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Original Research

Validation of a Foundry Craft Practical Skills Assessment Instrument (FCPSAI) in Nigerian Technical Colleges Using Content Validity Index

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ABSTRACT

This study evaluates the content validity of the Foundry Craft Practical Skills Assessment Instrument (FCPSAI) developed for technical colleges in Nigeria. The content validation of a foundry craft instrument using the CVI was conducted through a three -stage methodology. The first stage involved defining the instrument and its core aspects needing validation; the second stage focused on selecting a questionnaire as the validation tool. The third stage involved data collection, where validators completed the questionnaire and provided their assessments. A systematic validation process was carried out, in which a panel of subject matter experts from Nigeria and internationally evaluated the relevance of individual assessment items within the FCPSAI. The Individual Item-Level Content Validity Index (I-CVI) was calculated for each item, while the Scale-Level Content Validity Index (S-CVI/Ave) provided an overall measure of the instrument's validity across various domains. The evaluation yielded strong evidence of content validity, with I-CVI scores ranging from 0.75 to 1.0, demonstrating that the majority of items were deemed relevant and necessary by experts. Many individual items received perfect I-CVI scores of 1.0. The S-CVI/Ave scores for specific domains—including Pattern Layout, Pattern Construction, Core Preparation, Molding, Melting, Casting, and Finishing—ranged from 0.94 to 1.00. Notably, all domains surpassed the recommended threshold of 0.8, indicating comprehensive coverage of the relevant content. The overall S-CVI/Ave of 0.97 confirms the high validity of the FCPSAI, with 83 practical skill items recognized as valid. The study confirms that the FCPSAI is a reliable and valid tool for assessing practical skills in foundry craft practice and it was recommended among others that similar validation studies across other TVET trades worldwide should be encouraged.

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1. INTRODUCTION

Technical and Vocational Education and Training (TVET) plays a vital role globally in equipping learners with the practical skills necessary for employment and economic development (UNESCO, 2021). Effective skills assessment in TVET is critical for ensuring graduates meet industry standards and are work-ready (Mulder, et al., 2007). However, challenges in developing valid and reliable assessment tools persist,

especially in developing countries where contextual factors influence assessment design and implementation (Rauner & Maclean, 2008). Nigeria, like many countries, faces the challenge of assessing practical skills in foundry craft, a key industrial trade essential to manufacturing and engineering sectors (Obe et al., 2019)

The Foundry Craft Practical Skills Assessment Instrument (FCPSAI) was developed to address the gap in valid, contextually relevant assessment tools for technical college students. Validating such instruments through rigorous methods like the Content Validity Index (CVI) is essential to ensure they accurately measure intended competencies and align with international quality standards (Lynn, 1986). This study aims to validate the FCPSAI using CVI with experts from Nigeria and the international TVET community, situating the research within global efforts to improve TVET assessment validity and quality.

2. LITERATURE REVIEW

Assessment validity in TVET, particularly for practical skills, has been widely debated internationally (Mulder et al., 2007). Content validity which is the extent to which an instrument covers all relevant aspects of a construct, is fundamental in establishing assessment credibility (Polit & Beck, 2021). One promising approach to addressing this task is to use the Content Validity Index (CVI). The CVI is a statistical method that involves evaluating the relevance and representativeness of the items in an assessment tool by consulting subject matter experts (SMEs) (Yusoff, 2020; Wang & Wang, 2021).

Furthermore, CVI is a widely accepted quantitative approach involving expert ratings of each item's relevance (McKenzie & Walker, 2022). Although several validation approaches exist, including factor analysis, construct validation procedures, and criterion-related validation methods, the Content Validity Index (CVI) was selected because the FCPSAI is a newly developed practical skills assessment instrument requiring expert judgement to establish domain representativeness before field testing. CVI is appropriate at the early stage of instrument development and is widely used in TVET studies for evaluating observable psychomotor competencies (Lynn, 1986; Polit & Beck, 2021). It helps ensure that the assessment instrument truly measures the skills required and covers all the relevant aspects of the task performance.

Recent studies across diverse TVET contexts have applied CVI to validate practical skills assessments, from automotive technology in South Africa (Mokoena & Van der Merwe, 2022) to welding skills in Australia (Ahmed & Rofiq, 2020). Unlike earlier studies such as Mokoena and Van der Merwe (2022) and Ahmed and Rofiq (2020), which focused on single-country validation of automotive and welding competencies, this study applies the Content Validity Index to the under-researched foundry craft domain in Nigerian technical colleges and enhances the broader relevance of the FCPSAI through the inclusion of national and international experts. These studies emphasize transparency in expert selection, use of multiple CVI metrics (item-level and scale-level), and incorporation of feedback for instrument refinement. Foundry craft skills, despite their industrial importance, remain under-researched in TVET assessment validation literature, especially in Africa. The FCPSAI structure was based on the NBTE-approved NTC and ANTC foundry craft curriculum in Nigeria. Its domains—pattern layout, pattern construction, core preparation, molding, melting, casting, and finishing—reflect national competency clusters and industry expectations, ensuring validation focused on items grounded in recognized training standards. This study fills this gap by applying international validation techniques to a Nigerian context while engaging experts with cross-national expertise, thus contributing to global TVET research discourse.

3. METHOD

3.1. Research design

A quantitative descriptive design was used, focusing on content validation through expert judgment using the CVI methodology (Lynn, 1986).

3.2. Participants

Five experts were purposively selected based on their expertise in TVET, foundry craft, and assessment from Nigeria (3 experts) and international institutions (2 experts) from Europe and Asia. The criteria for selection included at least five years of relevant experience and academic or professional credentials. The first, second and third assessors selected were from Federal Colleges of Education (Technical), Asaba, Delta State, with 20, 15, and 17years' experience, respectively, in teaching foundry craft practice. Furthermore, the fourth and fifth assessors were from Kelson's group in Kolhapur, Maharashtra, and the Metec group in Italy, with extensive expertise in the trade. This number of experts, according to Wang and Wang (2021) is an acceptable number of experts.

3.3. Instrument

The FCPSAI consisted of 83 items covering core foundry craft practical skills, developed based on industry standards and existing curricula.

3.4. Operational Definitions of the FCPSAI Domains

- Pattern Layout: Interpreting and preparing design drawings for pattern making.

- Pattern Construction: Fabricating physical patterns from designs, including assembly and finishing.
- Core Preparation: Selecting, mixing, and testing sand and materials for cores used in molds.
- Core Forming: Shaping cores to create internal cavities for casting.
- Core Baking: Hardening cores in a furnace at controlled temperatures.
- Core Finishing: Refining baked cores to ensure correct dimensions and surface quality.
- Molding: Preparing the sand mold, placing patterns and cores, and creating vent holes.
- Melting: Heating metal to its melting point and preparing it for casting.
- Casting: Pouring molten metal into molds to create components.
- Finishing: Post-casting processes including cleaning, filing, heat treatment, inspection, and testing.

3.5. Procedure

The content validation of the Foundry Craft Practical Skills Assessment Instrument (FCPSAI) was conducted using the Content Validity Index (CVI) through a three-stage methodology:

1. Definition of the instrument and identification of core aspects requiring validation.
2. Selection of a questionnaire as the validation tool.
3. Data collection, where validators completed the questionnaire and provided their assessments.

The experts reviewed the assessment inventory and the NTC/ANTC foundry craft practice curriculum, judging the relevance of each item based on provided definitions and terminologies. Experts rated each item's relevance on a 4-point scale (1 = not relevant to 4 = highly relevant as presented in Table 1). Prior to rating the items, experts were provided with operational definitions of each domain and clarification of technical terminologies extracted from the NTC/ANTC curriculum to ensure uniform interpretation of the assessment items. This procedure helped minimize ambiguity and strengthen the consistency of expert judgement during the validation exercise. In addition to quantitative ratings, experts were encouraged to provide qualitative comments on item clarity, wording, and relevance. Items that attracted suggestions for improvement were carefully reviewed, and minor wording adjustments were made to improve clarity before final computation of the scale-level content validity indices.

3.6. Data analysis

Item-level CVI (I-CVI) was calculated as the proportion of experts rating the items. Scale-level CVI (S-CVI/Ave) was computed as the average I-CVI across all items. To determine the relevance of each item in the instrument, the item-level Content Validity Index (I-CVI) was calculated. Traditionally, Lynn (1986) recommended that when using a panel of three to five experts, only items with an I-CVI of 1.00 is considered relevant. However, subsequent researchers have noted that this criterion may be overly stringent and impractical, particularly in applied research settings. Polit and Beck (2021) propose that an I-CVI of 0.78 or higher is acceptable, even with small expert panels, especially when content validation is supported by additional procedures such as qualitative feedback or scale-level CVI analysis. In line with this more flexible approach, any item with a CVI of 0.79 or above was considered relevant; any item with a CVI between 0.70 and 0.79 needed revisions; and any item with a value below 0.70 was considered for elimination in this study. Items with I-CVI values between 0.70 and 0.79 were reviewed alongside qualitative expert comments and retained after minor wording refinement where necessary. No item recorded an I-CVI below 0.70, requiring elimination from the instrument.

4. RESULTS

This study evaluated the content validity of the Foundry Craft Practical Skills Assessment Instrument (FCPSAI), comprising 83 assessment items organized into ten practical skill domains: Pattern Layout, Pattern Construction, Preparation of Core Sand, Core Forming, Core Baking, Core Finishing, Molding, Melting, Casting, and Finishing. Five experts assessed the relevance of each item using a four-point rating scale, with ratings of 3 or 4 considered relevant. The Item-Level Content Validity Index (I-CVI) was calculated as the proportion of experts who rated each item as relevant. As presented in Table 1, the Pattern Layout domain consisted of five assessment items, four of which achieved an I-CVI of 1.00, indicating unanimous agreement among the experts. The remaining item obtained an I-CVI of 0.80, reflecting agreement among four of the five experts. The domain achieved a Scale-Level Content Validity Index based on average agreement (S-CVI/Ave) of 0.96 and a Scale-Level Content Validity Index based on universal agreement (S-CVI/UA) of 0.80. These findings indicate a high level of content validity for the Pattern Layout domain, although one item did not achieve universal expert agreement.

Table 1. Summary of Content Validity Index (CVI) of FCPSAI.

Task/skill items	Average proportions of items' relevance across the five experts	S-CVI/Ave	S-CVI/UA
Task 1 (5 items)	0.96	0.96	0.80
Task 2 (I8 items)	0.94	0.94	0.70
Task 3 (6 items)	1.00	1.00	1.00
Task 4 (7 items)	0.97	0.97	0.71
Task 5 (4items)	0.95	0.94	0.75
Task 6 (3 items)	1.00	1.00	1.00
Task 7 (17 items)	0.94	0.94	0.71
Task 8 (7 items)	0.97	0.97	0.86
Task9 (8 items)	0.95	0.95	0.75
Task10 (8 items)	0.98	0.98	0.90

5. DISCUSSION

The findings of this study provide strong preliminary evidence of content validity for the Foundry Craft Practical Skills Assessment Instrument (FCPSAI). The item-level content validity results indicate generally high levels of expert agreement regarding the relevance of the practical skill assessment items. These findings are consistent with Polit et al. (2007), who emphasized the usefulness of the Content Validity Index (CVI) in evaluating expert agreement concerning item relevance. Similarly, Yusoff (2019) highlighted the importance of systematic expert evaluation in establishing the content validity of newly developed assessment instruments. The Scale-Level Content Validity Index based on average agreement (S-CVI/Ave) across the ten domains—Pattern Layout, Pattern Construction, Preparation of Core Sand, Core Forming, Core Baking, Core Finishing, Molding, Melting, Casting, and Finishing—ranged from 0.94 to 1.00, as presented in Table 1. All domains exceeded the recommended S-CVI/Ave criterion of 0.90 for excellent content validity (Polit & Beck, 2006), suggesting that the assessment items adequately represent the intended practical skill domains.

Although the S-CVI/Ave values were consistently high, variations were observed in the Scale-Level Content Validity Index based on universal agreement (S-CVI/UA). Pattern Construction recorded the lowest S-CVI/UA value of 0.70, whereas Preparation of Core Sand and Core Finishing achieved complete expert agreement, with S-CVI/UA values of 1.00. Polit and Beck (2006) explained that S-CVI/UA is a more stringent measure than S-CVI/Ave because it requires unanimous agreement among experts for each item. The relatively lower universal agreement in Pattern Construction may be associated with the technical complexity and multiple procedural stages involved in pattern fabrication. However, this interpretation remains tentative because the study did not directly investigate the reasons for differences in expert ratings. These findings suggest that items without universal agreement may benefit from further review and refinement to strengthen their clarity and relevance (Yusoff, 2019).

The findings are also consistent with previous research on competency-based assessment in technical and vocational education. Obe et al. (2019) emphasized the importance of developing and validating competency-based assessment instruments that reflect the knowledge, manipulative skills, and practical performance requirements of mechanical metalwork students in Nigerian technical colleges. Similarly, Dahlback et al. (2020) demonstrated the importance of authentic workplace-based assessment in connecting vocational education with professional competence and practical performance. These studies support the educational relevance of developing structured assessment instruments that reflect occupational competency requirements. In this context, the FCPSAI provides a potentially useful framework for assessing essential practical skills in foundry craft education. The inclusion of experts from both Nigerian and international professional backgrounds also introduced diverse perspectives into the content validation process. Nevertheless, the instrument's applicability beyond Nigerian technical colleges requires further empirical investigation in different vocational education settings.

Despite these encouraging findings, several limitations should be acknowledged. First, the content validation process involved only five experts, and their judgments may have been influenced by differences in professional experience, institutional practices, and interpretations of the assessment items. Second, although CVI analysis provides evidence of item relevance and content representativeness, it does not independently establish the reliability or broader validity of an assessment instrument. The Standards for Educational and Psychological Testing emphasize the importance of accumulating multiple sources of evidence to support the intended interpretation and use of assessment results (AERA et al., 2014). Therefore, further research should investigate the FCPSAI through practical field testing, inter-rater reliability analysis, and additional validity studies involving students and assessors in authentic foundry workshop environments. Such investigations would help determine whether the instrument can consistently and accurately assess students' practical performance.

The findings have important implications for competency-based assessment in Nigerian technical colleges. The FCPSAI may serve as a structured assessment framework to assist teachers in observing and

evaluating students' practical performance across the ten identified skill domains. Furthermore, curriculum planners and technical education stakeholders may use these domains as preliminary reference points for reviewing instructional content and aligning practical training with occupational competency requirements. This potential application is consistent with Obe et al. (2019), who emphasized the relevance of curriculum-aligned competency-based assessment in technical education. Overall, the expert validation results support the content relevance of the 83-item FCPSAI and provide a foundation for subsequent reliability testing, instrument refinement, and broader implementation within technical and vocational education and training.

6. CONCLUSION AND RECOMMENDATION

This study successfully validated the FCPSAI instrument, contributing an evidence-based assessment tool for foundry craft practical skills in Nigeria and offering a model for other TVET contexts globally. The high CVI scores confirm its content relevance and clarity, essential for quality assessment in TVET.

Recommendations include applying the FCPSAI in practical settings to test reliability and predictive validity, expanding expert panels for broader international input, and encouraging similar validation studies across other TVET trades worldwide.

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DECLARATION OF INTEREST

The authors declare no conflicts of interest.

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ETHICAL STATEMENT

Ethical approval for the study was obtained from the Department of Metalwork Technology Education, Federal College of Education (Technical), Asaba. Experts participated voluntarily after being informed of the study's purpose, and their consent was obtained before completing the validation inventory. Confidentiality was maintained, and no conflict of interest existed between the researcher and the experts.

AI USE STATEMENT

The authors declare that no generative artificial intelligence (AI) tools were used in the preparation, analysis, or writing of this manuscript.

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Supplementary Data: The relevance ratings on the item scale by five experts for task 1 to 10

Table 1. The relevance ratings on the item scale by five experts for task 1: Pattern layout

Items	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	No of agreement	I- CVI	UA
1	3	4	4	4	4	5	1.00	1
2	4	4	4	4	4	5	1.00	1
3	4	3	2	3	4	4	0.80	0
4	4	3	3	4	4	5	1.00	1
5	4	4	4	3	4	5	1.00	1
			S-CVI/Ave				**0.96**	
Proportion relevance	**1.00**	**1.00**	**0.80**	**1.00**	**1.00**	**S-CVI/UA**		**0.8**
Average proportions of item relevance across the five experts						**0.96**		

Table 2. The relevance ratings on the item scale by five experts for task 2: Pattern construction

Items	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	No of agreement	I- CVI	UA
6	4	4	4	3	4	5	1.00	1
7	4	4	4	4	4	5	1.00	1
8	4	4	3	3	3	5	1.00	1
9	4	4	3	4	3	5	1.00	1
10	4	4	4	4	3	5	1.00	1
11	4	4	4	4	4	5	1.00	1
12	2	3	3	3	4	4	0.80	0
13	2	4	3	3	4	4	0.80	0
14	4	4	4	4	4	5	1.00	1
15	3	3	3	3	3	5	1.00	1
16	4	3	3	3	4	5	1.00	1
17	2	3	3	3	4	4	0.80	0
18	3	4	4	4	4	5	1.00	1
19	4	3	4	4	4	5	1.00	1
20	4	4	4	4	4	5	1.00	1
21	2	4	3	4	3	4	0.80	0
22	3	3	3	2	3	4	0.80	0
23	4	4	4	4	4	5	1.00	1
			S-CVI/Ave				**0.94**	
Proportion relevance	0.78	1.00	1.00	0.94	1.00	**S-CVI/UA**		**0.7**
Average proportions of item relevance across the five experts						**0.96**		

Table 3. The relevance ratings on the item scale by five experts for task 3: Preparation of core sand

Items	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	No of agreement	I- CVI	UA
24	4	4	4	4	4	5	1.00	1
25	4	4	3	4	4	5	1.00	1
26	3	3	3	3	4	5	1.00	1
27	4	4	4	4	4	5	1.00	1
28	4	4	4	4	4	5	1.00	1
29	4	4	4	4	4	5	1.00	1
			S-CVI/Ave				**1.00**	
Proportion relevance	1.00	1.00	1.00	1.00	1.00	**S-CVI/UA**		**1**
Average proportions of item relevance across the five experts						**1**		

Table 4. The relevance ratings on the item scale by five experts for task 4: Core forming

Items	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	No of agreement	I- CVI	UA
30	3	4	4	3	4	5	1.00	1
31	4	4	3	3	2	4	0.80	0
32	4	4	4	4	4	5	1.00	1
33	3	4	3	3	3	5	0.80	0
34	4	3	3	3	3	5	1.00	1
35	3	3	4	4	4	5	1.00	1
36	4	4	4	4	4	5	1.00	1
			S-CVI/Ave				**0.97**	
Proportion relevance	1.00	1.00	1.00	1.00	0.86	**S-CVI/UA**		**0.71**
Average proportions of item relevance across the five experts						**0.97**		

Table 5. The relevance ratings on the item scale by five experts for task 5: Core baking

Items	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	No of agreement	I- CVI	UA
37	4	4	4	4	4	5	1.00	1
38	4	4	4	4	4	5	1.00	1
39	3	4	3	3	4	5	1.00	1
40	3	3	3	4	2	4	0.75	0
			S-CVI/Ave				**0.94**	
Proportion relevance	1.00	1.00	1.00	1.00	0.75	**S-CVI/UA**		**0.75**
Average proportions of item relevance across the five experts						**0.95**		

Table 6. The relevance ratings on the item scale by five experts for task 6: Core finishing

Items	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	No of agreement	I- CVI	UA
41	4	4	4	4	4	5	1.00	1
42	4	4	4	3	4	3	1.00	1
43	4	4	4	4	4	5	1.00	1
			S-CVI/Ave				1.00	
Proportion relevance	1.00	1.00	1.00	1.00	1.00	**S-CVI/UA**		**1.00**
Average proportions of item relevance across the five experts						1.00		

Table 7. The relevance ratings on the item scale by five experts for task 7: Molding

Items	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	No of agreement	I- CVI	UA
44	3	4	4	4	4	5	1.00	1
45	4	4	4	4	4	5	1.00	1
46	4	4	4	4	4	5	1.00	1
47	4	4	4	4	4	5	1.00	1
48	2	3	3	4	4	4	0.80	0
49	2	4	3	3	3	4	0.80	0
50	4	4	4	4	4	5	1.00	1
51	3	4	2	3	3	4	0.80	0
52	4	4	4	4	4	5	1.00	1
53	3	3	4	3	2	4	0.80	0
54	3	3	3	3	3	5	1.00	1
55	3	4	3	2	4	4	0.80	0
56	4	4	4	3	3	5	1.00	1
57	4	4	4	4	4	5	1.00	1
58	4	4	4	4	3	5	1.00	1
59	4	4	4	4	4	5	1.00	1
60	3	4	4	4	4	5	1.00	1
			S-CVI/Ave				**0.94**	
Proportion relevance	0.88	1.00	0.94	0.94	094	**S-CVI/UA**		**0.71**
Average proportions of item relevance across the five experts						**0.97**		

Table 8. The relevance ratings on the item scale by five experts for task 8: Melting

Items	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	No of agreement	I- CVI	UA
61	4	4	4	4	4	5	1.00	1
62	4	4	4	3	3	5	1.00	1
63	4	4	4	4	4	5	1.00	1
64	3	4	4	4	4	5	1.00	1
65	2	4	3	4	4	4	0.80	0
66	3	3	3	3	4	5	1.00	1
67	4	4	4	4	4	5	1.00	1
			S-CVI/Ave				**0.97**	
Proportion relevance	0.86	1.00	1.00	1.00	1.00	**S-CVI/UA**		**0.86**
Average proportions of item relevance across the five experts						**0.97**		

Table 9. The relevance ratings on the item scale by five experts for task 9: Casting

Items	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	No of agreement	I- CVI	UA
68	4	4	3	3	3	5	1.00	1
69	4	3	4	3	4	5	1.00	1
70	2	3	3	3	3	4	0.80	0
71	4	4	4	4	4	5	1.00	1
72	4	4	4	3	3	5	1.00	1
73	4	4	3	3	3	5	1.00	1
74	2	3	3	3	3	4	0.80	0
75	4	4	4	4	4	5	1.00	1
			S-CVI/Ave				**0.95**	
Proportion relevance	0.75	1	1.00	1.00	1.00	**S-CVI/UA**		**0.75**
Average proportions of item relevance across the five experts						**0.95**		

Table 10. The relevance ratings on the item scale by five experts for task 10: Finishing

Items	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	No of agreement	I- CVI	UA
76	2	3	3	3	4	4	0.80	0
77	3	3	3	4	4	5	1.00	1
78	4	4	4	4	4	5	1.00	1
79	4	4	4	4	4	5	1.00	1
80	3	4	4	4	4	5	1.00	1
81	3	3	3	3	4	5	1.00	1
82	3	4	4	4	4	5	1.00	1
83	4	4	4	4	4	5	1.00	1

			S-CVI/Ave				**0.98**	
Proportion relevance	0.88	1.00	1.00	1.00	1.00	**S-CVI/UA**		**0.9**
Average proportions of item relevance across the five experts						**0.98**		

Appendix: Foundry Craft Practical Skills Assessment Instrument Inventory

No.	Items	Score			
	Task 1: pattern layout				
1	Reading blue-print of drawings	1	2	3	4
2	Designing patterns from blue-print of drawing	1	2	3	4
3	Making two view of the drawing on a sheet using shrink rule	1	2	3	4
4	Adding machine allowance to the design	1	2	3	4
5	Providing draft allowance to the design	1	2	3	4
	Task 2: Pattern construction	1	2	3	4
6	Establishing the number of parts that pattern will be made	1	2	3	4
7	Identifying pattern making materials	1	2	3	4
8	Measuring patterns material accurately	1	2	3	4
9	Using a marking out gauge to see if board is at right thickness.	1	2	3	4
10	Securing the board flat on the bench.	1	2	3	4
11	Marking out pattern correctly	1	2	3	4
12	Planning the two pieces of board to be joined to required length, thickness and width	1	2	3	4
13	Fastening board properly on bench and with plane,	1	2	3	4
14	Assembling the two pieces of board with glue and strengthen it with nails or screws.	1	2	3	4
15	Chiseling off part of a wood to make a mortise and tenon joint.	1	2	3	4
16	Setting out position for mortise and tenon joint.	1	2	3	4
17	Constructing butt joint with dowels.	1	2	3	4
18	Fastening each half of a split pattern to the opposite sides on one plate	1	2	3	4
19	Building fillets in a pattern without destroying the pattern.	1	2	3	4
20	Filling wax in all fillets in order to remove sharp corners	1	2	3	4
21	Giving a shellac coating to pattern	1	2	3	4
22	Coloring the pattern for identification purpose	1	2	3	4
23	Constructing pattern to a given specification	1	2	3	4
	Task 3: Preparation of core sand	1	2	3	4
24	Selecting suitable materials	1	2	3	4
25	Choosing correct sand type	1	2	3	4
26	Carrying out sand testing	1	2	3	4
27	Assembling the materials to correct specification	1	2	3	4
28	Mixing the material	1	2	3	4
29	Applying the right quantity of water	1	2	3	4
	Task 4: Core Forming	1	2	3	4
30	Setting the core box on a work bench	1	2	3	4
31	Fill the core box	1	2	3	4
32	Ramming the prepared sand into core box	1	2	3	4
33	Removing the extra sand from the core box	1	2	3	4
34	Reinforcing the core to ensure coherence and stability	1	2	3	4
35	Inverting the core box over the core plate	1	2	3	4
36	Providing vent holes to allow gases to escape	1	2	3	4
	Task 5: Core Baking	1	2	3	4
37	Determining the right furnace for the job	1	2	3	4
38	Setting the furnace to the accurate baking temperature of 100 degree Celsius	1	2	3	4
39	Choosing the baking time/hours	1	2	3	4
40	Observing the baking time/ hours determined	1	2	3	4
	Task 6: Core finishing	1	2	3	4
41	Carrying out felting operation on the core i.e trimming, brushing, coating etc	1	2	3	4
42	Checking and correcting the various dimensions by inserting fixture	1	2	3	4
43	Performing pasting of the core	1	2	3	4
	Task 7: Molding	1	2	3	4
44	Selecting suitable materials	1	2	3	4
45	Batching the materials to correct specification	1	2	3	4
46	Mixing the material	1	2	3	4
47	Applying the right quantity of water	1	2	3	4
48	Setting the drag flask on the board	1	2	3	4
49	Sprinkling dry facing sand on the board	1	2	3	4
50	Ramming the prepared sand into mold box	1	2	3	4
51	Removing of the excess sand with a strike rod.	1	2	3	4
52	Constructing vent holes to allow gases to escape	1	2	3	4
53	Positioning wire in mold sections to reinforce molds, using hand tools and glue	1	2	3	4
54	Cleaning and smoothing the mold	1	2	3	4
55	Sprinkling parting agents onto patterns and mold sections to facilitate removal of Patterns from molds.	1	2	3	4
56	Positioning patterns inside mold sections	1	2	3	4
57	Removing the pattern from the mold sections	1	2	3	4

58	Cutting spouts, runner holes, and sprue holes into molds	1	2	3	4
59	Positioning cores into lower sections of molds,	1	2	3	4
60	Reassembling molds for pouring	1	2	3	4
	Task 8- Melting	1	2	3	4
61	Operating melting furnaces	1	2	3	4
62	Carrying out tapping operations	1	2	3	4
63	Carrying out furnace linings,	1	2	3	4
64	Determining molten metal temperature	1	2	3	4
65	Operating thermocouples, optical and pyrometers	1	2	3	4
66	Carrying out fluidity testing	1	2	3	4
67	Measuring casting temperature	1	2	3	4
	Task 9- Casting	1	2	3	4
68	Carrying out slag and dross removal	1	2	3	4
69	selecting ladle	1	2	3	4
70	checking ladle	1	2	3	4
71	preparing ladle for pouring	1	2	3	4
72	transferring metal to ladle	1	2	3	4
73	carrying molten metal treatment	1	2	3	4
74	sampling and testing molten metal	1	2	3	4
75	pouring molten metal into molds	1	2	3	4
	Task 10- Finishing	1	2	3	4
76	conveying completed castings from one section to another	1	2	3	4
77	Removing gates, feeders, risers, and fins from castings	1	2	3	4
78	filing to smoothen cast with hand files	1	2	3	4
79	Carrying out heat treatment on cast	1	2	3	4
80	Carrying out inspection of finished products	1	2	3	4
81	Salvaging defective castings if required	1	2	3	4
82	Carrying out dust and noise control	1	2	3	4
83	Carrying out destructive testing of castings	1	2	3	4