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Development and Validation of an Instrument for Assessing Students' Practical Skills in Joinery at Science and Technical College Level in Nigeria

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Abstract

The fact that a student can present a quality product does not constitute a positive proof that process practical skills are obtained. This study was therefore designed to develop and validate an instrument for assessing students' practical skills in joinery at technical college level. Four research questions were set to guide the study and a null hypothesis. The study adopted the instrumentation design and was carried out in Adamawa State. The population for the study was sixty four (64) respondents. The instrument was subjected to validation, reliability test and results obtained from task-by-task reliability coefficient range from 0.67 to 0.98 through Cronbach Alpha coefficient. The instrument was imperiled to factor is alanalys is where a practical skill item was discarded. Based on the findings; nine (9) tasks with corresponding eighty three (83) practical skills were developed. The study recommended that (i) efforts should adopted to enforce the use of Joinery Skill Assessment Instrument (JSAI) for assessing students' practical skills in Nigerian technical colleges. (ii) Teachers should be encouraged to study and acquaint themselves with the use of JSAI. (iii) Stakeholders (ministries and institutions) should endeavor develop platforms (conferences, workshops) where the use of this new assessment instrument can be encouraged.

Keywords

assessment, validation, reliability, joinery, practical skills, science and technical colleges

1. Introduction

The National Policy on Education (FRN, 2013) spelt out the goals of TVET as follows: to provide trained manpower in the applied sciences, technology and business particularly at craft, advanced craft and technical levels; to provide the technical knowledge and vocational skills necessary for agricultural, commercial and economic development and to give training and impart necessary skills to individuals who shall be self-reliant economically. The purpose and goals of TVET cannot be realized without a sound, reliable and implementable and assessment of the curriculum content achieved by learners. The National Board for Technical Education (NBTE) developed a modular curricula for all the trades offered at science and technical college level. The curriculum was broken into modules of employable skills, which the students are expected to master within a given time frame (Tika, 2015). The breakdown of the curriculum into objectives also provides a level ground for assessment process to determine the overall achievement of the curriculum objectives and goals. Assessment is a form of evaluation that uses collected data for estimating the work, quality or effectiveness of a programmer project. Technical education assessment is the process of calculating or measuring the extent of skills the students have acquired. Assessment could be of an individual learner, class, workshop, the school or the educational system as a whole. In this study, assessment refers to a process of determining the performance of a student's skills by asking the student to perform tasks that require those skills.

Assessment is one of the most important aspects of teaching and learning process; because it propels student to learn. Ombugus (2013) defined assessment as the process of collecting evidence and making judgment on the extent and measuring progress towards the performance requirements set out in a standard learning outcome. Skills according to Ogbuanya (2010) are the abilities in carrying out a task. Tika (2015) defined task as logically related set of actions required for completion of a job objective. In the context of this study, task referred to a piece of work that must be performed on the work piece or industrial project in order for it to be successful. The carpentry and joinery trade curriculum emphasized tasks and skills that students are expected to acquire in wood preparation, joinery, formwork, framing carpentry and joinery machining, hand tools fitting and finishes among other operations (Umar, 2014). Each of these operations have tasks that are performed through a sequence of practical activities or skills in consonance with the objectives. The carpentry and joinery trade teachers have to improve on the joints used in frame-like construction where the wood members are jointed end to edge, with their edges at right angles, e.g., paralleled doors, tables, chairs, picture frames among others. The face sides of the wood members are usually flush. Some of the common joints for frame construction according to Umar (2014) are: halving go rhalf-lap, mitred, dowelled, mortise and tendon, bridle among other joints. The variations of these joints are occasionally necessary and may be

designed to suit special jobs. Okwori, Adamu, and Odo (2013) concluded that the knowledge, skills and application of manipulative skills to various types of joints must be properly evaluated hence the need for joinery skill assessment instrument.

Based on the Item Response Theory propounded by Hambleton, Swaminathan, and Rogers (1991), which is a body of logically related statements describing the application of mathematical models to data from questionnaires and tests as a basis for measuring abilities, attitudes, skills or other variables. The use of this theory as an approach to developing a valid instrument provide these important features; it provides information about the amount of manipulative skill measured by each task, student performance on a given task provides information about how much skillful each student is so far. Supporting the profounder, Gall, Gall, and Borg (2007) describe edited responses theory as an approach to test construction. They also considered factor analysis to play a major role in the development of various types of assessment instruments used in education. For effective assessment, the joinery practical skills instrument should be valid.

Validity of an instrument, according to Nwabueze (2009) is the degree to which an instrument measures what it is designed or made to measure. An instrument with high validity will measure accurately the particular qualities it is supposed to measure. In the views of Okwelle and Okoye (2012), validity of a measuring instrument is the property of a measure that helps to ensure that the instrument measures what it supposed to measure. Enyi (2009) classified four types of validity, face (logical), content (domain), construct and criterion-referenced (concurrent and predictive) validity. Face, content and construct validity were utilized in this study. In the construct validity, factor analysis is employed to determine the validity of an instrument. Ombugus (2013) observed that the higher the absence of low factor loading skill items, the more important and suitable the instrument items. An instrument used for assessing students should not only bevalidbut also reliable.

Reliability of a measuring instrument according to Ofuebeand Izueke (2011) is the ability of the instrument to measure consistently the phenomenon it is designed to measure. It therefore means the consistency with which an instrument measures what ever it measures. The use of valid and reliable practical skill test for assessing NTC students in carpentry and joinery trade will provide an effective tool for evaluating both process and product skills acquired by the students on carrying out tasks. However, at present only product assessment is employed at the science and technical colleges. The product rating method used by the teachers and examination bodies in measuring performance of the students is in adequate. The current practice has made it impossible for the full achievement of the objectives of carpentry and joinery trade in science and technical colleges. This is because procedural steps to arrive at the completed project are not properly assessed. The study is therefore prompted on the derisory nature of the present method of evaluation which is product-based, there is an urgent need to improve overhaul the standard of assessment in carpentry and joinery trade by using valid and reliable assessment instruments which will take account of the processes of practical activities leading to the completion of the final practical products. The assessments of practical skills practiced by the

carpentry and joinery teachers and final examination by NABTEB have produced graduates of carpentry and joinery that are unemployable in the field. This explains why many of the graduates are into other unskilled jobs like commercial motorcyclist, motor-parks workers others even hungry, kidnapping among others or remain unemployed. This study was therefore designed to develop and validate an instrument for assessing students' practical skills in joinery at science and technical college level.

2. Method

The study adopted the instrumentation design and was carried out in Adamawa State. The population for the study is sixty four (64) respondents. Purposive sampling technique was employed to arrive at the use of Government Science and Technical College, Yola for the trial test and the entire population was used as sample size since it is manageable. The Joinery Skill Assessment Instrument (JSAI) was developed using the following strategy build up based on the suggestions of Okwelle and Okoye (2012) and UNESCO (2002).

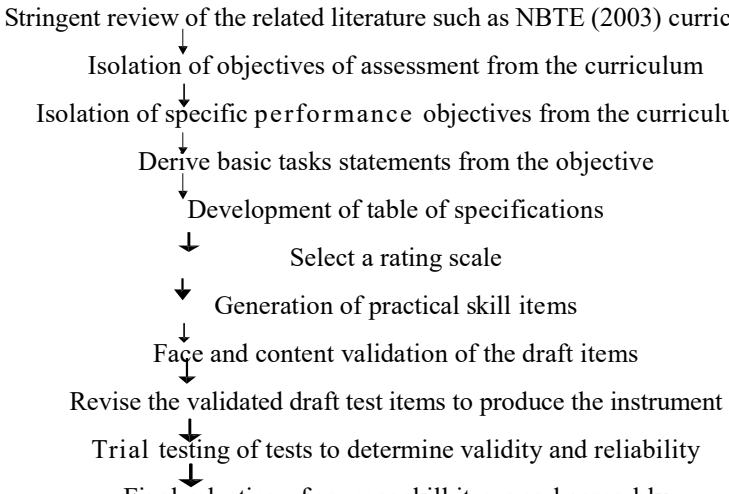

Figure 1. Flowchart for JSAI Development

Table of specifications was developed by researcher through identifying observable skills processes involved in performing the extracted practical tasks items, after carefully analyzing NBTE (2003) curriculum and NABTEB (2015) syllabus with some literature. In doing so, caution was taken to ensure that each aspect of the taxonomy of psychomotor domain is covered based on Simpson model of psychomotor objectives with the proportionate percentage. Simpson (1972) model classified psychomotor objective to seven stages, these include: Perception, Set, Guided Response, Mechanism, Complex Overt Response, Adaption and Origination. After conducting task analysis, nine tasks were identified, and expanded further to give 84 practical skill items. The instrument was subjected to face, content and construct validation. A 5–point scale with rating values of 5, 4, 3, 2, and 1 was

incorporated into the instrument. The instrument was subjected to factorial analysis where a practical skill items was discarded from the six NTC Joinery modules. Three teachers of Carpentry and Joinery were used as assessors for observing and assessing the students as they execute given tasks with corresponding skills of the developed instrument during the try-out. Cohen, Manion and Marrison (2011) recommended that a coefficient rangingfrom0.51to1.00indicate high degree of agreement between two or more assessors. The method of data analysis includes the factorial analysis, Simpson's (1972) taxonomy of psychomotor objectives, Cronbach Alpha coefficient, Kendall coefficient of concordance (Tau) and z-Test.

2.1 Purpose of the Study

The main purpose of this study was to develop and validate an instrument for assessing students' practical skills in joinery at science and technical college level. Specifically, the study will: -

1) identify the practical task items considered appropriate for inclusion in Joinery Skill Assessment Instrument (JSAI) for assessing students' practical skills in science and technical colleges,

2) identify the practical skill items considered appropriate for inclusion in Joinery Skill Assessment Instrument (JSAI) for assessing students' practical skills in science and technical colleges,

3) determine the validity of the developed instrument for assessing joinery trade students' practical skills in science and technical colleges,

4) establish the reliability of the developed instrument for assessing joinery trade students' practical skills in science and technical colleges.

2.1.1 Hypothesis

One null hypothesis was tested at 0.05 level of significance:

Ho_1: There is no significant difference between the mean responses of carpentry and joinery craft teachers and carpentry and joinery professionals on the practical task items considered appropriate for inclusion in Joinery Skill Assessment Instrument.

3. Results

Research question 1. What are the practical task items considered appropriate for inclusion in Joinery Skill Assessment Instrument (JSAI) for assessing students' practical skills in science and technical colleges?

Table 1. Practical Task Items Considered Appropriate for Inclusion in Joinery Skill Assessment Instrument (JSAI)

Psychomotor modules	Practical Tasks	Factor loading	Remark
Joinery I	Butt Joints	Above 0.50	Appropriate
	Halving Joints	Above 0.50	Appropriate
	Common Mortise and Tenon Joints	Above 0.50	Appropriate

	Bridle Joints	Above 0.50	Appropriate
	Through Dovetail Joints	Above 0.50	Appropriate
	Lap Dovetail Joints	Above 0.50	Appropriate
Joinery II	Haunched Mortise and Tenon Joint	Above 0.50	Appropriate
	Half-Lap Cross Joint	Above 0.50	Appropriate
	Tongue and Groove Joint	Above 0.50	Appropriate

Table 1 presents result of the practical tasks considered appropriate for inclusion in the Joinery Skill Assessment Instrument (JSAI) for assessing students' practical skills in science and technical colleges. The result of factor analysis from the data obtained shows that nine (9) practical tasks from the psychomotor modules of Joinery curriculum at the science and technical colleges are appropriate. With a cluster factor loading ranging from 0.500 to 1.000, it can therefore, be concluded that the practical tasks obtained through content analysis of the NBTE Joinery curriculum were unanimously accepted by the respondents.

Research question 2. What are the practical skill items considered appropriate for inclusion in Joinery Skills Assessment Instrument (JSAI) for assessing students' practical skills in science and technical colleges?

Table 2. Practical Skills Items Considered Appropriate for Inclusion in Joinery Skill Assessment Instrument (JSAI)

S/N	Practical Tasks	Corresponding Skills	Factor loading (Range)	Remark
1	Butt Joints	9	0.65-0.76	All items appropriate
2	Halving Joints	7	0.65-0.76	All items appropriate
3	Common Mortise and Tenon Joints	8	0.60-0.80	All items appropriate
4	Bridle Joints	9	0.65-0.75	All items appropriate
5	Through Dovetail Joints	14	0.59-0.77	All items appropriate
6	Lap Dovetail Joints	11	0.60-0.77	All items appropriate
7	Haunched Mortise and Tenon Joint	10	0.58-0.81	All items appropriate
8	Half-Lap Cross Joint	9	0.58-0.81	All items appropriate
9	Tongue and Groove Joint	7	Item 84 with 0.42	One item discarded
	Total	**84**		**83 items appropriate**

To select practical tasks, factorial analysis of the instrument items were determined which Gall, Gall

and Borg (2007) considered to play a major role in the development of various types of assessment instruments used in education. The procedures involved; (1) identifying nine psychomotor tasks areas in the NTC curriculum in Joinery, (2) building a table of specification based on Simpson's (1972) taxonomy of psychomotor objectives. This followed a process of task analysis (3) generating practical skill items which closely fit the table of specification. The skill items were subjected to factor analysis using 0.50 as factor loading at 5% over lapping variance. Therefore, any practical skill with factor loading of 0.50 and above was included in the Joinery Skill Assessment Instrument while skill items with factor loading less than 0.50 were not included in the final copy of JSAI. One (1) out of the 84 Joinery practical skill items had factor loading below 0.50 and so needed exclusion. Item 84 was the skill discarded (Clean up the assembled article). The Joinery Skill Assessment Instrument (JSAI) is presented in **Note 1.**

Research question 3. What is the validity of the developed instrument for assessing carpentry and joinery trade students' practical skills in science and technical colleges?

The instrument was subjected to face, content and criterion-referenced validation as well as factor analysis. Three validates from the Department of Technology and Vocational Education and two from the Department of Measurement and Evaluation from Nigerian Universities, as well as two Technical teachers teaching Carpentry and Joinery at the science and technical colleges assisted in the validation. All the above identified professional Carpentry and Joinery practitioners validated the instrument. The experts reviewed, reworded and re-structured the instrument and made satisfactory comments about the entire tasks and corresponding skills. The Table of specifications constructed based on the Simpson's (1972) model of psychomotor domain revealed that out of the 84 practical skills, 7.4% comprising 7 practical skill items were assessing the Perception Level; 10.53% comprising 9 practical skill items were assessing the Set Level; 27.41% comprising 22 practical skill items were assessing the Guided Response Level; 26.29% comprising 21 practical skill items were assessing the Mechanism Level; 17.78% comprising 16 practical skill items were assessing the Complex Overt Response Level and 10.51% comprising 9 practical skill items were assessing the Adaptation Level. The Origination Level of Simpson's Model was not involved in the study because it adjusted as being beyond the scope of this study. These results showed that 6 levels of the domain were adequately covered in the assessment instrument. This means that all the 84 practical skill items were valid for inclusion in the in Joinery Skill Assessment Instrument for assessing students' practical skills in science and technical colleges.

Research question 4. What is the reliability of the developed instrument for assessing Joinery students' practical skills in science and technical colleges?

Table 3. Reliability Coefficient of Task-by-Task of the Developed Instrument for Assessing Joinery Students' Practical Skills in Science and Technical Colleges

S/N	Operational Tasks	Number of Skills	Reliability Coefficient
1	Butt Joint	9	0.67
2	Halving Joint	7	0.73
3	Common Mortise and Tenon Joint	8	0.81
4	Bridle Joint	9	0.71
5	Through Dovetail Joint	14	0.74
6	Lap Dovetail Joint	11	0.97
7	Haunched Mortise and Tenon Joint	10	0.91
8	Half-Lap Cross Joint	9	0.82
9	Tongue and Groove Joint	7	0.98
	Overall Reliability Coefficient		**0.82**

Table 3 reveals that; the results obtained from task-by-task reliability coefficient range from 0.67 to 0.98, while the overall reliability of the instrument is 0.82 which indicates that the assessment instrument was are fined test in consonance with the recommendation of Uzoagulu (2011) that acceptable reliability of tests used in education is generally in the rangeof0.50—0.95. The result also revealed that none of the tasks and corresponding skills in the instrument has reliability coefficients of less than 0.6. This shows that the entire tasks can be included in the instrument. In order to establish the inter-rater reliability in the instrument, atria ltesting was conducted using 15 NTC III students of Joinery and three teachers (assessors). Data obtained from the trial testing was analy seducing Kendall's Coefficient of Concordance, Tau (W) to find out if there is significant relationship between the three rater's scorings in the developed instrument for assessment. The degree of agreement of concordance among the raters on the instrument scorings were then computed. The inter rater reliability of the 3 raters were found to be 0.64, 0.85 and 0.71 for raters A and B; Band C; A and Respectively. These values were in agreement with the recommendation by Cohen *et al.* (2011) that a coefficient ranging from 0.51 to 1.00 indicate high degree of agreement between 2 or more examiners.

Ho_1: There is no significant difference between the mean responses of Carpentry and Joinery teachers and Carpentry and Joinery professionals on the practical task items considered appropriate for inclusion in Carpentry and Joinery Skill Assessment Instrument.

Table 4. Z–Test of Carpentry and Joinery Teachers and Carpentry and Joinery Professionals on the Practical Task Items Considered Appropriate for Inclusion in Joinery Skill Assessment Instrument

Respondents	N	$\bar{x}$	S. D	Df	z - value	P -value	Remark
Carpentry and Joinery teachers	20	3.78	1.69				
				62	0.056	0.956	Not Significant
Carpentry and Joinery professionals	44	4.07	0.83				

The results of z-Test on Table 4 determined the significant difference between the mean responses of Carpentry and Joinery Trade teachers and Carpentry and Joinery professionals on the practical task items considered appropriate for inclusion in Joinery Skill Assessment Instrument. The result shows that 44 Carpentry and Joinery professionals had a mean response of 3.78 with a standard deviation of 1.69 and z-value of 0.056 and with the P-value (probability value) of 0.956 greater than 0.05, which implies that there is no significant difference between the mean responses of carpentry and joinery craft teachers and carpentry and joinery professionals on the practical task items considered appropriate for inclusion in Joinery Skill Assessment Instrument.

4. Discussion

The findings relating to construct validity of the psychomotor modules revealed nine tasks considered appropriate for inclusion in the instrument. The first output from the factor analysis employed is the reliability statistics which ranges from 0.985 to 0.997 for all the tasks and corresponding practical skills hence appropriate for inclusion in the instrument. However, a practical skills could not load and was discarded. After the reliability statistics then the table of descriptive statistics for all the variables under investigation. This tables typically give the mean, standard deviation and number of respondents (N) who participated in the survey are given. Looking at the mean, one can conclude that checking the machine before operation and griping the blade by tightening are the most important variables that influence process skills. They had the highest mean of 13.82 and 14.11. The next item from the output is a table of communalities which shows how much of the variance. That is, the communality value which should be more than 0.5 to be considered for further analysis. Otherwise, these variables are to be removed from further steps of the factor analysis, if the variables have been accounted for by the extracted factors.

Total Variance Explained shows the actual factors that were extracted. In the section labeled “Rotation Sums of Squared Loadings,” it shows only those factors that met the cut-off criterion (extraction method). In this case, there were two factors with eigen values greater than 1. SPSS always extracts as many factors initially as there are variables in the dataset, but the rest of these did not make the grade. The “% of variance” column informs how much of the total variability (in all of the variables together) can be accounted for by each of these summary scales or factors. Factor 1 representing the tasks

account for 93.68 to 99.88% of the variability in all 84 corresponding practical skills. The scree plot is a graph of the eigen values against all the factors which was used to determine how many factors to be retained. The point of interest is where the curve starts to flatten. It observed that most of the curves begin to flatten between Factors 1 and 2. Factor 3 onwards have an eigenvalues of less than 1, so only two factors have been retained across all the 9 tasks. Finally, the Rotated Component Matrix showed the factor loadings for each variable across each row and highlighted the factor that each variable loaded on most strongly. Based on these factor loadings, it can be deduced that the factors represented by the tasks loaded strongly ranging from 0.58 to 0.81 for about 83 corresponding skills out of 84. This confirmed the importance and construct validity of the Joinery Skill Assessment Instrument. This finding agrees with the observation by Ombugus (2013) that the higher the absence of low loading skill items, the more important and suitable the instrument items.

It was found that 9 tasks with their 83 corresponding skill items were considered appropriate for inclusion in the Joinery Skill Assessment Instrument (JSAI) for assessing students' practical skills in science and technical colleges. The findings that 83 out of 84 practical skill items with high factor loading were considered appropriate for inclusion in the Joinery Skill Assessment Instrument (JSAI) for assessing students' practical skills in science and technical colleges was in consonance with the findings of Ombugus (2014) who concluded that items that satisfied all psychometric properties with high factor loading are adequate for selection. Skills such as preparing the pieces of wood to the required size, Gauging lightly round one end of each piece to receive dovetail/pins, chiseling off the waste portion halfway down each piece, and removing end piece by sawing across grain then mortising out centre piece received the highest factor loading of 1.00 probably because of the importance in process skills development. The results obtained from task-by-task reliability coefficient range from 0.67 to 0.99, while the overall reliability of the instrument is 0.88. Therefore, given the high reliability coefficients for various tasks in the instrument, the answer to the research question about the reliability of the tests was in the affirmative.

5. Conclusion

The major findings of the study serve as the basis for drawing conclusion that the developed instrument is a valid and reliable assessment instrument that could be used in assessing student's practical skills in Joinery in science and technical colleges in Nigeria. It is expected that Joinery teachers in technical colleges will be encouraged to use the instrument to assess students' practical skills in the trade. The school administrators and potential employers will also find the instrument useful as it will enable them to make proper placement of students for admission in to higher institution, also it will help to predict students' performance when admitted for further education as well as employment.

6. Recommendations

Based on the findings of the study, the following recommendations were proffered:

1) The Ministry of Education should adopt and enforce the use of Joinery Skill Assessment Instrument (JSAI) for assessing students' practical skills in Nigerian technical colleges.

2) Technical colleges teachers of Carpentry and Joinery trade should be encouraged to study and acquaint themselves with the use of the new assessment instrument.

3) Stake holders (ministries and institutions) should Endeavour develop platforms (conferences, workshops) where the use of this new assessment instrument can be encouraged.

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Note 1

The Developed Carpentry and Joinery Skill Assessment Instrument (CJSAI) for Assessing Students in Science and Technical Colleges (1)

S/N	**Rating Scale**							
	Excellent (E) 5 Very good (VG) 4 Good (G) 3 Fair (F) 2 Poor (P) 1	Ensure proficiency in the use of equipment and machines,	Ability to read and understand wood structure and texture	Complete the project within as pacified time limit	Blue print inter predation	Ability to understand wood behavior in different conditions	Safety and health considerations	Ability to work as an individual

	Task 1: Butt Joints; The student should be able to:							
1	Plane the two pieces of wood to be joined to required length							
2	Plane the two pieces of wood to be joined to required thickness							
3	Plane the two pieces of wood to be joined to required width							
4	Square the end of one member so it fits against the flat surface or edge of the second							
5	Fit the two pieces of wood together							
6	Use glue to strengthen the joint							
7	Use nails to strengthen the joint							
8	Use copper blocks to strengthen the joint							
9	Use dowels to strengthen the joint							
	Task 2: Halving Joints							
10	Plane the two pieces of wood to be joined to required length							
11	Plane the two pieces of wood to be joined to required cross-section							
12	Cut the U groove across the faces of the two pieces of wood to be joined							
13	Chisel off the waste portion halfway down each piece							
14	Assembling the two pieces of wood together							
15	Apply glue to fasten the joint							
16	Strengthen the joint with nails							
	Task 3: Common Mortise and Tenon Joints							
17	Prepare the pieces of wood to be joined face-face edge-width-thickness							
18	Use a mortise gauge to make lines showing the position of the mortise on one piece.							
19	Use a mortise gauge to make lines showing the position of the tenon on the other piece.							
20	Set mortise gauge to a required dimension say: 6mm							

21	Chisel out waste halfway through from both edges then leaving about 3 mm waste at each end of the mortise							
22	Slightly tapping the sides of the mortise to allow fitting in to the tenon							
23	Saw off waste at each end/centre of the tenon along pencil lines							
24	Assemble with glue plus a wedge							
	Task 4: Bridle Joints							
25	Prepare the pieces of wood to be joined to required length, thickness and width							
26	Mark the position to be cut off leaving waste							
27	Set out lines around block for position of joints using cut lines							
28	Set mortise gauge to mortise chisel/gauge lines							
29	Cut the tenon shoulder with a fine saw							
30	Remove grooves on first piece to receive the second piece then from tenon on the third piece							
31	Chop out waste in the socket or notch with a coping saw							
32	Saw into three sections/take centre pieces							
33	Assemble while trimming off to flush							
	Task 5: Through Dovetail Joints							
34	Plane the pieces of wood to the required size.							
35	Mark off lengths, leaving waste.							
36	Saw off waste pieces, leaving a small fraction then plane off on shooting-board							
37	Set marking-gauge to thickness of wood while testing gauge on edge.							
38	Gauge lightly round one end of each piece to receive dovetail/pins							
39	Mark dovetail on one piece only (A) with pencil/sliding-bevel, marking on one side and end only.							
40	Saw down oblige lines on waste side of line forming dovetails.							

41	Remove end piece by sawing across grain then mortise out centre piece.							
42	Fix other piece (B) in vice with gauged end uppermost, hold piece A firmly in position then mark across end.							
43	Determine the exact size of the pin/half-pins.							
44	Mark down each side with try-square plus knife							
45	Saw down on the waste side of the line							
46	Remove waste with bow-saw, chisel plus mallet.							
47	Fit together then clean up.							
	Task 6: Lap Dovetail Joints							
48	Plane up a piece of wood to size required.							
49	Mark off lengths leaving waste.							
50	Saw to lengths leaving a small amount.							
51	Plane off to line on shooting-board.							
52	Rightly gauge round one end of piece A equal to length of dovetails (lap)							
53	Saw down on waste line of lines forming dovetail.							
54	Remove corner pieces by sawing across the grain then mortise out centre piece							
55	Gauge piece B across grain on one side a light line equal to thickness of dovetail.							
56	Place B in vice, hold piece A firmly while marking round dovetail with point of compass.							
57	Saw down as far as possible then cut out remainder of waste with chisel/mallet leaving the pins.							
58	Fit together then clean up.							
	Task 7: Haunched Mortise and Tenon Joint							
59	Plane up the two required pieces of wood							
60	Mark off lengths							
61	Mark off shoulder lines on rail pieces for tenon on opposite side to face							
62	Set marking-gauge to mortise chisel							

63	Chop out waste often on sockets with other mortises vertically and horizontally							
64	Assemble leg in a vice, remove piece to receive haunch with saw and chisel							
65	Cut thenarrowstilesorpostand rails							
66	Ripthejointsfortopandbottomrails							
67	Cut the tenon according to specification in working drawing							
68	Clean up then fit together							
	Task 8: Half-Lap Cross Joint							
69	Plane up block of wood to required size both face-side/edge							
70	Mark off length leaving 6mm waste at each end/centre using cut lines							
71	Mark off cut lines on face-side/reverse side of other section for groove forming joint							
72	Gauge lines for depth of grooves on both edges							
73	Saw down for depth of grooves							
74	Remove waste by horizontal paring							
75	Saw off waste pieces at each end/centre							
76	Fit the pieces together							
77	Clean off with smoothing-plane							
	Task 9: Tongue and Groove Joint							
78	Prepare the pieces of wood to the required size							
79	Clamp the work piece on the bench							
80	Cut the groove to one-third the thickness of piece A							
81	Cut the groove to one-third the thickness of piece B							
82	Cut the tongue to fit into groove							
83	Assemble the pieces without glue							

The Developed Carpentry and Joinery Skill Assessment Instrument (CJSAI) for Assessing Students in Science and Technical Colleges (2)

S/N	**Rating Scale**

	Excellent (E) 5 Very good (VG) 4 Good (G) 3 Fair (F) 2 Poor (P) 1	The use of the right tool for the right job	Ability to conserve materials and supplies	Overall quality of finishing	Members nd joints in relation to strength and rigidity	Ability to produce articles with proportionality of parts	Consideration of object fitness for purposes	Total
	Task 1: Butt Joints; The student should be able to:							
1	Plane the two pieces of wood to be joined to required length							
2	Plane the two pieces of wood to be joined to required thickness							
3	Plane the two pieces of wood to be joined to required width							
4	Square the end of one member so it fits against the flat surface or edge of the second							
5	Fit the two pieces of wood together							
6	Use glue to strengthen the joint							
7	Use nails to strengthen the joint							
8	Use copper blocks to strengthen the joint							
9	Use dowels to strengthen the joint							
	Task 2: Halving Joints							
10	Plane the two pieces of wood to be joined to required length							
11	Plane the two pieces of wood to be joined to required cross-section							
12	Cut the U groove across the faces of the two pieces of wood to be joined							
13	Chisel off the waste portion halfway down each piece							
14	Assembling the two pieces of wood together							

15	Apply glue to fasten the joint							
16	Strengthen the joint with nails							
	Task 3: Common Mortise and Tenon Joints							
17	Prepare the pieces of wood to be joined face-face edge-width-thickness							
18	Use a mortise gauge to make lines showing the position of the mortise on one piece.							
19	Use a mortise gauge to make lines showing the position of the tenon on the other piece.							
20	Set mortise gauge to a required dimension say: 6mm							
21	Chisel out waste halfway through from both edges then leaving about 3 mm waste at each end of the mortise							
22	Slightly tapping the sides of the mortise to allow fitting in to the tenon							
23	Saw off waste at each end/centre of the tenon along pencil lines							
24	Assemble with glue plus a wedge							
	Task 4: Bridle Joints							
25	Prepare the pieces of wood to be joined to required length, thickness and width							
26	Mark the position to be cut off leaving waste							
27	Set out lines around block for position of joints using cut lines							
28	Set mortise gauge to mortise chisel/gauge lines							
29	Cut the tenon shoulder with a fine saw							
30	Remove grooves on first piece to receive the second piece then from tenon on the third piece							
31	Chop out waste in the socket or notch with a coping saw							
32	Saw into three sections/take centre pieces							
33	Assemble while trimming off to flush							
	Task 5: Through Dovetail Joints							
34	Plane the pieces of wood to the required size.							
35	Mark off lengths, leaving waste.							

36	Saw off waste pieces, leaving a small fraction then plane off on shooting-board							
37	Set marking-gauge to thickness of wood while testing gauge on edge.							
38	Gauge lightly round one end of each piece to receive dovetail/pins							
39	Mark dovetail on one piece only (A) with pencil/sliding-bevel, marking on one side and end only.							
40	Saw down oblige lines on waste side of line forming dovetails.							
41	Remove end piece by sawing across grain then mortise out centre piece.							
42	Fix other piece (B) in vice with gauged end uppermost, hold piece A firmly in position then mark across end.							
43	Determine the exact size of the pin/half-pins.							
44	Mark down each side with try-square plus knife							
45	Saw down on the waste side of the line							
46	Remove waste with bow-saw, chisel plus mallet.							
47	Fit together then clean up.							
	Task 6: Lap Dovetail Joints							
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50	Saw to lengths leaving a small amount.							
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55	Gauge piece B across grain on one side a light line equal to thickness of dovetail.							
56	Place B in vice, hold piece A firmly while							

	marking round dovetail with point of compass.							
57	Saw down as far as possible then cut out remainder of waste with chisel/mallet leaving the pins.							
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