

Development of an instrument for testing students manipulative skills in brick block laying and concreting trade in Bauchi State Technical colleges

Original Research Article | Volume 1 | Issue 3 | 2026 | Article Number: 010

Accepted: 21 July 2026 | Published: 10 August 2026 | ISSN: 2979-8582 (Online)



Crossref : <https://doi.org/10.67693/BJCR-LZZWP7PP>



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Abstract

This study examined the development of an instrument for testing students' manipulative skills in brick/block laying and concreting trade in Bauchi State technical colleges. Descriptive survey research design was adopted for the study. Three research questions were developed and answered in line with the purpose of the study. The population of the study comprises 47 respondents. The instrument for data collection was a structured questionnaire which was developed in line with the research questions and two hypotheses were formulated and tested at 0.05 level of significance. Three experts validated the instrument. The study adopted a test-retest approach to establish the reliability coefficient of 0.91 using Cronbach's Alpha statistical tool, Mean and standard deviation were used to analyze the data collected for the study. SPSS version 21 was used to analyze the data for the study. The findings of the study among others revealed that: Three assessment instruments are operational for testing students' manipulative skills in brick/block laying and concreting trade. The study further revealed that most of the identified tasks used for NTC levels were appropriate and the majority of the skills identified were commonly appropriate for inclusion in the instrument for assessing students' manipulative skills. The study therefore recommended that the existing instruments should be identified and used to test students' manipulative skills in brick/block laying and concreting trade.

Keywords: Development, Assessment Instrument, Manipulative Skills, Brick/Block Laying And Concreting

Introduction

In Nigeria, various institutions provide technical and vocational education programs including the technical colleges. Technical and vocational education programs are defined as those aspects of educational processes involving, in addition to general education, the study of technologies and related sciences and the acquisition of practical skills, understanding, knowledge and attitudes necessary for entry into occupations in various sectors of the economic and social life (Federal Republic of Nigeria, 2026). Furthermore, the national curriculum for technical and vocational colleges is centered around the psychomotor domain with relevant emphasis on cognitive and affective domains (Federal Republic of Nigeria, 2026; National Board for Technical Education, 2026) thus by implication, much attention is focused on psychomotor (practical) component of the studies in technical colleges without overlooking the relevant emphasis on critical areas of cognitive and affective components. The psychomotor components require that the appropriate materials that are necessary for effective training of craftsmen in their chosen trades must be available. This makes it important that while these items are made available, the effective utilization of these materials would help to achieve the objectives and goals of technical education as outlined in the National Policy on Education (Federal Republic of Nigeria, 2026). The national goals for vocational and technical education include: to provide trained manpower in applied sciences, technology and business particularly at the craft, advanced crafts and technical levels, to give training and impart the necessary skills to individuals who shall be self-reliant economically and to give technical knowledge and vocational skills necessary for solving industrial, agricultural, economic problems of the nation (Federal Republic of Nigeria, 2026).

The effort for achieving these objectives is the implementation of National Technical Certificate (N.T.C) and Advanced National Technical Certificate (A.N.T.C) programs in Technical Colleges; thus, the importance of Technical and Vocational Education cannot be overemphasized. This is why practical work has traditionally played a very important part in all technology education programs right from technical colleges to tertiary institutions. The expectation is that during the practical activities, students are provided with experiences predisposing towards acquisition of manipulative skills. Manipulative skills are those aspects of Technical and Vocational Education which involve hands-on-the-job experience by students (Olawale et al., 2024). On the other hand, competencies can be defined as those skills needed by the students in carrying out a particular job or task. These competencies were evaluated based on students' abilities to execute practical work. (Olojuolawe & Adelowo, 2022, p. 6). The practical components in brick/block laying and concreting practice trades according to NBTE curricula (2026) include; mixing with hand or machine mortar suitable for moulding of bricks, compressive strength of bricks, aggregates test, bonding mortar to specification for specified jobs, test to determine porosity of a given brick, mould clay/sandcrete brick to specification, setting out, ground floor construction, solid walls construction among others. These components need to be evaluated to ascertain the achievement of the learners.

Assessment in any educational programme ascertains the outcome of the learner's achievement in terms of knowledge, skills, attitudes, ability and intelligence acquired in the course of study (Suhaini et al., 2021, p. 1529). This is why different organizations for different reasons carry out assessment in different forms, thus very important criteria for the achievement of the stated objectives and through reliable assessment of tasks performance is to construct and use a well-designed assessment instrument (Opeyemi et al., 2024). The author further remarked that, without valid assessment instruments, teachers will be generating and working with unreliable data, which will mislead both the students and their parents. Similarly, assessment of manipulated skills should proceed logically from action and their sequences to the outcomes and the quality of the outcomes if the students are going to graduate with quality practical skills. The practical skills of students also need to be observed and scored meticulously by the teacher; this can only be

achieved by using acceptable assessment instruments (ADELAJA & DAHUNSI, 2023). Instruments in education are measurement tools used by researchers and practitioners to aid in assessment of the students (Nwabudike et al., 2023). According to them, there are several measurement tools in education which are; standardized tests, live observations, interviews, surveys, scales, indexes. These instruments are important because they are needed for assessing students' manipulative skills in Brick/Block laying and Concreting and without these instruments' teachers will be generating and working with unreliable data which will mislead both the students and the parents (Raji & Yisa, 2022, p. 4). A situation which is liable to adversely affect the realization of the ultimate goal of the school programme and the attainment of the stated objectives. From the foregoing therefore, assessment and testing have become factors of critical concern among the activities of teachers, especially those of psychomotor skills.

Statement of the Problem

Technical colleges in Nigeria are mainly established for the training of students to acquire practical skills, knowledge and attitudes essential for employment in a given occupation. Brick/block laying and concreting teachers are instructors who are skilled to carry out construction work. Brick/Block laying and concreting teachers at technical college in Bauchi State are supposed to be assessing students' manipulative skills to improve their employability opportunities and as well sustain and generate confidence but it was observed that some building technology teachers assess students' practical projects performance by taking cursory look at the finished works only. It is worthy to note that, if practical projects performance of students are assessed by taking cursory look at the finished work only, then unreliable data will be generated thereby affecting the entire process of assessment system, which in turn will mislead both students and parents. According to the National Business and Technical Examination Board marking scheme on rating skills in Brick/block laying and concreting practical examination shows that some tasks are not included in the scheme which could affect student's performance. This is in line with Ibidapo (2024) who stated that lack of problem identification, practical guide or appropriate instrument for teaching and assessing students work, diagnosis, assessment and decision-making will lead to the decline of educational standard in technical colleges in Nigeria. Thus, assessment and testing should become factors of critical concern among the activities of teachers, especially those psychomotor skills. Therefore, with seemingly no appropriate operational instrument for assessing students' manipulative skills in brick/block laying and concreting practice at technical colleges in Bauchi State, the need to identify operational instruments, tasks and skills for inclusion in assessing students' practical exercises becomes paramount, hence the need for the study.

Purpose of the Study

The primary purpose of this study is to identify appropriate assessment instruments for testing students' manipulative skills in brick/block laying and concreting trade in Bauchi State Technical Colleges. Specifically, the study sought to:

1. Identify operational assessment instruments for testing students' manipulative skills in brick/block laying and concreting trade in Bauchi State Technical Colleges.
2. Identify appropriate manipulative tasks required for proficiency in brick/block laying and concreting trade in Bauchi State Technical Colleges.
3. Identify appropriate skills for inclusion in the instrument for assessing students' manipulative skills in brick/block laying and concreting trade in Bauchi State Technical Colleges.

Research Questions

The following research questions guided the study.

1. What are the specific operational assessment instruments currently in use for testing students' manipulative skills in brick/block laying and concreting trade in Bauchi State Technical Colleges?
2. Which manipulative tasks are considered most appropriate for assessing proficiency in brick/block laying and concreting trade in Bauchi State Technical Colleges?
3. What are the appropriate skills that should be included in the assessment instrument for testing students' manipulative skills in brick/block laying and concreting trade in Bauchi State Technical Colleges?

Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance:

H₀₁: There is no significant difference in the mean opinion of teachers and registered builders regarding the appropriateness of manipulative tasks for proficiency in brick/block laying and concreting Trade in Bauchi State Technical Colleges.

H₀₂: There is no significant difference in the mean opinion of teachers and registered builders regarding the appropriateness of skills for inclusion in the assessment instrument for testing students' manipulative skills in brick/block laying and concreting Trade in Bauchi State Technical Colleges.

Methodology

This study adopted descriptive survey research design. The study had a total population of 47 respondents. The population comprises all the 27 Brick/Block laying and Concreting teachers and 20 registered builders in the study area. The study adopted total sampling, therefore, there was no sampling in this study. The instrument used for data collection for this study was a structured questionnaire, which was subdivided into two parts, namely: part I: demographic data and part II: questionnaire items. Two different scales were also adopted to respond to the research questions. Five-point Likert rating scale was adopted for research one, while a different five-point rating was adopted for research question two and three. The scales are: Strongly Agreed (SA) = 5, Agreed (A) = 4, Undecided (U) = 3, Disagreed (D) = 2, Strongly Disagree (SD) = 1, were used to answer research question one. While Highly Appropriate (HA) = 5, Appropriate (A) = 4, Moderately Appropriate (MA) = 3, Inappropriate (I) = 2, and Highly Inappropriate (HI) = 1, were used to answer research question two and three. The instrument was validated for both face and content validity by 3 experts. The study adopted a test-retest approach to establish the reliability coefficient of 0.91 using Cronbach Alpha statistical tool. The data collected for the study were analyzed using Mean ($\bar{x}$) and Standard Deviation (SD) to answer the research questions, while the t-test statistical tool was used to test the null hypotheses. The analysis was carried out with the aid of Statistical Package for Social Science (SPSS) version 21. The decision rule for the Mean was hinged on the cut-off point of 3.50. Any item with a mean score of 3.50 and above was considered agreed/appropriate, where otherwise was considered disagreed/inappropriate. While the decision rule for the t-test was based on the calculated P - value. If the calculated P - value is greater than 0.05 level of significance, the null hypothesis was accepted and where otherwise was rejected.

Result and Discussion

Research Question I

What are the operational assessment instruments for testing students' manipulative skills in brick/block laying and concreting trade in Bauchi State Technical Colleges?

Table 1: Mean Responses of Respondents on Operational Assessment Instruments in Brick/Block laying and Concreting Trade for Testing Students' Manipulative Skills

N=27				
S/N	Items	X	SD	Remark
1	Checklist is one of the operational instruments used for assessing students' practical skills in your school	3.71	0.64	Agreed
2	Direct Observation is used for testing students' skills in BBC	4.48	0.58	Agreed
3	Paper and pen test are one among many of the commonly used tools in assessing students' manipulative skills	4.22	0.58	Agreed
4	Interactive charts are used as an assessment instrument for testing students' practical skills	3.15	0.60	Disagreed
5	Interview is an important tool for assessing BBC students' skills	3.04	0.76	Disagreed
6	Interest invention is one among many important instruments used for assessing the practical skills of students' in BBC trade	3.15	0.81	
7	Rating Scales is one of the assessment tools used in assessing students' practical skills in BBC	3.07	0.47	Disagreed
8	Rubrics is used for testing students' manipulative skills in BBC trade	2.85	0.66	Disagreed
9	Surveys is a common assessment instrument used for testing students' practical skills in BBC trade	3.00	0.56	Disagreed

Key: $\bar{X}$ = Mean score for the respondents, **SD** = Standard Deviation, **N** = Number of Teachers

The data on Table 1 shows that the respondents were in agreement with items 1,2, and 3 with mean of 3.71, 4.48 and 4.22 respectively were the assessment instruments operational in Bauchi Technical Colleges, while Items 4, 5, 6, 7, 8 and 9 with mean ranging from 2.85- 3.15 were disagreed upon which imply that they are not in operation.

Research Question II

What are the appropriate manipulative tasks required for proficiency in brick/block laying and concreting trade in Bauchi State Technical Colleges?

Table 2: Mean responses of Respondents on Appropriate Manipulative Skills Required for Tasks in BBC Practice

N1=27; N2=20						
S/N	Items	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_G$	δ	Remark
1	Setting out building to specification	3.90	3.92	3.91	0.55	Appropriate
2	Ground floor constructions	3.29	4.00	3.65	0.63	Appropriate
3	Solid walls construction involving end junctions and quoin in English and Flemish bond	4.22	3.15	3.68	0.62	Appropriate
4	Cavity walls construction involving stopping ends	3.00	3.05	3.03	0.55	Inappropriate
5	Brick wall features (detached pier, attached piers, buttress capping and square jambs)	4.04	3.40	3.72	0.65	Appropriate
6	Decorative brick work	4.00	3.29	3.65	0.70	Appropriate
7	Diaper bond, basket weave and herring bone bond	3.80	3.68	3.74	0.69	Appropriate
8	Timber and tubular scaffolds	2.89	3.45	3.67	0.67	Appropriate
9	Arches construction	3.70	4.05	3.88	0.62	Appropriate
10	Fireplace and chimney stacks	2.85	3.05	2.95	0.60	Inappropriate
11	Construction of Septic tanks, soak away and inspection chamber	3.95	4.40	4.18	0.82	Appropriate
12	Brick walls construction in English, Stretcher, Header, Flemish, Rat-trap, Dutch and Monk bond	4.19	3.99	4.09	0.59	Appropriate
13	Perform operation with finishing tools	3.92	3.35	3.64	0.77	Appropriate
14	Floor screeding operations	3.92	4.00	4.00	0.56	Appropriate
15	Leveling operations	3.33	4.10	3.72	0.60	Appropriate
16	Rendering and plastering operations	3.89	4.15	4.02	0.78	Appropriate
17	Slump test	4.02	3.60	3.81	0.75	Appropriate
18	Compacting factor test	3.93	3.60	3.77	0.78	Appropriate
19	Cube test	2.82	2.80	2.81	0.84	Inappropriate
20	Decorative panel	2.93	2.55	2.74	0.84	Inappropriate
21	Concrete mix	4.15	3.20	3.68	0.44	Appropriate

Key:N1= Number of Teachers; $\bar{X}_1$ = Mean Responses of Teachers; N2=Number of Builders

$\bar{X}_2$ = Mean responses of Builders; $\bar{X}_G$ = Grand Mean of all Responses; δ = Standard Deviation

The data on Table 2 shows that the respondents are in agreement that items 1, 2, 3, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18 and 21 with mean ranging from 3.64 - 4.18 were considered as the most appropriate manipulative tasks required for proficiency in brick/block laying and concreting practice, while items 4, 10, 19 and 20 were considered as inappropriate manipulative tasks. It therefore, inferred that seventeen out of the twenty-one identified manipulative tasks for proficiency in brick/block laying and concreting were considered as most appropriate in Bauchi State Technical Colleges.

Research Question III

What are the appropriate skills for inclusion in the instrument for assessing students' manipulative skills in brick/block laying and concreting trade in Bauchi State Technical Colleges?

Table 3: Mean responses of Respondents on Skills Appropriate for inclusion for Assessing Students' Manipulative Skills in BBC Practice

S/N	Items	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_G$	δ	Remark
1	Ability to read and interpret drawings	3.74	3.55	3.65	0.48	Appropriate
2	Skill to analyze the plan work	3.37	3.80	3.59	0.48	Appropriate
3	Identifying and selecting tools/equipment for the given task	4.41	4.20	4.31	0.51	Appropriate
4	Ability to use appropriately the identified tools and equipment	4.44	4.50	4.47	0.63	Appropriate
5	Preparing ground for a given task	4.04	3.40	3.72	0.56	Appropriate
6	Skill in designing a given task	3.07	3.90	3.50	0.58	Appropriate
7	Selecting suitable materials for a given task	4.19	3.15	3.67	0.58	Appropriate
8	Using suitable materials of a given task to specification	4.30	3.05	3.68	0.61	Appropriate
9	Competence in measuring accurately on a given task	3.07	4.30	3.69	0.82	Appropriate
10	Ability to read and apply easily technical information	3.22	3.90	3.56	0.60	Appropriate
11	Record properly all dimensional specification of a given task	3.37	4.70	4.04	0.71	Appropriate
12	Construct a given task properly without visible errors	3.30	3.85	3.58	0.59	Appropriate
13	Care of tools/equipment during and after work	4.15	4.20	4.18	0.56	Appropriate
14	Follow correctly the various work stages	4.11	3.45	3.78	0.54	Appropriate

	in a given task					
15	Ability to proceed logically from a given action to the outcome of a given task	3.11	3.10	3.11	0.53	Inappropriate
16	Observation of safety to prevent accident to self or damage to the work piece	4.37	4.10	4.24	0.68	Appropriate
17	Ability to complete all the work stage on a given task	3.15	4.20	3.68	0.59	Appropriate
18	Answer oral question on a given task correctly	4.00	4.25	4.13	0.60	Appropriate
19	Provide level surface of given task	4.15	4.30	4.23	0.60	Appropriate
20	Comportment during and after carrying out a given task	4.33	3.00	3.67	0.64	Appropriate
21	Assess the beauty of a finished product	3.15	3.35	3.25	0.64	Inappropriate

N1=27; N2=20

The data on Table 3 shows that the respondents are in agreement that items 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19 and 20 (with mean ranging from 3.50 to 4.47) were the most appropriate skills for assessing students' manipulative skills in brick/block laying and concreting practices in Bauchi Technical Colleges, while items 15 and 21 (with means of 3.11 and 3.25) were inappropriate skills. The data inferred that nineteen out of the twenty-one identified skills for assessing students' manipulative skills in brick/block laying and concreting were most appropriate in Bauchi State Technical Colleges.

Hypotheses Testing

Hypothesis 1

H₀₁: There is no significant difference in the mean opinion of teachers and registered builders regarding the appropriateness of manipulative tasks for proficiency in brick/block laying and concreting Trade in Bauchi State Technical Colleges.

Table 4: t-Test Analysis of the differences in the Mean of Items Identified by Teachers and Registered Builders on Appropriate Manipulative Tasks for proficiency in Brick/Block laying and Concreting Practice

Groups	N	$\bar{X}$	SD	t	Df	P	Decision
Teachers	27	3.48	0.51	0.49	45	0.62	Accepted
Builders	20	3.40	0.60				

Key: N = Number of Respondents, $\bar{X}$ = Mean score, SD = Standard Deviation

Df = Degree of Freedom, **t** = t-test value, **P** = value

Table 4 shows mean opinion of teachers and that of registered builders on appropriate manipulative tasks for proficiency in brick/ block laying and concreting practices. The following mean and standard deviation expresses the opinion of the two groups: Teachers ($\bar{X}$ = 3.48, SD = 0.51) and Builders ($\bar{X}$ = 3.40,

SD = 0.60); t – value = 0.49, df = 45, and P -value = 0.62, this value is greater than the alpha value of 0.05 level of significant. This inferred that the null hypothesis H_{01} after careful analysis and its testing found out that the null hypothesis H_{01} was accepted. This implied that the null hypothesis was not rejected.

Hypothesis 2

H_{02} : There is no significant difference in the mean opinion of teachers and registered builders regarding the appropriateness of skills for inclusion in the assessment instrument for testing students' manipulative skills in brick/block laying and concreting Trade in Bauchi State Technical Colleges.

Table 5: t-Test Analysis of the differences in the Mean Opinion of Teachers and that of Registered Builders on appropriate skills for inclusion in the instrument for assessing students' manipulative skills in BBC Trade in Bauchi State Technical Colleges

Groups	N	$\bar{X}$	SD	t	Df	P	Decision
Teachers	27	3.74	0.45	1.34	45	0.18	Accepted
Builders	20	3.55	0.51				

The data on this Table 5 shows the mean of items identified by teachers and registered builders on appropriate skills for inclusion in the instrument for assessing students' manipulative skills in brick/block laying and concreting practice. The following mean and standard deviation expresses the opinion of the two groups: Teachers ($\bar{X}$ = 3.74, SD = 0.45) and Builders ($\bar{X}$ = 3.55, SD = 0.51); t – value = 1.34, df = 45, and P -value = 0.18, this value is greater than the alpha value of 0.05 level of significant. This inferred that the null hypothesis H_{02} after careful analysis and its testing found out that the null hypothesis H_{02} was accepted. This implies that the null hypothesis was not rejected.

Findings/Discussion of Results of the Study

The findings of research question one revealed that three assessment instruments are in operation for testing students' manipulative skills in brick/block laying and concreting trade in Bauchi State Technical Colleges while six are not in operation. While six are not in operation. This result agreed with the position of Nwabudike et al. (2023) in which he affirmed that there are several instruments (measurement tools) used by researchers and practitioners to aid in the assessment of students and that these instruments provide the best means available for assessing the effective psychomotor as well as cognitive skills of the learners.

The findings of research question two revealed that setting out buildings, ground floor construction, solid wall construction, cavity wall construction and various other tasks were the major manipulative tasks in brick/block laying and concreting trade. This finding was in line with the views of NBTE curricula (2026) who pointed out that setting out building to specification, solid wall constructions of thickness of $\frac{1}{2}$ B – $1\frac{1}{2}$ B involving ends junction and quoins in English and Flemish bond, cavity wall involving stopping ends, brick wall features, diaper bond, basket weave and herring bone bond, fire place and chimney stack for any class of fuel, arches constructions, decorative panel, square and rebated jambs in cavity wall among others are the major manipulative areas students' engaged upon. Supporting this view, (Ministry of Education, 2026) sees practical tasks as the manipulative tasks that involve the movement of the body or use of tools to assist performance as the case of operating machines.

Findings of research question three revealed that the majority of skills identified were appropriate for inclusion in the instrument for assessing students' manipulative skills in brick/block laying and concreting trade. This finding is in agreement with ADELAJA & DAHUNSI (2023) who observed that in combining process and product assessments, certain attributes of the learners, such as the skill to analyze the plan work, the skill to use and care of tools and equipment, ability to construct a given task properly without visible errors, the quality of work among others could be easily and systematically observed, objectively and comprehensively evaluated. The author went further to suggest a number of tools that can be used in obtaining information about students' achievement in manipulative skills which includes: direct observation, rating scale, check list, interest invention, participation charts, test and interview. In support of the above (Mbagha & Dahiru, 2023), in their study stated that these methods provide the best means available for assessing the effective psychomotor as well as cognitive skills of the learner. These authors are unanimous in their views concerning the above method since; process assessment has to do with observing a performance and objectively passing a valued judgment over it. The authors further stressed on students' ability to read and interpret drawings (mechanical, electrical/ electronic or wood working), and ability to appropriately use the identified tools and equipment in their practical work. In line with the above, practical task/projects must be evaluated properly so as to induce high standard students' who are expected to think (cognitive), execute, design and construct (psychomotor) and exhibit good cooperative attitude towards others and the use of tools and equipment (affective)(Olojuolawe et al., 2024, p. 1960).

It is therefore, imperative to note that carrying out tasks in brick/block laying and concreting trade involves skills such as tools selection and usage, comportment of the students', care of tools/equipment and safety considerations. It said that where safety is ignored or compromised, danger of equipment, human injury is brought closer. Therefore, to observe and evaluate these appropriate skills in a student during brick/block laying and concreting practice is not out of place, thus including them in the final copy of the process assessment instrument becomes paramount.

Conclusion

Based on the findings of the study, it was concluded that most of the identified tasks and skills for NTC levels were appropriate for the entire instrument. However, one of the factors responsible for the decline of practical skills acquisition in technical colleges may be attributed to lack of an appropriate instrument for teaching and assessing students' practical work. Students' however, tend to get encouraged and learn more when they engage in self-practices and their assessment scores are revealed to them from time to time. It was therefore concluded that when the findings of this study are effectively implemented, a batch of skilled, trained and well-equipped graduates will be produced. This will in turn improve the assessment of students' manipulative skills in brick/block laying and concreting practice in Bauchi State Technical colleges.

Recommendations

The following recommendations were made based on the findings and conclusion of this study:

1. Brick/block laying and concreting students should be allowed to engage in practical task performance, classroom presentation and exhibition/demonstration so as to become skilled, trained and well-equipped graduates.
2. Students should be exposed to all manipulative task areas in brick/block laying and concreting practice.
3. The skills identified in this study should be integrated into the curriculum of brick/block laying and concreting for training students in Technical Colleges.

4. Teachers of brick/block laying and concreting should combine both process and product assessment methods rather than the use of product assessment only.

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