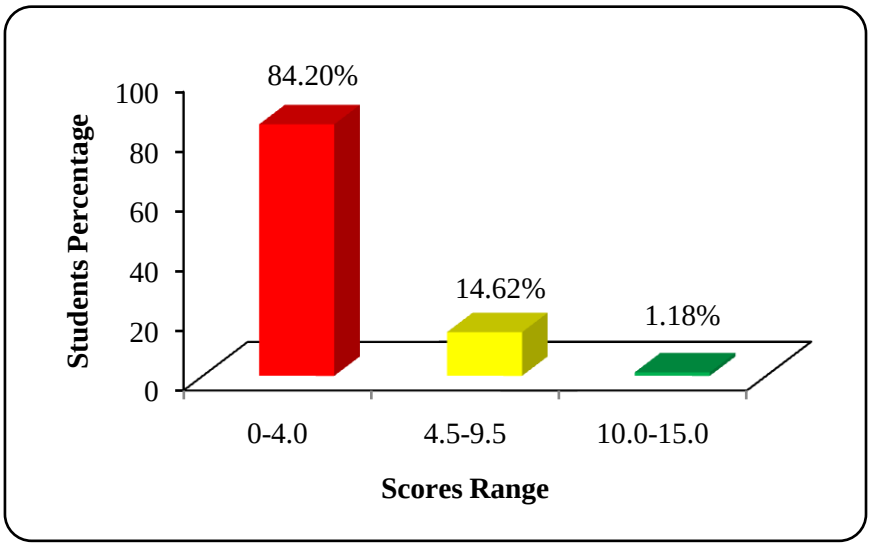


Figure 10:*Students' Performance in Question 10*

Figure 10 shows that the students' general performance on this question was weak since 357 (84.20%) students scored from 0 to 4 marks.

Students who scored low marks (0-4) had inadequate knowledge of the furnace used to extract pig iron from iron ore. Most of them failed to give a relevant response to the question due to lack of knowledge on engineering materials. For example, in part (a), one student wrote: *I will advise the company to use the electric furnace, which is the modern furnace used in the production of steel and has a great market in the world compared to the metals.* This misconception shows that the student concentrated on the modernity and advicing the company management about the appropriate furnaces to insatall based on the function of each type. This student lacked the knowledge that a cupola furnace is the only type of furnace used for extracting iron from its ores. Further analysis on students scripts' responses that those who were unable to choose the proper type of furnace in part (a) also failed to respond correctly to part (b) of this question.

Consequently, in part (c) most of the students failedto provide the chemical reactions that happened during all process. For example, one student wrote: "Combustionzone *as the zone that requires heat processing for production;* reduction zone *as the zone in which the impurities are removed;* and melting zone *as the zone that occurs after combustion and reduction of iron."* This student failed to describe those zones where the raw materials for pig iron production are processed. Student should has understood that the combustion

zone is the area where iron and impurities such as carbon, silicon, and manganese are mixed with hot air and oxidize with oxygen to form oxides. Alternatively, in a "reducing zone," the carbon dioxide decomposes to form carbon dioxide and heat, while in the melting zone, iron combines with carbon dioxide to form iron carbide and carbon dioxide. Failure to describe these components demonstrates that the students in this category had insufficient knowledge and lacked skills about extraction of engineering materials from their ores. Extract 10.1 is a sample of weak responses from one of the students'.

10. A certain company decided to install a plant for Iron and its product smelting from iron ores. They found out that there are Open hearth furnaces, Cupola furnace and Electric furnace.

(a) Giving a reason, advice the company management the type of furnace to install.

...Electric furnace,...because...is...a...furnace...which...uses ...iron...ores...and...other...product....to....manufacture...very.... ...strong...metals...and...materials...that...is...used...elect tricity...for...furnacing.....

.....

(b) What are the four advantages of the furnace chosen in (a) when compared to others?

(i) ....it...uses...electricity...at...low...amount...compared.... ...to...other...furnances.....

(ii) ....it...produce....very...strong...metals...such as...cast iron ...and...compared....to...other.....furnance.....

(iii)....it...does...not....use...more....efficient....to...operate.... ...it...compare.....to...ther.....furnances.....

(iv)....it...produce...very...high...temperature...when...heat ...ing....and...compared...to...other...metal...furnances.

(c) Pig iron production using cupola furnace may involve three main zones namely combustion or oxidizing zone, reducing zone and melting zone. With the help of chemical reactions, describe the process undergone in those zones.

(i) Combustion or Oxidizing zone ....This.....zone...is....completem..... ...by...having...high...amount....of...hot....oxygen...and... .....it...has....still....low....temperature.....

Chemical reaction .....FeO_2.....

.....

.....

(ii) Reducing zone ....is....the....zone....which....there...is...very...high ...amount....of....temperature...for....production...of.... ...pig...iron.....

Chemical reaction ....Fe_2O_2...+...CH_3.....

.....

.....

(iii) Melting zone ...is...a...zone...which....allows....the...molten...iron...to...cool...and...form...pig...iron.....

Chemical reaction ....$FeO_2 + C_{O_2} = (FeO_4)_2$.....

Extract 10.1: *A Sample of Student's Weak Response in Question 10*

In Extract 10.1, the studentprovidedincorrect responses to almost all parts of the question showing that she/he lacked knowledge of Engineering materials.

On the other hand, 14.62 percent of students scored average marks (4.5 -9.5). Most of these students providedthe description of stages and the required chemical reactions for production of pig iron in the cupola furnace while others wrote the correct type of furnace in part (a) and chemical reactions in part (c), but failed to provide the advantages of cupola furnace in part (b).

However, few students (1.18%) scored good marks (10-15). These students provided the correct responses in most parts of the question. They suggested a suitable furnace to install with its advantages. Some of them described correctly the processess undergone in all zone with the aid of balanced chemical reactions. This shows that they had adequate knowledge of engineering materials and their production processes. Extract 10.2 presents one of the correct responses provided by one of the students.

10. A certain company decided to install a plant for Iron and its product smelting from iron ores. They found out that there are Open hearth furnaces, Cupola furnace and Electric furnace.

(a) Giving a reason, advice the company management the type of furnace to install.

The type of furnace to install is Cupola furnace because cupola furnace may conduct into three zone such as Oxidizing zone, Reducing zone, and Melting zone which make easy to the process of producing iron.

(b) What are the four advantages of the furnace chosen in (a) when compared to others?

(i) The furnau make iron production easier than other furnaces.

(ii) The furnau is very accurate compared to other furnaus.

(iii) The furnau is very cheaper than other furnaus.

(iv) The furnace is easy to manage compared to other furnaus.

(c) Pig iron production using cupola furnace may involve three main zones namely combustion or oxidizing zone, reducing zone and melting zone. With the help of chemical reactions, describe the process undergone in those zones.

(i) Combustion or Oxidizing zone In this zone heating of iron contents to produce pig iron being conducted or it's zone where by heating conducted.

Chemical reaction oxygen + iron $\xrightarrow{\text{Heat}}$ Contaminated molten pig iron. $O_2 + Fe \quad 2OFe_2$

(ii) Reducing zone In this zone reduction is being conducted it means make cool of the iron ore being heated.

Chemical reaction

(iii) Melting zone This is the zone where by changing of iron to molten pig iron being conducted.

Chemical reaction Iron ore + limestone + coke $\xrightarrow{\text{Heat}}$ molten pig iron

Extract 10.2:*A Sample of Student's Good Response in Question 10*

In Extract 10.2 the studentcorrectly describeda suitable type of furnace and its benefits. He/she wrote a balanced chemical reactions that took place in the cupola furnace. Despite the fact that some of it were incorrect,thestudent scored good marks.

3.0 ANALYSIS OF THE STUDENTS PERFORMANCE ON EACH TOPIC

The mechanical engineering paper had six topics that were assessed. These topics are: *Metal Work Technology, Mechanical Engineering Jobs and Occupations, Introduction to Science, Engineering, and Technology, Workshop Tools and Equipment, Workshop Management* and *Safety Rules, and Engineering Materials.*

Based on the analysis of the students' performance, good performance was observed in question 1 drawn from varioustopics of:*Engineering Materials, Workshop Tools and Equipment, Workshop Management and Safety Rules, Mechanical Engineering Jobs and Occupations.*The good performance was also observed in*Introduction to Science, Engineering, and Technology, and Metalwork Technology (98.35%)* followed by *Workshop Management and Safety Rules (67.29%)*in questions 2, 6, and 9 respectively. Students whith good performances understood the requirements of the questions and had ability to apply their knowledge and skills to the topics tested.

The average performance was observed in question 5 and 8 (57.2%) from the topic of*Metalworking Technology*and in questions 4 and 7 (44.94%) from the topic of *Workshop Tools and Equipment*. Analysis reveals that the students had satisfactory knowledge and ability to apply the knowledge and skills in the topics assessed in producing drawings, providing explanations, and identifying some mechanical components and systems.

Moreover, weak performance (18.3 percent) was observed in the topic of*Engineering Material (18.3%)* which was tested in question 3 and 10. Lack of knowledge and practical abilities in the subject matter being assessed as well as failure to comprehend the nature of the questions are factors that contributed to students' low performance. A summary of the students' performance on each topic is presented in Appendix I.

4.0 CONCLUSION AND RECOMMENDATION

This section is concluding the remarks and the way forward after the analysis summarized in the previous sections. It concludes the response analysis based on each question and each topic. Although there are several stakeholders responsible for this analysis, most of the recommendations are directed to the students for future improvement.

4.1 Conclusion

The overall performance in the Mechanical Engineering subject on the Form Two National Assessment (FTNA) in 2022 was average, as 59.67 percent of the students scored average or above.

The weak performance of the students was attributed to different factors as explained in the analysis of each question.These includes students' failure to understand the demands of the questions which as observed in question 3 and 10, where most of the students wrote irrelevant responses;insufficient knowledge in some of the tested subject matters was observed in question 10 where 84.20 percent of students failed and in question 3 where 70.28 percent failed;lack of mechanical skill andthe students' failure to explain practical oriented questions asobserved in questions 3 and 10.

4.2 Recommendations

In order to improve the performance of candidates in Mechanical Engineering subject, the following are recommended:

(a) Students should be guided and encouraged to read various Mechanical Engineering books so as to widen their knowledge and skills.

(b) Students should be aided to improve English language by developing the passion of speaking and writing in English. This can be achieved by allowing them to participate in debates, group discussions and presentation of various assignments.

(c) Students should practice drawing different Mechanical Engineering systems, components and graphs. This will help them to acquire appropriate skills of drawing neatly and correctly label diagrams and graphs.

(d) read different books and other sources in order to expand their knowledge, and understand the requirements of the question and subject matter.

(e) Teachers should prepare practical activities so as students can perform well on topics of Engineering Materials.

(f) Students should develop the culture of reading questions carefully before attempting them so that they understand the requirements of the questions.

Appendix I: A Summary of Students' Performance (Topic-Wise)

Table 2: A Summary of Students' Performance (Topic-Wise)

S/N	Topics	Question Number	Percentage of students who scored 30% or more	Remarks
1	Metal Work Technology, Mechanical Engineering Jobs and Occupations, Introduction To Science, Engineering and Technology, Workshop Management and Safety Rules and Engineering Materials	1	98.35	Good
2	Workshop management and Safety rules	2, 6 and 9	67.29	Good
3	Metal work Technology	5 and 8	57.20	Average
4	Workshop Tools and equipment	4 and 7	44.93	Average
5	Engineering Materials	3 and 10	22.76	Weak

Appendix II: General Students' Performance in Mechanical Engineering Subject

Table 3: General Students' Performance in Mechanical Engineering Subject

Grade	Percentage Range	Description	Number of students	Percentage
F	0 – 29	Weak	171	40.33
D & C	30 – 64	Average	251	59.20
B & A	65 – 100	Good	2	0.47
TOTAL			**424**	**100**

Appendix III: Distribution of Student' Performance in Each Question

Table 4: Distribution of Student' Performance in Each Question

Questions	Qn 1	Qn 2	Qn 3	Qn 4	Qn 5	Qn 6	Qn 7	Qn 8	Qn 9	Qn 10
Weak	7	60	298	157	134	221	310	229	136	357
Average	243	245	118	177	252	142	90	181	204	62
Good	174	119	8	90	38	61	24	14	84	5
TOTAL	**424**	**424**	**424**	**424**	**424**	**424**	**424**	**424**	**424**	**424**

Appendix IV: Overall Performance of Students Question Wise for Year 2022

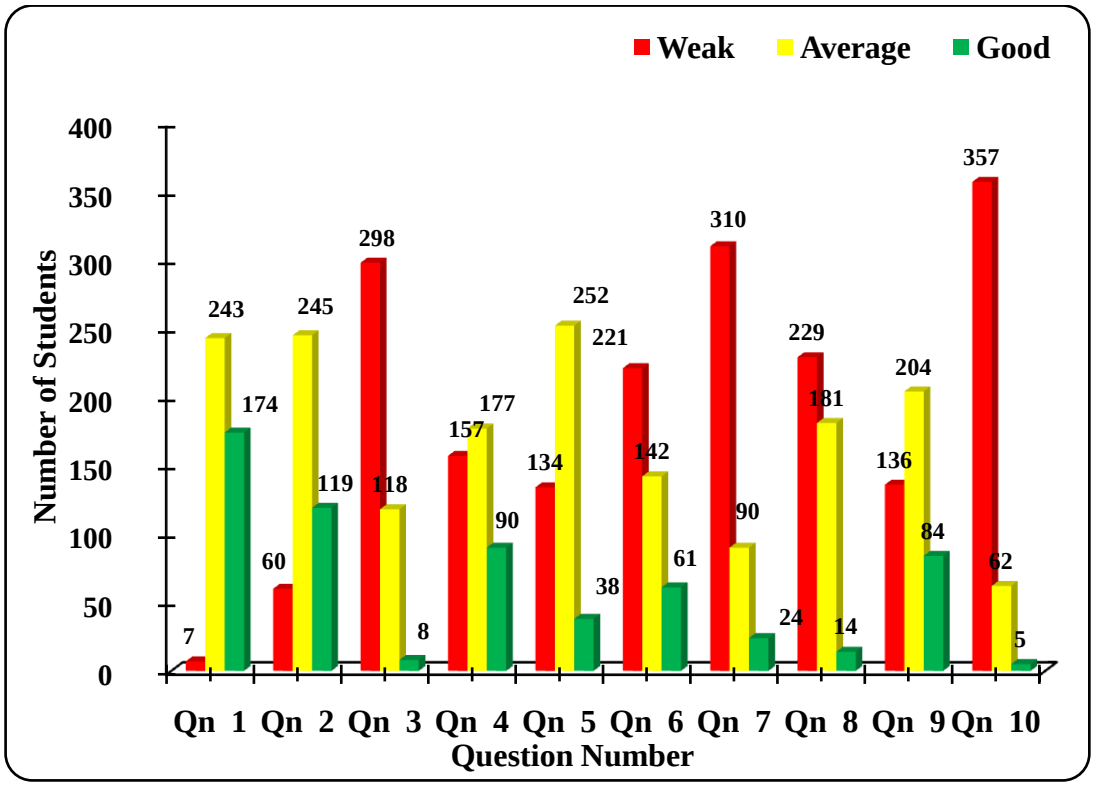


Figure 11: Overall performance of students question wise for year 2022

Appendix V: Student's performance for year 2022 in comparison to the year 2021

Table 5: Student's performance for year 2022 in comparison to the year 2021

YEAR	A	B	C	D	F	TOTAL
2022	0	2	79	172	171	**424**
2021	0	1	28	113	309	**451**