THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

STUDENTS' ITEMS RESPONSE ANALYSIS REPORT ON THE FORM TWO NATIONAL ASSESSMENT (FTNA), 2024

ENGINEERING DRAWING

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091 ENGINEERING DRAWING

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FOREWORD

This report presents Students' Items Response Analysis (SIRA) in Form Two National Assessment in Engineering Drawing subject, which was conducted in November 2024. The report aims to provide feedback to all educational stakeholders on the students' performance in Engineering Drawing subject.

The Form Two National Assessment (FTNA) is a formative evaluation, which intends to monitor students' learning and provide feedback that teachers, students and other educational stakeholders can use to improve teaching and learning processes. This report reveals that, the general performance of the students was good. The assessed students had good performance in the sub topic of Pictorial Drawing, in question 5 and 7 respectively. Followed by sub topic of Construction of International Standard Organization (ISO) Sheet Layout and Sketching, Similar Figures and Intersections of Cylinders in questions 3, 1 and 6. However, the students had average performance in sub topics of Construction of Geometric Figures and poor performance in the sub-topic of Free Hand Sketching.

The performance analysis shows that good and average student performance was influenced by several factors. These include understanding the questions' requirements and having adequate knowledge and skills in some of the tested subject matters. The poor performance of students was due to factors such as misunderstanding the question requirements, lacking knowledge and skills to interpret the problem, and failing to present all required features in their drawings.

The analysis of the students' performance helps to identify students' strengths and weaknesses for future improvement in their learning before sitting for Certificate of Secondary Education Examination (CSEE). It also identifies challenging areas for taking appropriate measures to improve teaching and learning process.

The National Examinations Council of Tanzania (NECTA) expects that, the feedback provided in this report will enable the education stakeholders to take appropriate measures in improving teaching and learning of Engineering Drawing subject. Consequently, students will acquire knowledge, skills and competence indicated in the syllabus for better performance in future assessments and examinations.

Dr. Said A. Mohamed
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report presents the students' performance for Form Two National Assessment (FTNA) in Engineering Drawing subject, which was administered in November 2024. The assessment measured the competencies that the Form Two students had attained in accordance to Engineering Drawing Secondary Education Syllabus which was issued in 2019.

The Engineering Drawing assessment had two sections; A and B, all of which comprised of 7 questions. The students were required to answer all the questions for each section. Section A had four short answer questions, 1, 2, 3 and 4. The questions were constructed from four sub-topics, which are Similar Figures, Geometric Figures, International Standard Organization (ISO) Sheet Layout and Freehand Sketches. The section had a total of 40 marks.

Section B consisted of three questions, (5, 6, and 7) derived from two subtopics from two topics. Question 5 and 7 were based on Pictorial Drawing while question 6 focused on Intersection of Cylinders. The section had a total of 60 marks.

The analysis shows that the overall performance in the 2024 Engineering Drawing FTNA was good, with 241 (70.06%) of passed students. The students' grades were distributed as follows: A-22 (6.36%), B-33 (9.54%), C-121 (34.97%), and D-65 (18.79%). However, 103 students (29.77%) failed by receiving an F grade. The overall performance in 2024 decreased by 3.49% compared to the 2023 Engineering Drawing FTNA, where 317 (73.55%) students passed out of 445 who sat for the paper.

The students' performance in this report is grouped into three categories: poor, average, and good. The categories are based on the percentages of students who scored above average in range of 0-29, 30-64 and 65-100 marks respectively. This given performance is presented in figures and tables using colours, whereby red, yellow and green colours are used to represent weak, average and good performance respectively. Figure 1 shows overall performance in each question for 346 students who sat for Engineering Drawing assessment in November, 2024.

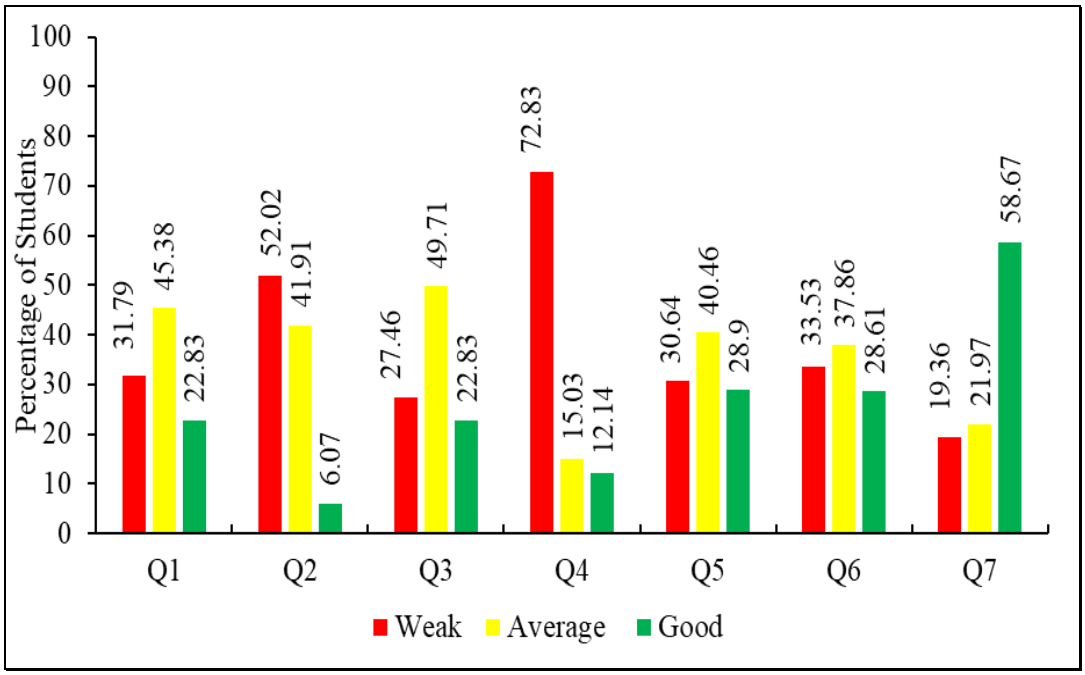


Figure 1*:* The overall performance of students who sat for Engineering Drawing Assessment

2.0 ITEM RESPONSE ANALYSIS IN EACH QUESTION

This part addresses the performance of the students based on the scores obtained in each question. It covers the type of questions, topic from which the questions were constructed, competencies test, the requirements of each question and the percentages of the students who had poor, average or good performance based on their responses in each question

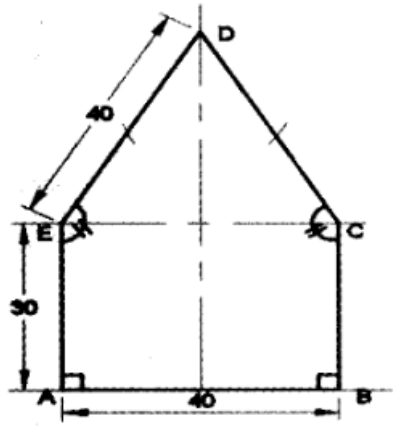
2.1 Section A: Short Answer Questions

This section comprised of four questions, 1, 2, 3 and 4 carrying a total of 40 marks. These questions were constructed from four topics, which were Similar Figures, Geometric Figures, International Organization for Standardization sheet layout and sketching and Freehand Sketches respectively. Each question carried 10 marks.

2.1.1 Question 1: Similar Figures

This question was constructed from the topic of *Similar Figures.* In this question the students were required to enlarge an irregular polygon with a ratio of 2:1. The question was;
Construct an irregular polygon on a given base similar to that of polygon in Figure 1, whereby line AB=40mm, AE=BC=30, CD=DE=40mm.

Enlarge the figure with the ratio of 2:1.



The question was attempted by 346 (100%) students whose scores were as follows; 110 (31.79%) students scored from 0 to 2 marks, 157 (45.38%) scored from 3 to 6 marks and 79 (22.83%) scored from 7 to 10 marks. Generally, students' performance in this question was good since 236 (68.21%) students scored from 3 to 10 marks. This performance is summarized in Figure 2.

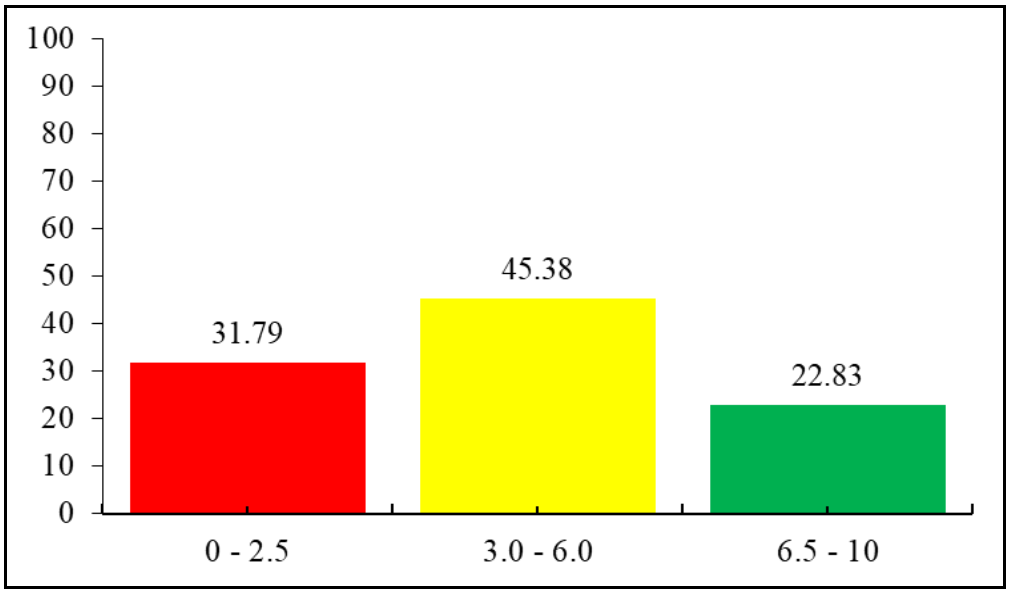
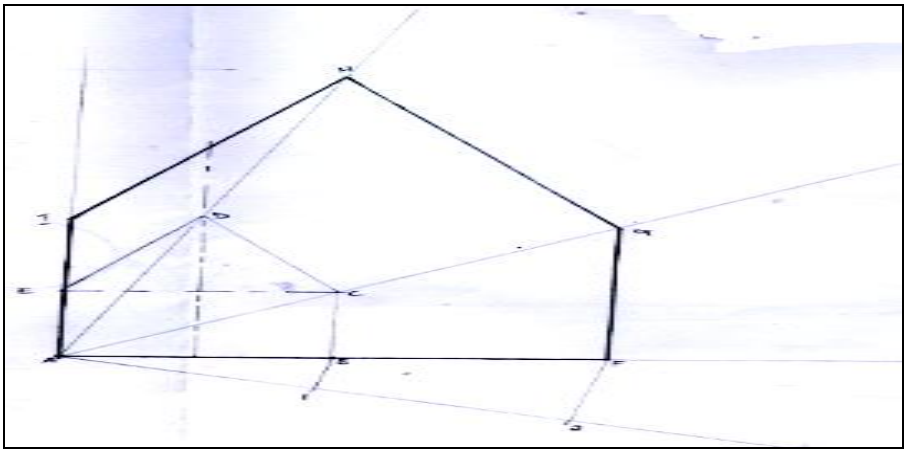


Figure 2: *Students Performance in Question 1*

22.54 percent of the students who scored well successfully enlarged the figure using the given ratio. They managed to draw and bisect the line AB into two equal parts. Furthermore, they extended upward the bisection line to pass though D. Also, these students were able to enlarge by extending

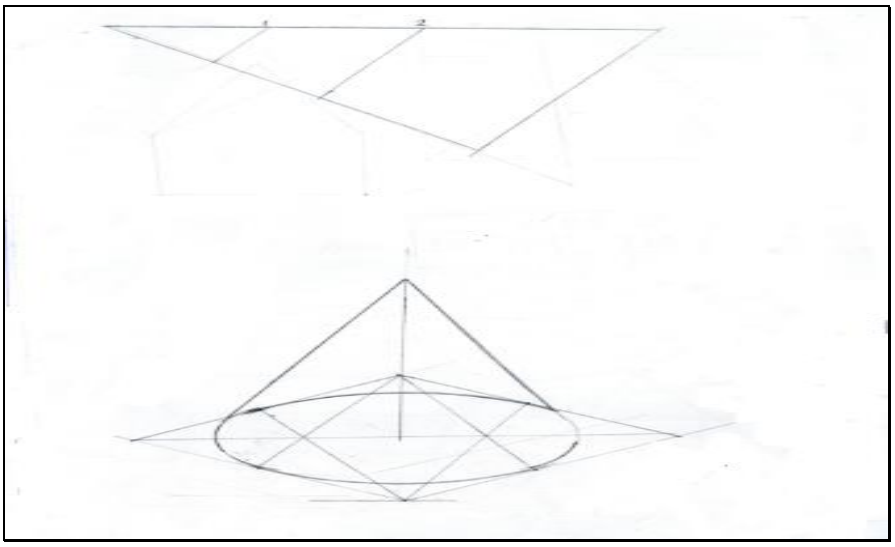
length of line xb to XB as well as line xa to AX. Furthermore, they managed to draw construction lines and thick usable lines on their drawings. Extract 1.1 is a sample of good responses from a script of one of the students



Extract 1.1: *A Sample of a Student's Good Response in Question 1*

The students who scored average (37.28%) managed to show only some of the features in their drawings. Their responses to this question revealed they had partial knowledge on the topic of similar figures. Others Most of them had ability to understand the requirement of the question but failed to use drawing techniques on enlarging the figure. Some failed to show the thick usable outlines, construction lines, bisect lines and extension of bisecting lines.

Despite the good and average performance on this question, 139 (40.17%) of the students performed poorly due to various reasons. They were not able to copy the given figure to the correct dimensions, as well as bisecting the line AB, extend the bisecting line and showing construction lines. Moreover, they failed to show the thick usable outlines and drawing parallel lines to construct the figure. These students had inadequate knowledge and drawing skills on construction of similar figures. Their responses showed weakness on demonstrating the lines usage and construction techniques to obtain the requested responses. Extract 1.2 is a sample of poor responses from a script of one of the students.



Extract 1.2: *A Sample of a Student's poor Response in Question 1*

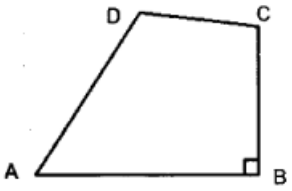
In the Extract 1.2 student was not capable to Construct an irregular polygon on a given base similar to given polygon. He/she constructed irrelevant diagrams, which led him/her to score a zero mark. He/she failed to construct correctly base on the ratio given, instead wrongly distribute a line into three equal parts. This student lacked drawing knowledge, skills as well as techniques specifically in the topic of similar figures.

2.1.2 Question 2: Geometric Figures

This question was extracted in the topic of *Geometric figures*. The question has two parts (a) and (b). The students were required to answer both parts of this question. The question was:

(a) National museum has decided to build Msonge house which the shape of the base is cylindrical. If the plot available is triangle in shape and marked ABC with the dimensions of AB=60mm, BC=CA=75mm, construct an inscribed circle which fit the plot.

(b) *A school has a plot of quadrilateral shape as shown in Figure 2 having dimensions AB=60 mm, BC=50 mm, CD=40, AD=65 and angle B=90°. If the school management decided to make a garden with triangle shape having the same area as that of quadrilateral, design the required garden.*



A total of 346 (100%) of students attempted question 2. The results of their scores indicate that 198 (52.02%) students scored from 0 to 2 marks, 127 (41.91%) students scored from 3 to 6 marks, and 21 (6.07%) students scored from 7 to 10 marks. Generally, the students' performance on this question was poor since 148 (47.98%) scored average. Figure 3 illustrates the given results.

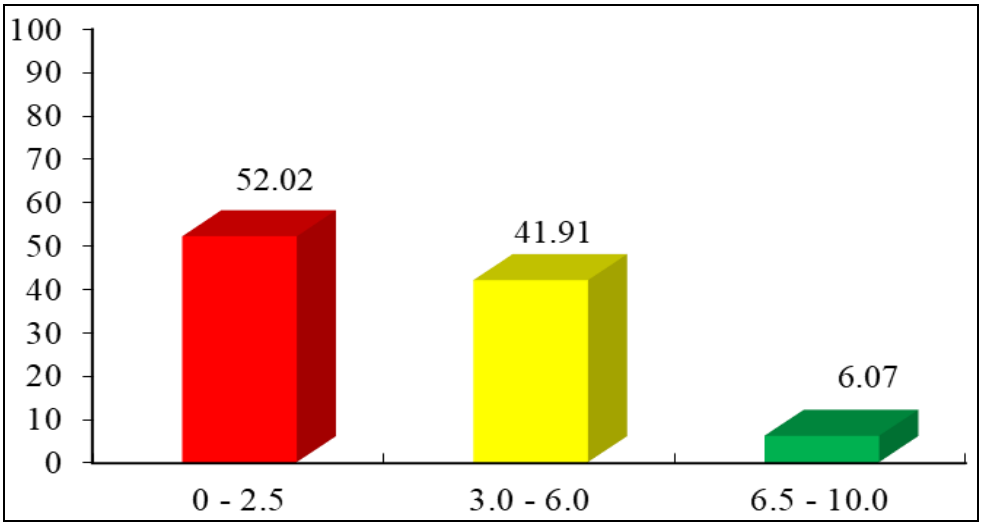


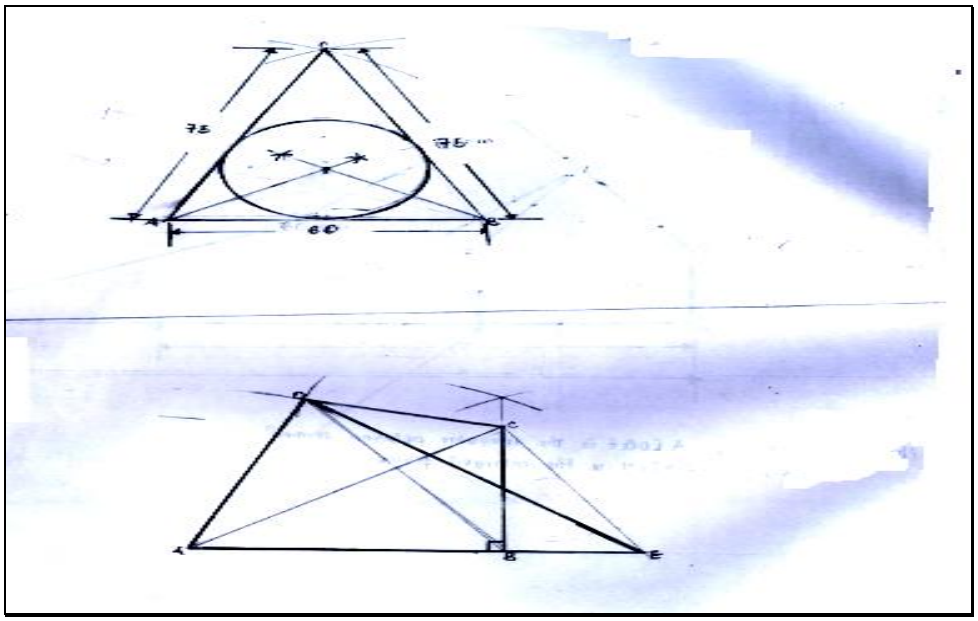
Figure 3: *Students' Performance in Question 2*

The analysis of students' performance depicted their strengths and weaknesses based on the responses provided. In part (a), the students were required to construct an inscribed circle to fit the triangle plot. This part was testing the students' ability to construct geometric figures, specifically on their skills of the drawing steps which are to bisecting triangle angles to get centre point. Moreover, they were required to construct a perpendicular line from the center point to one side of the triangle as a result of the distance, they were also supposed to place compass on the center point, adjust its length to where the perpendicular crosses the triangle, and draw the inscribed circle.

Most of the students who scored good (6.07%) in this question followed the necessary steps and demonstrated all the required drawing skills and techniques to obtain the inscribed circle. These students constructed triangle ABC to correct dimensions, bisected the two angles so as to obtain the point where bisection line meet. Furthermore, these students were able to identify the center ‘o’ on an intersection point of all bisected angle of a triangle ABC which in turn was a center which was employed during the process of inscribing circle. Finally, the students were able to construct the inscribed circle to the correctness of the provided dimensions.

In part (b), students were required to construct a tringle shape from a school quadrilateral plot as show in figure 2 with dimensions of AB = 60 mm, BC = 50mm, CD = 40mm, AD = 65mm and angle B = 90^{o} to fit the design area for garden.

The students managed to score good marks were capable to apply the required skills to construct a triangle shape with the same area as that of the quadrilateral garden. These students drew quadrilateral ABCD using arcs technique for construction, drew the diagonal BD and parallel lines of CE on reference to BD. They demonstrated the skills on extending lines AB to E and joined DE to complete visible triangle plot ADE, which had the same area as that of quadrilateral ABCD. Students in this category demonstrated neatness and accuracy in their drawings. They understood question requirements and were skilled to use drawing techniques to construct the geometric figures needed. Extract 2.1 is a sample of good responses from a script of one of the student in both part (a) and (b).



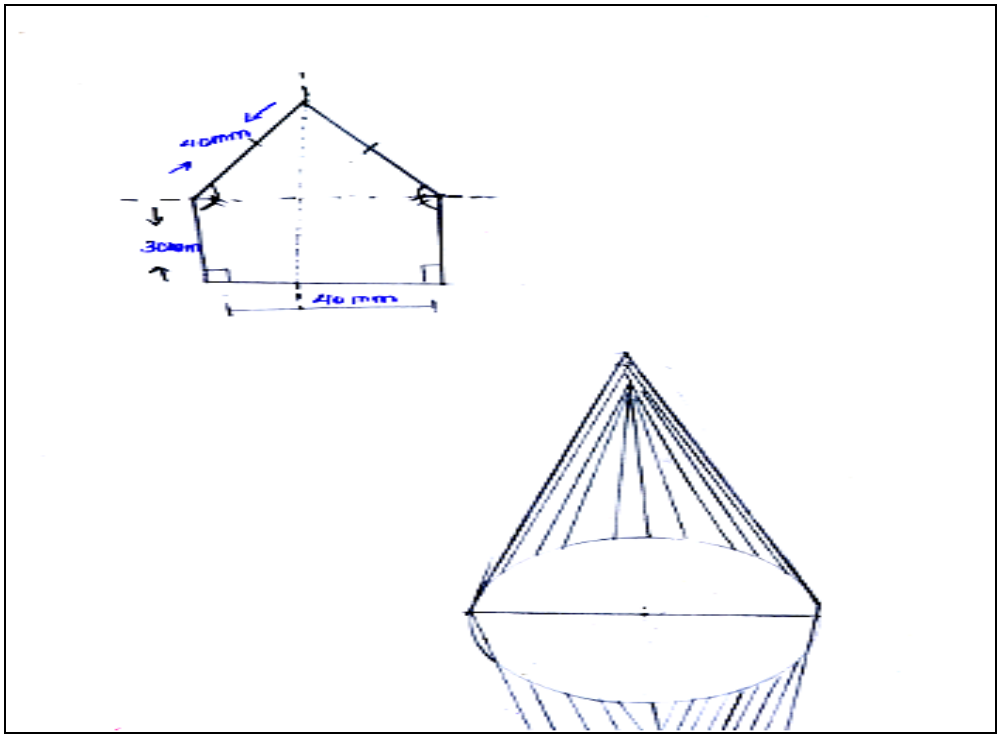
Extract 2.1: *A Sample of a Student's Good Response in Question 2*

In Extract 2.1 students constructed triangle ABC to correct dimensions, and bisected the two of the three angles and obtained the center 'o' on an intersection point and employed it to inscribe the circle in part (a). In part (b) students drew quadrilateral ABCD and demonstrated the skills on extending lines AB to E and joined DE to complete visible triangle plot ADE as was demanded in the question.

Moreover, for students who scored average 145 (41.91%) had partial knowledge on how to inscribe circle in a triangle in part (a) since they did not inscribe the circle into triangle as was requested, instead they only copied the given figure. Their responses indicated that, they lacked enough understanding and skills for the topic of geometric constructions that demands good spatial understanding, precision, and knowledge of geometric properties. Further analysis of the students' responses revealed that the students lacked enough skills for drawing steps as well as techniques to bisect angles and getting a center for inscribing circle. Also their responses revealed that, some of them had difficult in drawing the correct angle bisectors; especially they seemed to lack confident in using tools like protractor or compass. Therefore, the bisectors were not drawn precisely as a result the incenter was incorrectly located, which resulted in an inaccurate inscribed circle, hence performing averagely. In part (b), they

failed to demonstrate how to draw or transform quadrilateral into triangle with the same area. Others from this group managed to copy the quadrilateral, but failed to follow some steps to make triangles out of using lines of quadrilateral. Hence, they scored average marks. The responses in part (b) revealed that most of them reconstructed the quadrilateral ABCD using arcs but failed to construct a diagonal line BD and transfer parallel line BD to join CD.

For those students scored poor 180 (57.23%) were thoroughly unable to draw a triangle ABC, while others drew a triangle without correct given dimension. Furthermore, failure to use correct dimension led them to wrongly bisect the angles as well as using wrong bisection lines to extract the centre of circle as a result they constructed incorrect circle in part (a), hence scoring weak marks. Their weaknesses were due to failure to draw the incenter which is the point where the angle bisectors of a triangle intersect, and is the center of the inscribed circle. Some students did not clearly understand how to accurately find this point. In part (b) some of these students failed to understood the requirement of question as a result they drew irrelevant figures. Their responses showed they lacked drawing skills and techniques on constructing the required figure. They were incompetent to redraw the quadrilateral ABCD by using arcs, as well as to indicate diagonal BD and showing parallel line and extension lines. These students were incapable to complete the correct visible triangle ADE with the same area as quadrilateral ABCD. The students in this category had little knowledge and skills in geometric figures. Extract 2.2 is a sample of poor responses from a script of one of the students.



Extract 2.2: *A Sample of a Student's poor Response in Question 2*

The extract 2.2, show the student who presented incorrect drawings in this question. S/he was not able to use the drawing skills and apply the drawing knowledge of geometric figures to provide correct draws in both part (a) and (b) of this question.

2.1.3 Question 3: International Standard Organization (ISO) Sheet Layout and Sketching

The question had two parts. (a) and (b). In parts (a) student were asked to draw border lines, margin lines showing drawing area and the title block. Part (b) was concerned with circumscribing circle in a triangle. The question was:

(a) Make a sketch of an A3 size drawing sheet, which shows border lines, margin lines, drawing area and title block.

(b) You have been assigned to draw a certain geometrical triangle ABD into a circle. Draw a circumscribed circle to a triangle ABD where line AB=70mm, BD=65mm, and AD=45mm.

A total of 346 (100%) students attempted question 3. The results of their scores indicate that 95 (27.46%) students scored from 0 to 2 mark, 172 (49.71%) students scored from 3 to 6 marks, and 79 (22.83%) scored from 7 to 10 marks. Generally, the students' performance on this question was poor since 251 (72.54%) scored good Figure 4 illustrates the given results.

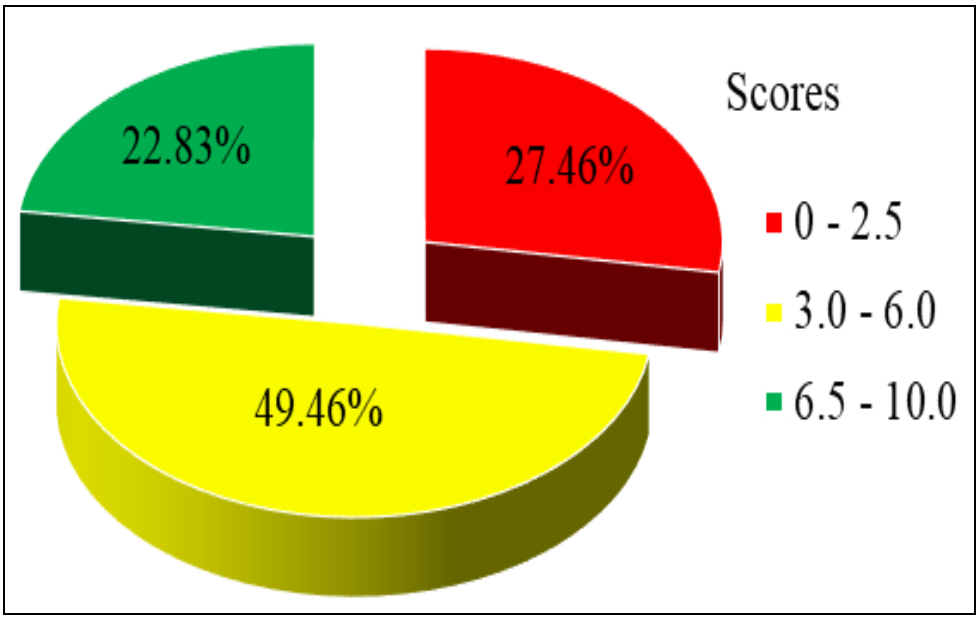


Figure 4: *Students' Performance in Question 3*

The analysis on the students' performance in each category is presented as follows:

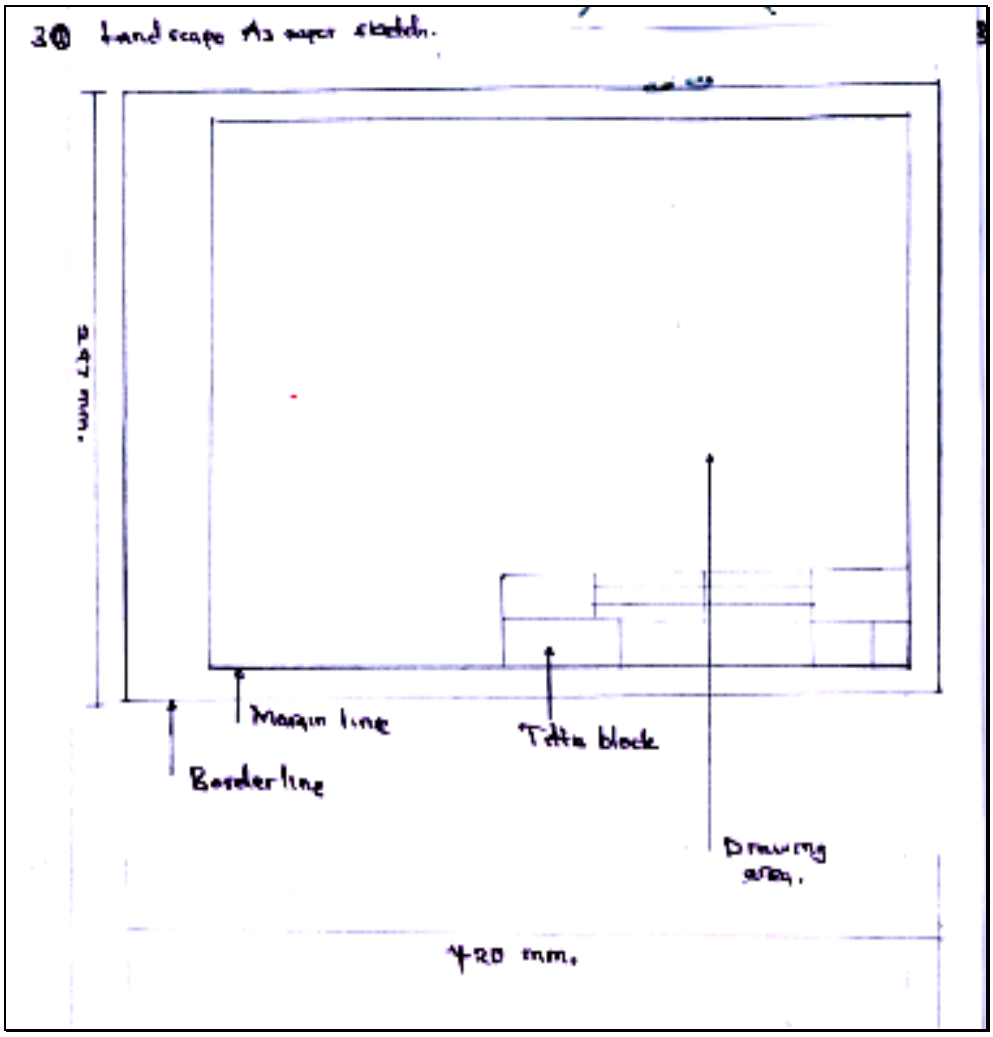
In part (a), students were required to sketch an A3-sized drawing sheet showing border lines, margin lines, the drawing area, and the title block. In this part (a) students were tested on knowledge of understanding standard drawing sheet by using standard dimensions to obtain all features required.

Most of the students were capable to sketch of A_3 size drawing sheet and showed all the features such as border lines, margin lines, drawing area and title block as well as paper dimensions. These students proved their competences in the topic of International Organization for Standardization sheet layout and sketching. They further demonstrated strong understanding of drawing sheet standards. The student knew the specific areas and boundaries that need to be marked on the sheet, and how to organize these areas effectively. For example, drawing the border lines to the correct distance from the edges of the sheet, understanding the space required for

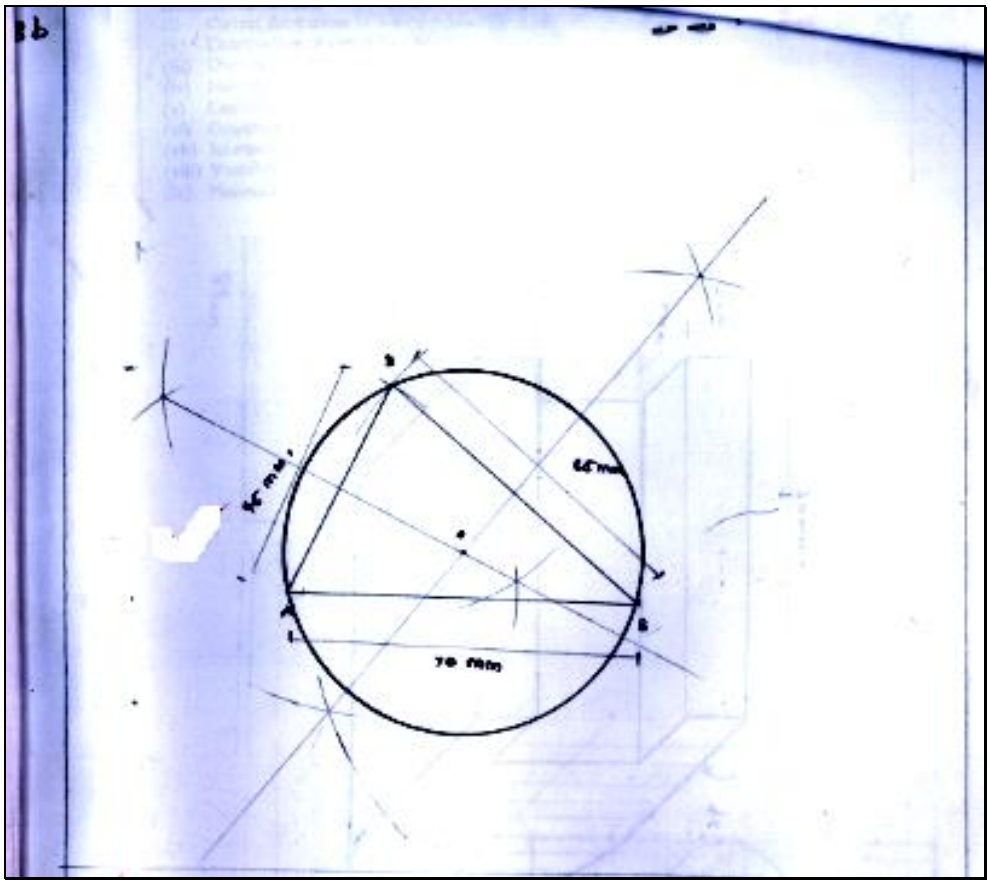
margins “usually 10, 20 mm from the edge of the paper”, which creates a visually balanced frame and ensuring the actual drawing area is the correct size and centered within the available space.

In part (b), students who scored well were able to construct triangle ABD with the correct dimensions and bisect AB and AD, AB and BD, or BD and AD to find the center of the circle. They were also capable to set compass to either CA, CB or CD and drew thick visible outlines of the circumscribed circle with all construction lines showed in the diagrams. Most students who performed well answered the question correctly, although some made minor mistakes, such as untidy work or incorrect dimensions, which prevented them from scoring the full 10 marks.

For those who scored all 10 marks they were able to demonstrate the drawing sheet standards and displayed the specific areas and boundaries marked on the sheet and organized effectively the drawing areas in part (a). In part (b) these students understood the concept of a circumscribed circle, where they were able to draw all three vertices of the triangle. This concept was crucial for them thus managed to construct the circle correctly. They were able to construct the circumcenter by correctly drawing the perpendicular bisectors of at least two sides of the triangle (AB, BD, or AD). These students demonstrated a clear understanding of the geometric principles with respect to constructing a circumscribed circle and circumcenter. They followed each step methodically and committed no significant errors in their construction, and it was revealed that their final drawing was both accurate and neat. Also their response showed they successfully used the drawing tools and paid attention to dimensions’ detail as this is the result contributed to a good response, therefore they scored full mark. Extract 3.1(a) and 3.1(b) is a sample of good responses from a script of one of the students.



Extract 3.1 (a) *A Sample of a Student's Good Response in Question 3(a)*



Extract 3.1(b): *A Sample of a Student's Good Response in Question 3(b)*

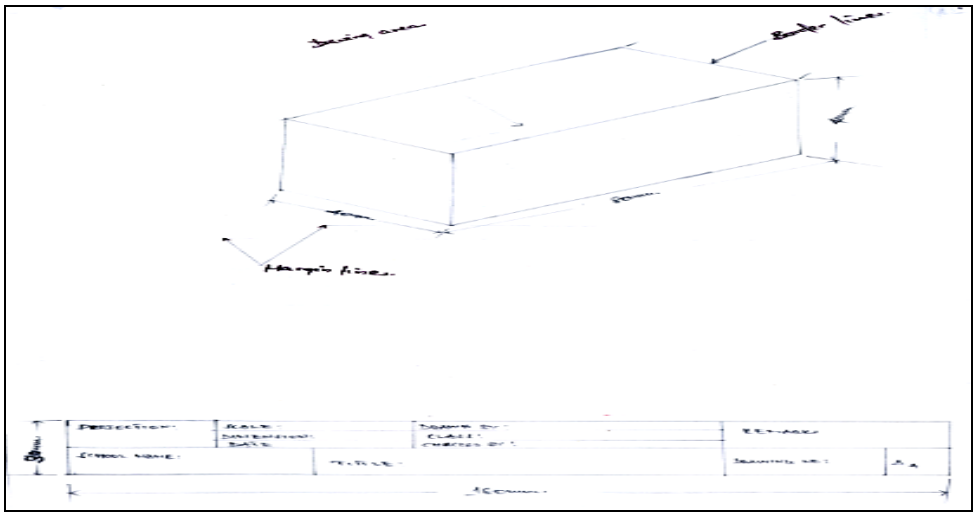
The extracts 3 (a) and (b), show the correct response in this question. This student was able to apply the knowledge of International Organization for Standardization sheet layout and drew the border lines from the edges of the sheet and provided the space required for margins. In part (b) effectively employed the drawing tools and took precise measurements to draw the sides of the triangle and constructed the triangle accurately with the correct angles and proportions.

However, 172 (49.71%) of students scored average marks in this question and due to their partial sketch presented. They either only managed to sketch the border lines and margin lines in correct dimensions but they mostly failed to indicate paper size dimension in part (a) which indicated that, students in this category had insufficient drawing skills or did not recognize the layout of standardization sheet.

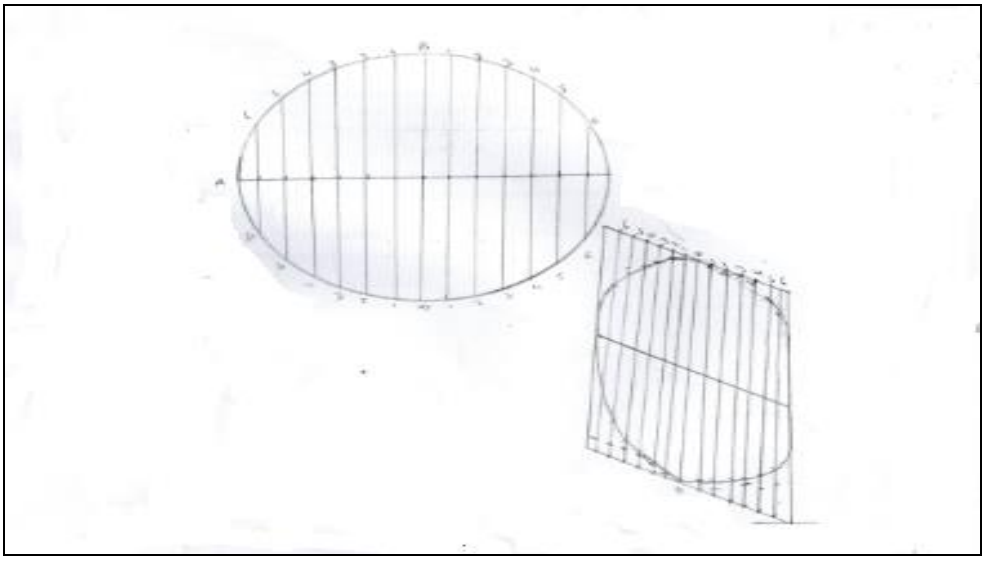
Although some students managed to construct triangle ABD with correct dimensions and bisect lines in part (b), most failed to set the compass correctly to draw the circumscribing circle. The lack of drawing skills resulted in average scores for these students.

Further analysis showed that, 95 (27.46%) students scored below average. In part (a), these students were not able to sketch an A_3 size drawing sheet. They failed to show border lines, margin lines, drawing areas and title block. Most of their responses revealed their incompetence on identifying paper dimension on the drawing they presented. This indicated their failure to apply skills and techniques to meet the question demand.

In part (b), the students failed to construct the correct triangle ABD but also failed to use drawing techniques in attempting to draw the circumscribing circle to a triangle ABD. These students exhibited severe misunderstandings of the geometric principles involved in constructing a circumscribed circle and failed to apply the correct procedures. Most of them struggled with basic geometric construction skills, such as accurate measurement, drawing bisectors, or understanding the relationship between the circumcenter and the triangle's vertices. Their drawings were incomplete or fundamentally inaccurate, leading to low marks or zero mark. Extract 3.2(a) and (b) is a sample of poor responses from a script of one of the students.



Extract 3.2 (a): *A Sample of a Student's Poor Response in Question 3a*



Extract 3.2(b): *A Sample of a Student's Poor Response in Question 3b*

The extracts 3(a) and (b), show the student who presented incorrect drawings in this question. In part (a) drew unwanted rectangle with a wrong title block while in part (b) he/she confused the question, instead of circumscribing a circle drew an unwanted ellipse and therefore scoring zero mark on this question.

2.1.4 Question 4: Freehand sketches

The question was on freehand sketch where students were asked to draw twist drill. The question was:

Suppose you are a workshop foreman and you need to buy a twist drill for the shop which is 145mm long and a diameter of 20mm; Draw a freehand sketch of the twist drill so that a shopkeeper will be aware of the tool you requested

A total of 346 (100%) students attempted the question 4. The results of their scores indicate that 252 (72.83%) of students scored from 0 to 2 marks, 52 (15.03%) students scored from 3 to 6 marks, and 42 (12.14%) scored from 7 to 10 marks. Generally, the students' performance on this question was poor since only 81(27.17%) scored average and above. Figure 5 illustrates the given results.

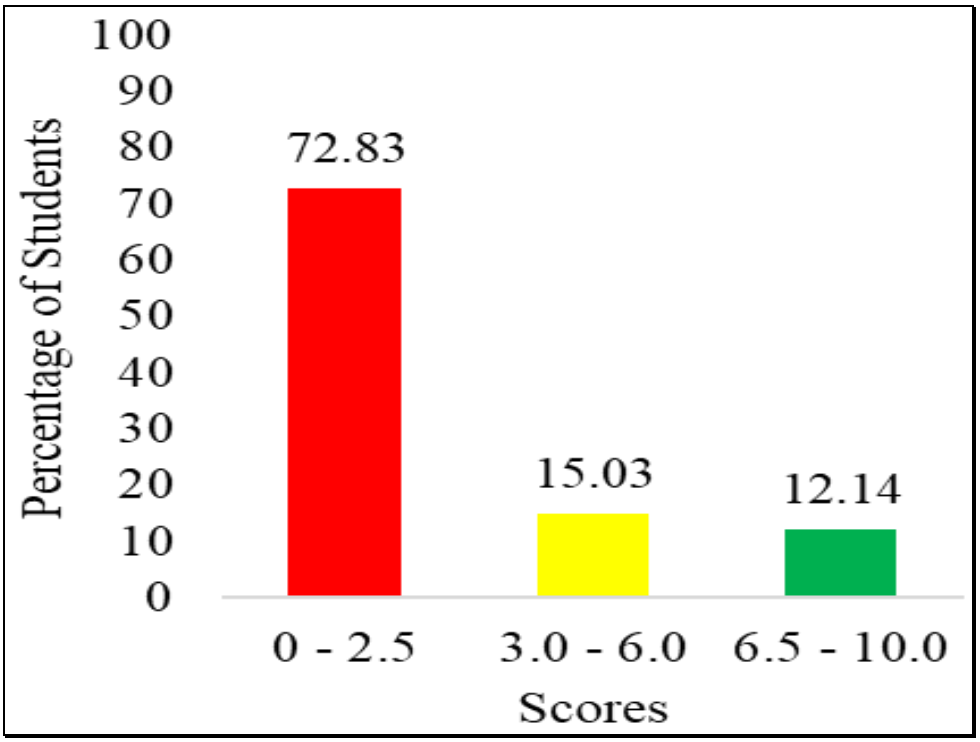
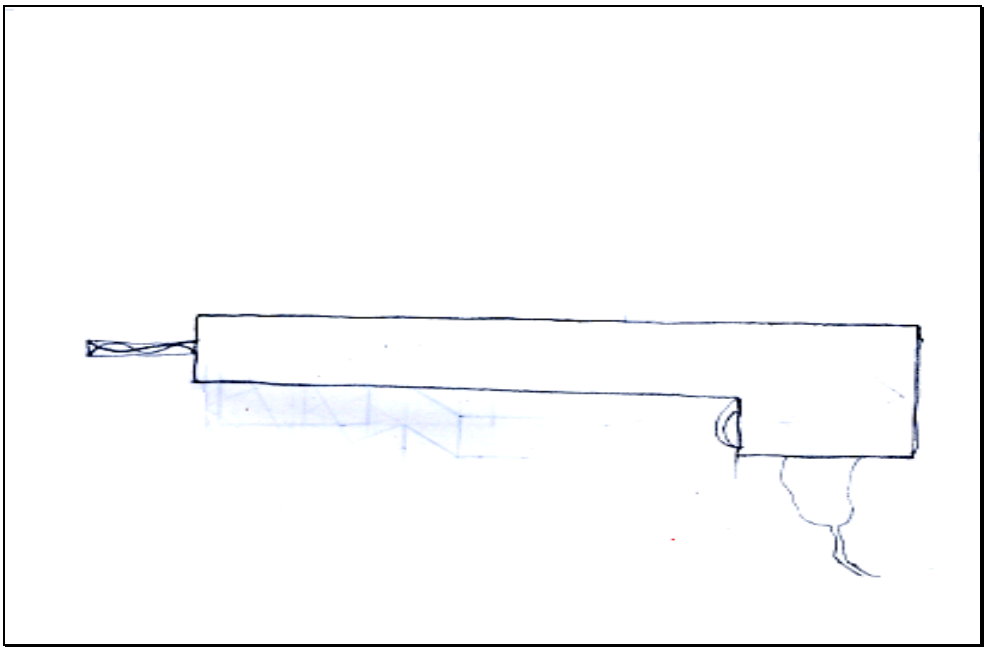


Figure 5: *Students' Performance in Question 4*

The analysis of student responses shows that most, 252 (72.83%), scored below average due to a lack of drawing skills and knowledge about the drill bit tool. These students failed to present all features required to be visible for a freehand sketch as a result they scored zero mark. Some students confused the twist drill with a portable hand drilling machine. Instead of sketching twist drill they drew hand-drilling machine, therefore they scored zero mark. Further analysis on the responses of poorly performed students indicated that, some of the sketches drawn had unclear or very simplified diagram without conveying any information, as well as without any recognizable twist drill features such as missing spiral flutes or incorrect shape for the cutting edge. It further revealed that, these students confused a twist drill with another tool, such as a straight drill or an entirely different tool altogether or among others lacked the steady hand needed to draw clean, well-defined shapes, resulting in a disordered or unclear sketch as a result scored poor marks. Extract 4.2 is a sample of poor responses from a script of one of the students.



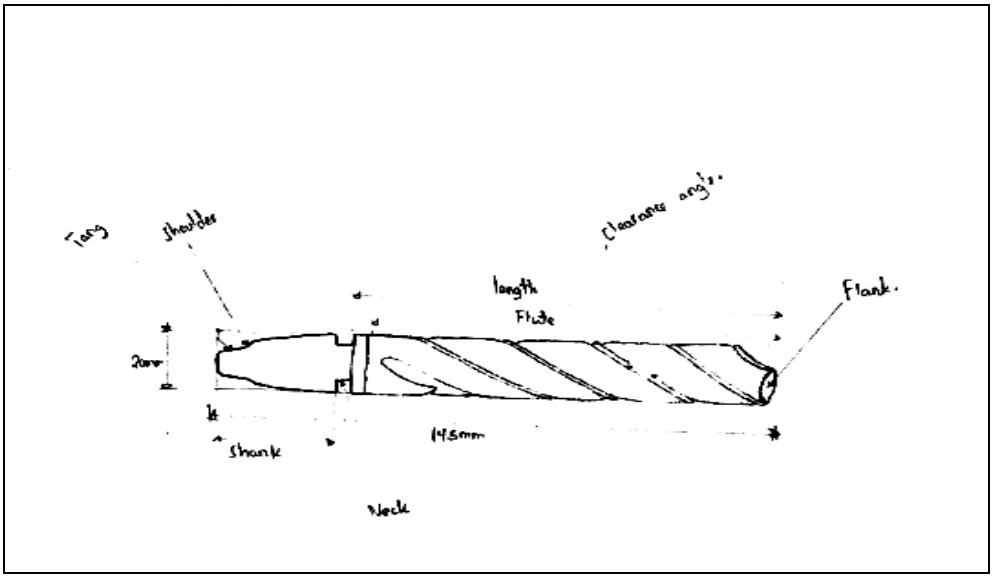
Extract 4.2: *A Sample of a Student's poor Response in Question 4sss*

The extract 4.2, show the student who confused between drill bit and hand drilling machine. Instead of drawing a drill bit he/she drew a portable hand drilling machine.

Further analysis showed that, 52 (15.03%) of the students had an average performance on this question. These students likely missed or inaccurately depicted key aspects of the twist drill's structure, such as the flute spiral or the cutting edges such that while they drew the basic shape, there were some unclear details or they omitted in their presentation. For example, some students did not indicate the spiral properly while others did not draw the cutting edges accurately and this was an outcome to achieve mediocre in this question.

Despite the mass failure on this question 42 (27.14%) students scored good as they presented correct drawing skills to accomplish the demand of the question. Some of them were able to use by freehand to draw the twist drill bit with all features required to be visible on a sketch. These students demonstrated good free hand skills and understanding of all twist drill features such as they managed to indicate on the sketch the fluent of the twist, cutting edge as well as cutting angle. They also presented side of shank, visible outline and neatness. Some of these students had good skills and techniques on freehand sketches made few mistakes and therefore they

scored high but less than 10 marks. Extract 4.1 is a sample of good responses from a script of one of the students.



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

The extract 4.1 show the sample of response of the student who was able to understand the question requirement and drew a freehand sketch of a drill bit. This student was able by free hand to structure the twist drill bit with all required features.

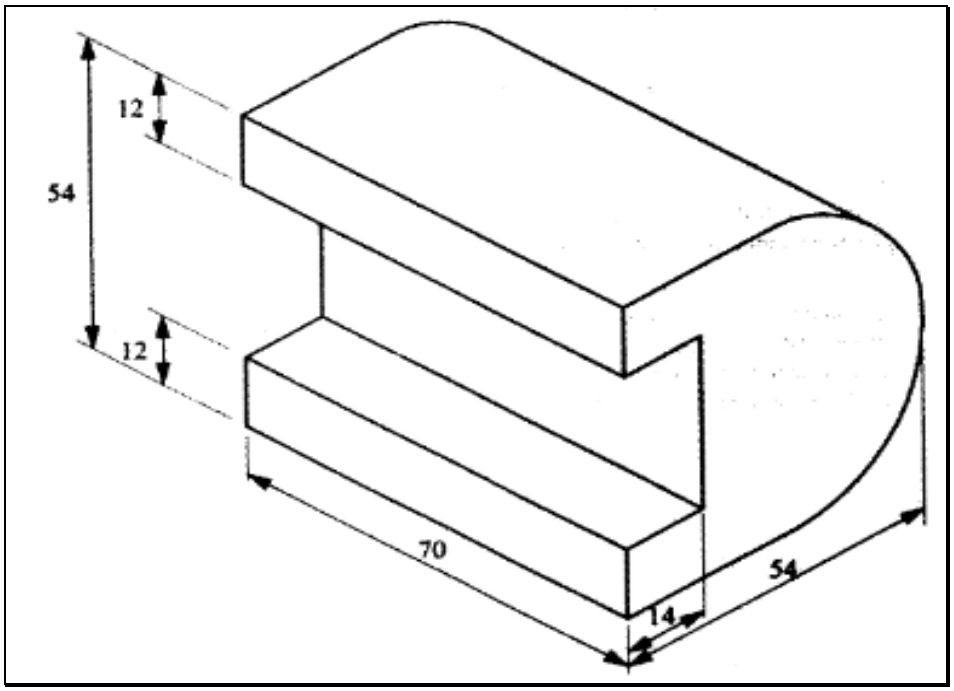
2.2 Section B: Structured Questions

This section comprised of three (3) structured questions. The questions were constructed from the sub-topics of, *Pictorial Drawing* and *Intersection of Cylinders.* Each question carried 20 marks, making a total of 60 marks for the whole section.

2.2.1 Question 5: Pictorial Drawing

This question was constructed from the topic of *Pictorial Drawing.* The students were required to redraw the given figure in a full-size dimension by putting it in Oblique Projection. The question was;

Figure 3 is a jig presented in Isometric Projection. Draw it in a full-size dimension using Oblique Projection.



The analysis shows that, all 346 (100%) of the students attempted the question, with 106 (30.64%) scoring 0 to 5.5 marks, 140 (40.46%) scoring 6 to 12.5 marks, and 100 (28.90%) scoring 12.5 to 20 marks. These data are summarized in Figure 6.

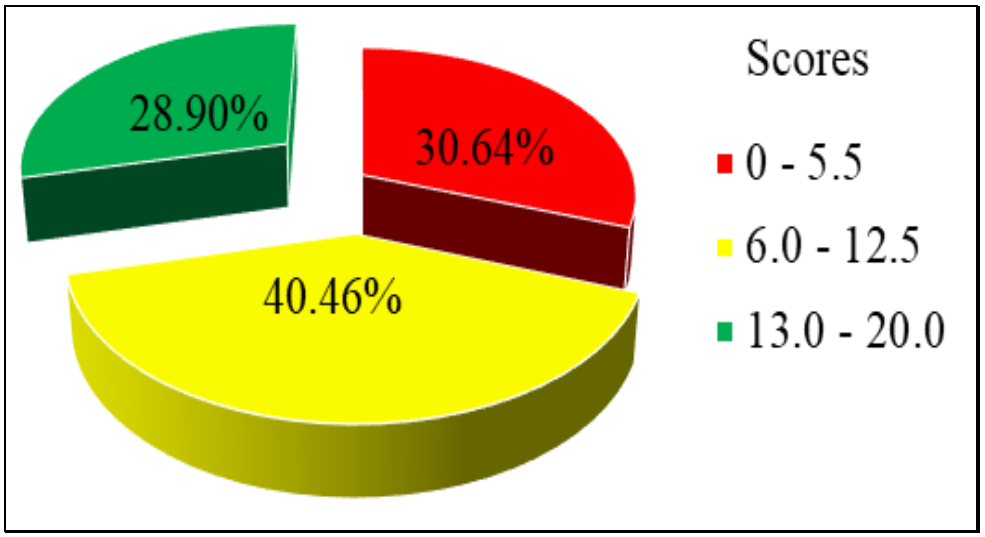
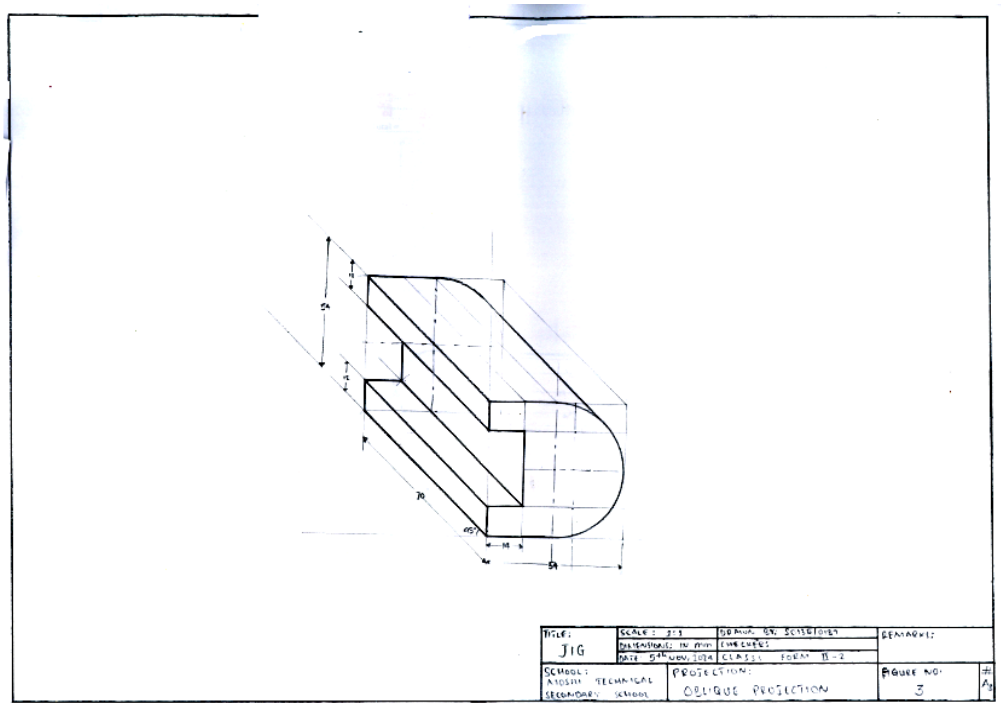


Figure 6: *Students' Performance in Question 5*

The analysis indicates that some students responded correctly and managed

to perform well. Some of them were able to construct an oblique angle at 45°, oblique lines, use of correct dimensions and showed all construction lines. They presented a visibility of jig, neatness and completeness of the correct figure requested, these were 5 (1.4%) students and scored all 20 marks. These students demonstrated ability to use drawing skills and techniques to draw a jig in oblique projection. Some of students who scored high marks from 13 to 19.5 were able to draw the jig, but some did not have neatness or made some small mistakes through the process of making drawing and therefore scored high but less than 20 marks. Extract 5.1 is a sample of good responses from a script of one of the students.



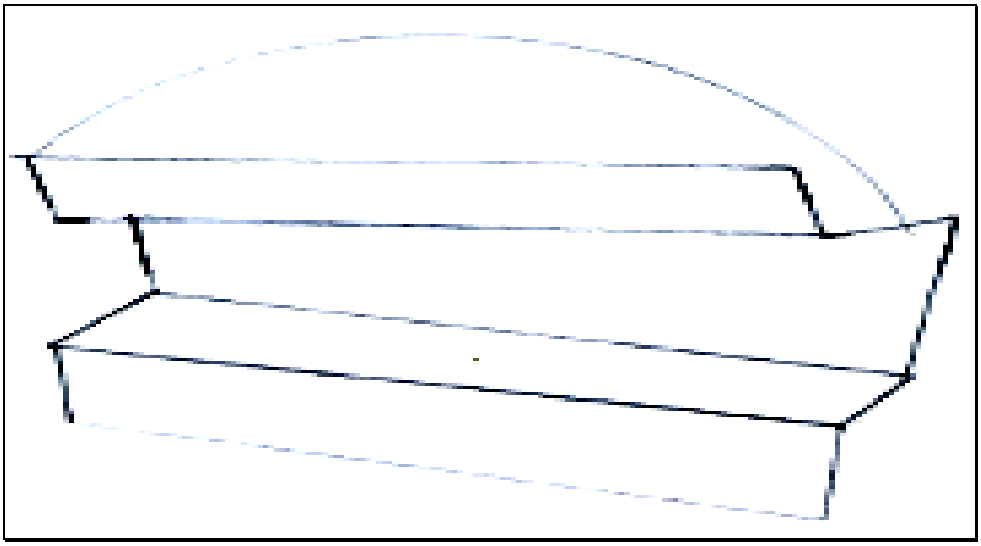
Extract 5.1: *A Sample of a Student's Good Response in Question 5*

Extract 5.1 shows a sample of the correct responses done by a student who managed to draw correctly jig into oblique projection.

Further analysis depicted that, 140 (40.46%) students scored average marks in this question. These students provided drawing with partial details. Most of them accomplished to present initial ways of constructing oblique drawing, such as constructing oblique angle 45° and oblique lines as well as employed correct dimensions as provided in isometric figure, but they failed to accomplish the required response thus, scored average. Others

failed to apply drawing skills to join line, transfer dimensions and draw lines using transferred dimensions as a result they did not meet the requirement of assigning visibility to the lines of the needed figure and also failed to maintain neatness of the drawing sheet thus, they scored average marks. Their responses demonstrated their partial knowledge and skills to construct an oblique box which could be used to draw the needed oblique projection.

In addition, 106 (30.60%) of students scored below average. The analysis shows that, this performance was due to insufficient of drawing skills and drawing techniques presented by students in this group. Most of these students were incompetent to construct oblique angle at 45°, oblique lines, use of correct dimensions and did not draw construction lines. Despite the low scores of these students, each had different weaknesses. There were those who failed to draw an oblique projection diagram and instead drew unwanted lines so they scored zero mark. Others presented poor visibility of wrong drawn jig, lack of neatness and incomplete oblique projected line. These students demonstrated failure of applying drawing skills and techniques to present a jig in oblique projection. Apart from those who did and got a poor score there were some students who didn't understand the question instead they copied the question as it was and ended up getting zero marks. Extract 5.2 show the sample of poor performance from one of a student.



Extract 5.2: *A sample of a Student's Poor Response in Question 5*

In Extract 5.2 the student provided irrelevant response. This student started drawing an oblique projection without following any oblique projection rule. He/she drew a sketch, which did not align with an oblique angle at 45°, and oblique lines therefore, ended up scoring zero mark.

2.2.2 Question 6: Intersection of Cylinders

This question was constructed from the topic of Intersection of Cylinders. The question consisted of two parts (a) and (b). Students were required to draw a complete plan in part (a) and a line of intersection in part (b). The question was;

Figure 4 shows the incomplete drawing of an electrical conduit having two similar cylindrical pipes joined at the right angle. Draw the following views:

(a) A complete plan elevation

(b) Line of intersection

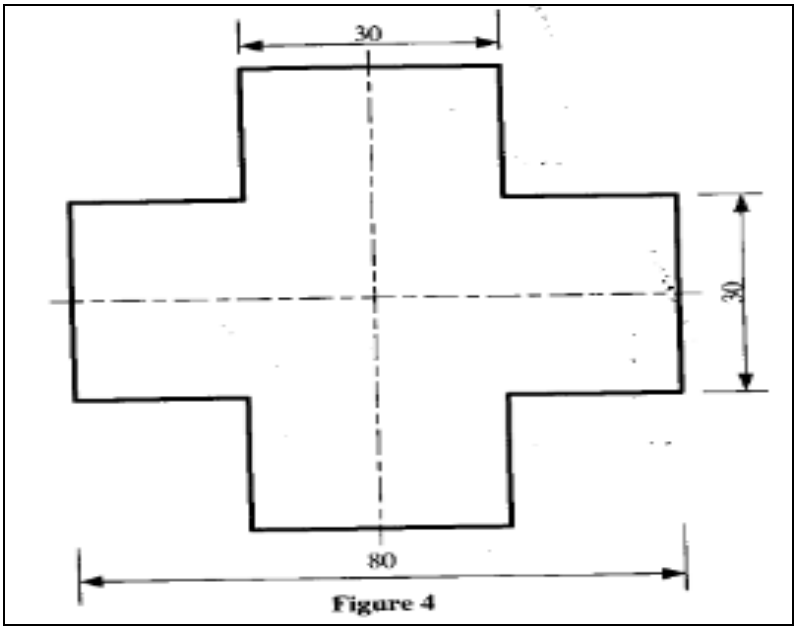


Figure 4

The question was attempted by 346 (100%) students out of which 116 (33.53%) scored from 0 to 5.5 marks, 131 (37.86%) scored from 6.0 to 12.5 marks, and 99 (28.61%) scored from 13 to 20 marks. This analysis shows that the performance in this question was average as 66.47 percent scored

from 6 to 20 marks. Figure 7 portrays the students' performance in this question.

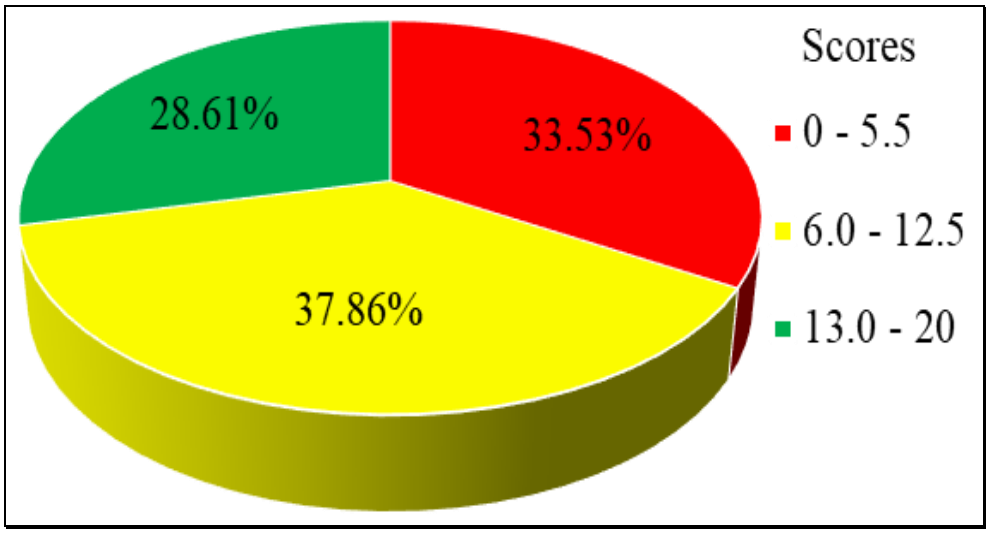
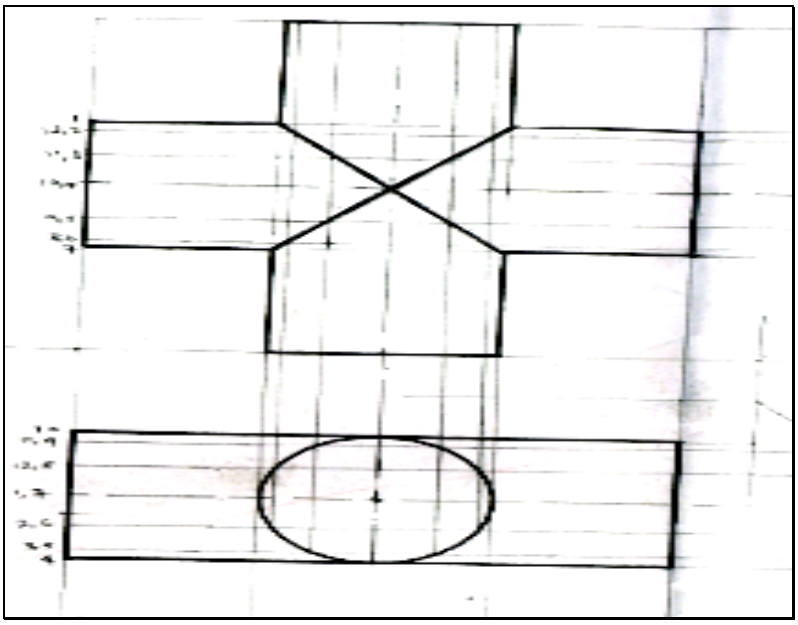


Figure 7: *Students' Performance in Question 6*

The analysis carried out in question 6 revealed that 28.61 per cent of students managed to score good marks in this question. These students were able to present correct drawings in both parts (a) a plan elevation and (b) a line of intersection. They were able to apply drawing knowledge and skills to respond well in this question. They presented correct dimension of figure, construction of circle and semi circles, dividing circles into equal parts and, numbering or lettering and drew correct center lines in both part (a) and (b). They also drew complete plan elevation and line of intersection. Generally, these students correctly showed the intersection between the two cylinders in the plan and elevation views. Their drawings were typically clean, with appropriate labelling and clear differentiation between the plan and elevation views, which earned them the full 20 marks. For those who scored high but less than 20 marks they had some mistakes, which led them, scoring below 20 marks. For example, minor issues with detailing**,** in some cases, while the overall structure of drawing was good, minor errors such as detailing or the exact positioning of lines, though did not affect the overall clarity and correctness of the drawings but reduced the scores from getting all 20 marks. Extract 6.1 illustrates the responses given by one of the students who attempted correctly the question.

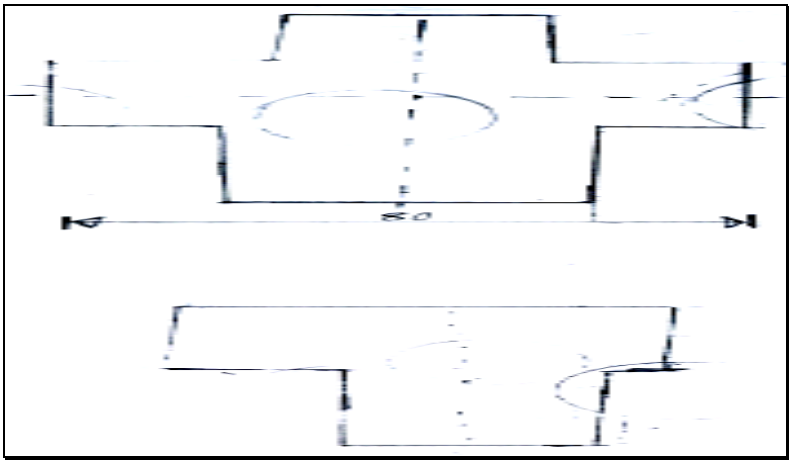


Extract 6.1: *A Sample of Student's Good Response in Question 6*

In extract 6.1, the student drew correctly a plan elevation in part (a) and a line of intersection in part (b). This student demonstrated ability to apply drawing skills and techniques to present the intersection of two electric conduit of similar cylinder pipe at the right angle in both plan elevation as well as line of intersection.

However, some students scored average 131 (23.86%) marks in this question. These students provided drawings with partial details. Most of them accomplished to present initial construction in drawing the plan and elevation but failed to apply drawing skills to complete the line of intersection as they presented some features on their partial drawing which led to average scores. They managed to construct circle, dividing the circles into equal parts numbering and lettering the circles but some of them committed errors in transferring of dimensions due to incorrect dimension taken at initial stage. For example, the line of intersection of the two equal cylinders penetrated at other angle rather than 90^{o} was incorrect with respect to question requirements. Some of these students had insufficient knowledge, drawing skills and techniques in the topic of Intersection of Cylinders. Therefore, found themselves scored average marks. Others were able to drew different line of intersection, from the requirement.

Further analysis showed that, 116 (33.53%) of the students scored below average as they were unable to correctly present drawings for both the plan elevation and the line of intersection. For those who scored a 0 mark were incompetent to apply drawing knowledge and skills to respond to this question. They presented incorrect copy of the given figure with respect to dimensions, construction of circle and semi circles, wrong division of equal parts of circles, wrong numbering and lettering of the views and also they failed to draw the centre lines on both elevation and plan view. Some students only copied the given view and did not follow the proper procedures to construct the plan view and line of intersection on the front elevation. Thus, they scored weak marks. Extract 6.2 shows a sample of an incorrect response from the student who scored poorly in this question.



Extract 6.2: *A Sample of Student's Poor Response in Question 6.*

In extract 6.2, the student showed inability of applying drawing skills and techniques to draw the intersection of two electric conduit of similar cylinder pipe at the right angle in both plan elevation as well as line of intersection.

2.2.3 Question 7: Pictorial Drawings

This question was derived from the topic of *Pictorial Drawings*. The students were required to use full size scale to draw the given oblique projection into complete isometric projection. The question was designed to assess students' knowledge and skills to draw isometric drawing. The question was:

Figure 5 shows a component drawn in oblique projection. Using a full-size scale, draw the component in isometric projection.

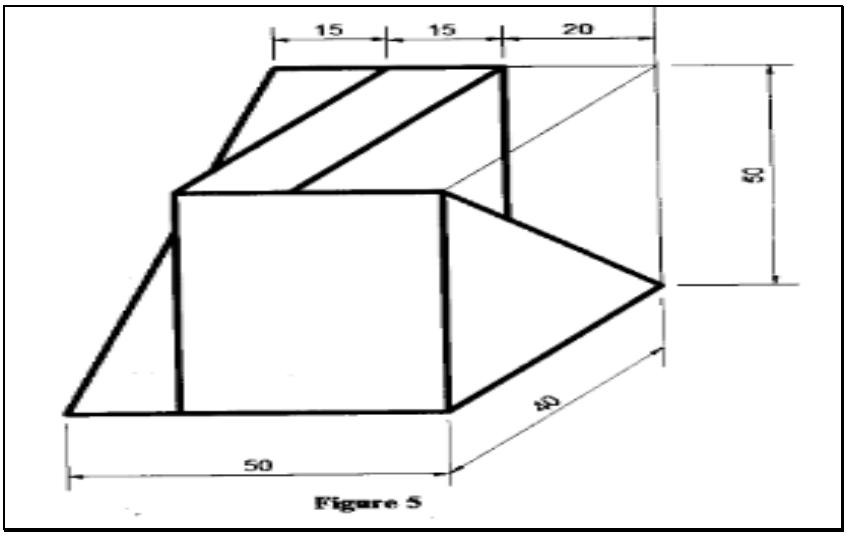


Figure 5

The question was attempted by 346 (100%) students, from which 67 (19.36%) scored from 0 to 5.5 marks, 76 (21.97%) scored from 6 to 12.5 marks, and 126 (58.67%) scored from 13 to 20 marks. Generally, the students' performance in this question was good, since 279 (80.64%) of the students scored from 6 to 20 of the allocated marks. This performance is summarized in Figure 8.

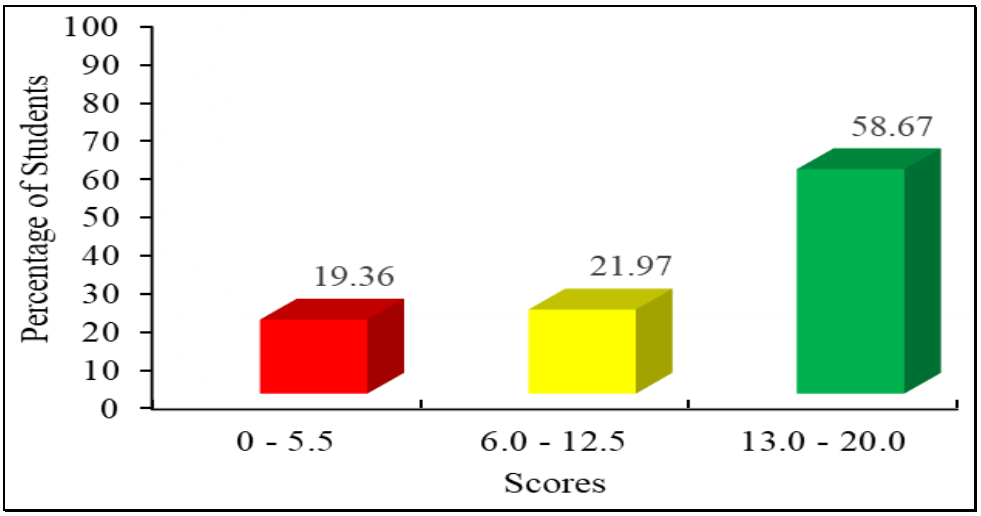
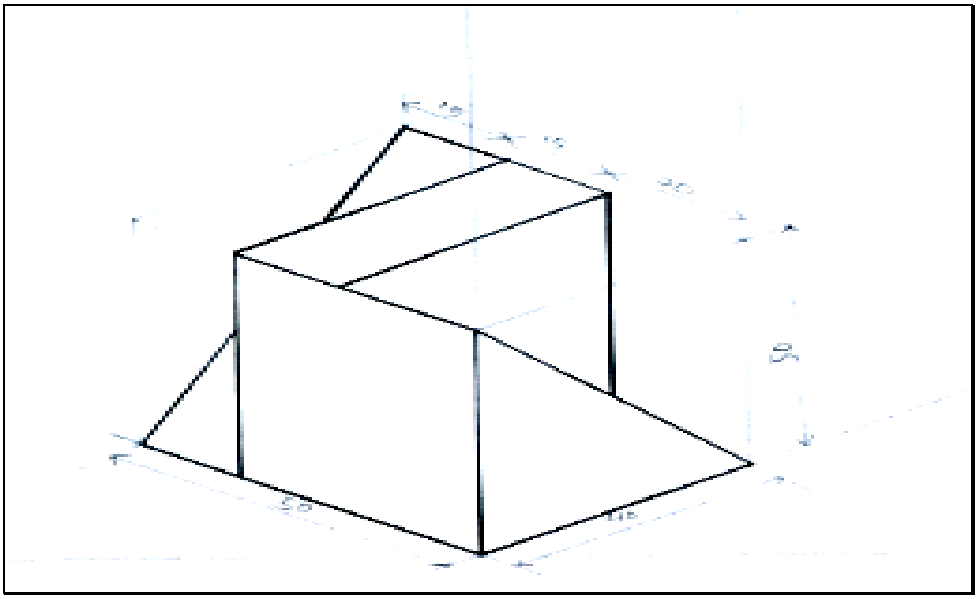


Figure 8: *Students' Performance in Question 7*

This is the most well performed question in this paper. The analysis of the

performance indicates that, 279 (80.64%) of the students scored average and above. Among them 77(22.30%) scored all 20 marks allotted to this question. Some students understood that in oblique projection, one face is drawn parallel to the projection plane, while the other faces are slanted, usually at a 45° angle. While in an isometric projection all three principal axes (X, Y, Z) are equally foreshortened, and the component is rotated so that its axes are equally inclined to the plane of projection typically at an angle of 30° from the horizontal. They were also able to set up the isometric axes, where they drew a set of isometric axes at 30° angles to the horizontal for the X and Y-axes and they projected Z-axis vertical. They present isometric lines, isometric angles, isometric box with regard to dimension taken from the oblique component. They also indicated construction lines, correct dimension, as well as good visibility and neatness of the drawn component. These students showed ability to apply drawing skills and techniques to draw an isometric projection; they understood the requirement of the question and responded correctly. Others, who scored high, attempted the whole question correctly but made few mistakes which led them not to score all 20 marks. For example, one student drew the isometric required but was able to allocate the measurement. Thus, some of the dimensions such as isometric angles (30^{o}) were not properly drawn which lead him/her to score less than 20 mark. Extract 7.1 is an example of a good response from one of the students' scripts.

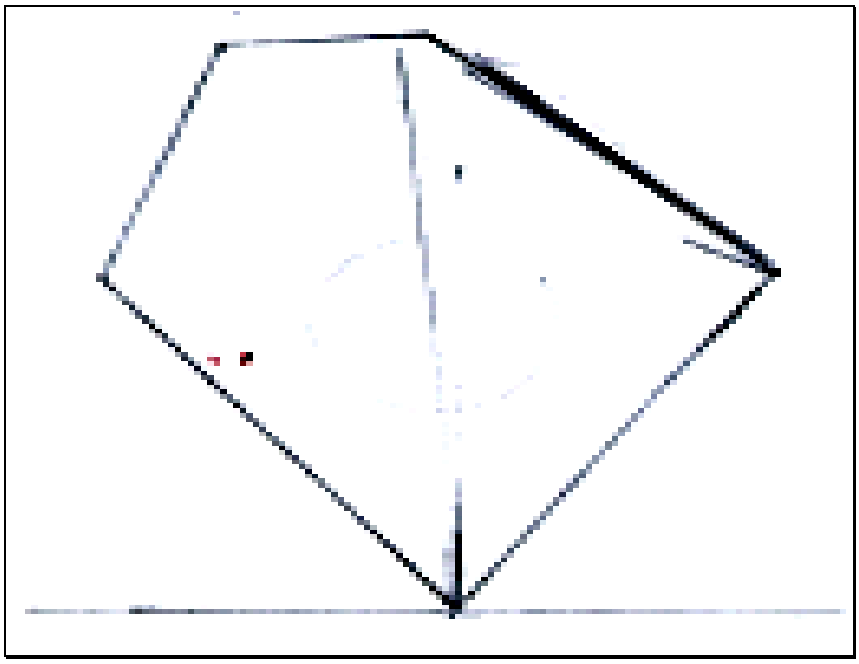


Extract 7.1: *A Sample of Student's good Response in Question 7*

In Extract 7.1, the student drew correct component in isometric projection. The student was competent and was able to apply his/her knowledge and skills to draw the required component.

For those (21.97%) who scored average marks in this question provided drawing with partial details. Some of these students accomplished to present only initial processes of constructing isometric drawings, such as constructing isometric box, isometric lines, isometric angles as well as some construction lines. Whereas, they failed to apply drawing skills to join line, transfer dimensions and obtain slanted faces. Others failed to impose visibility on a drawn component and lacked tidiness as their drawing sheets were not neat hence led to average performance on this question. It was furthermore predicted that some of the students in this category had partial practical skills and experience in converting the oblique projection into isometric projection.

Additionally, further analysis revealed that 67 (19.36%) performed poorly on this question. Among them, 28 (8.09%) of the students scored zero because they were unable to draw the isometric axes at 30° angles to the horizontal for the X and Y-axes and failed to project the Z-axis. They could not draw the isometric lines, angles, or box, which are essential for creating the required isometric component. Furthermore, they did not draw the construction lines necessary for dimensioning, which contributed to their poor performance. Other students who performed poorly attempted some steps, but with errors. For example, one student correctly drew the isometric box but failed to transfer dimensions from the oblique object to create the required isometric component, leading to a poor score. From the responses of the students who performed poorly it was verified that, they had incorrect projection of points and edges such that improperly projected the key points and edges from the oblique drawing onto the isometric axes and this led to isometric view to have incorrect shapes, misaligned edges, or inaccurate relationships between the component's features. Moreover, their responses revealed that students did not draw correctly the symmetry of the object or its proportional when converting to isometric as a result the isometric component was distorted which led confusion as well as incorrect interpretation of the drawn isometric view and therefore they scored poor mark. Extract 7.2 is an example of responses from a student who performed poor.



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

In extract 7.2, the student drew irrelevant diagram. He/she failed to draw the isometric box, which could lead him/her to draw the required component.

3.0 ANALYSIS OF STUDENTS' PERFORMANCE IN EACH TOPIC

The FTNA in Engineering Drawing subject had six sub-topics. These sub-topics are: *Similar Figures, Geometric Figures, International Standard Organization (ISO) Sheet Layout and Sketching, Freehand Sketches, Pictorial Drawing and Intersection of Cylinder.* Based on the analysis of the students' performance. This report reveals that, students had good performance in the topics of *Pictorial Drawing* (75.00%) in question 5 combined with 7 and *International Organization for Standardization sheet layout and sketching* (72.54%) in question 3. Followed by the topic of *Similar figures* (68.21%) and *Intersection of cylinder* (66.47%) in questions 1 and 6 respectively. However, the students had average performance in sub-topics of *Construction of Geometric* Figures (47.98%) in questions 2.

The good and average performance of the students was contributed by several capabilities mastered by students which are correct selection of line types and construction of basic shapes such as circles, triangle and

rectangular, as well as creating clear isometric and oblique drawings. Weak performance was observed in freehand sketches (question 4) with the performance of 27.17. The reasons for their failure could be due to lack of concentration and misunderstanding of the question leading to irrelevant responses and poor hand steadiness when constructing features of twist drill.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

In conclusion, the analysis shows that students did well in most subtopics, especially in Pictorial Drawing and ISO Sheet Layout and Sketching, showing strong skills in these areas. However, there were challenges in Freehand Sketches, where students failed due to lack of focus, misunderstanding of questions, and weak drawing skills.

The analysis of the students' responses performed on each question indicates that, the overall performance was good in Engineering Drawing subject on FTNA of 2024. This can further be verified by the general students' performance in which 70.06 Percent of the students passed the assessment.

Most students did well on questions 5, 7, 3, 1, and 6, which covered Pictorial Drawings, ISO Sheet Layout and Sketching, Similar Figures, and Intersections of Cylinders. However, students had average performance on question 2, which was about the Construction of Geometric Figures.

Further analysis showed that, the subtopic which had weak performance was freehand sketches that was in question 4. The reason of failure in this sub-topic is students' failure to follow drawing procedures, and inability to maintain hand steadiness when constructing freehand features. Therefore, it is expected that this analysis will enhance educators, students, and other stakeholders in education to address the weaknesses noted in order to improve performance on future assessments.

4.2 Recommendations

From this analysis, recommendation is provided to students and teachers for improvements.

4.2.1 Recommendations to Students

To improve hands-on skills, students should do practical activities that connect theory with practice. This helps them learn about hand tools and how to use them, as explained in Workshop Tools and Equipment.

(a) Students should be encouraged to join Engineering Drawing clubs. This will help them become more interested in the subject.

(b) Students should use the drawing skills and knowledge of Engineering Drawing I and II from other subjects and connect them to Mechanical Engineering. This will help them learn to draw neatly and label diagrams correctly.

4.2.2 Recommendations to Teachers

(a) Teachers should prepare learning supportive environment to students in order to gain and expand their knowledge and understand the requirements of the question and subject matter.

(b) Teachers should prepare practical session and guide students during execution on the topics or sub-topics which are practical orientated on the topics of Engineering drawing.

(c) Teachers should guide students on developing the culture of reading questions carefully before attempting them. This will help students to understand the requirements of the questions before attempting.

Appendix I:

A Summary of Students' Performance (Question-Wise) in FTNA 2024

S/N	Topic	Sub-Topic	Performance for EachTopic		Remarks
			Question Number	Percentage of Students who Scored 30% or More	
1.	Engineering Drawing II	Pictorial Drawings	5 and 7	75.00	Good
2.	Engineering Drawing I	International Standard Organization (ISO) Sheet Layout and Sketching	3	72.54	Good
3.	Engineering Drawing I	Similar Figures	1	68.21	Good
4. 5.	Engineering Drawing II	Intersections of Cylinders	6	66.47	Good
5.	Engineering Drawing I	Construction of Geometric Figures	2	47.98	Average
6.	Engineering Drawing II	Free Hand Sketching	4	27.17	Weak