

EFFECTS OF MANUAL AND COMPUTER-BASED CONCEPT MAPPING INNOVATIVE STRATEGIES ON ACADEMIC PERFORMANCE OF PRE-SERVICE TEACHERS IN KWARA STATE COLLEGES OF EDUCATION

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Abstract

Education is the vital instrument for a nation's efficiency, prosperity, and development to increase its inhabitants' capabilities. The purpose of this study was to look into the impact of Manual-Based Concept Mapping (MBCM) and Computer-Based Concept Mapping (CBCM) Innovative Strategies on the academic performance of pre-service teachers in Kwara State Colleges of Education. The study used a quasi-experimental pre-test - post-test approach. The research population comprised year one Economics pre-service teachers all from three colleges of education in Kwara State. The findings showed a significant effect of Computer-Based Concept Mapping (CBCM) Innovative Strategy on the academic performance of pre-service teachers in Economics at Kwara State Colleges of Education, but no significant effect of the treatments on the academic performance of both male and female pre-service teachers in Economics. Predicated on the study's findings, it was suggested that lecturers at Kwara state colleges of education employ the CBCM innovative teaching methodology for their instruction delivery.

Keywords: Manual-Based Concept Mapping; Computer-Based Concept Mapping; Innovative Strategy; Pre-service Teacher; Sustainable Development.

Introduction

Without a doubt, the crucial functions and core of education are essential in the development of any nation. As cultures develop, it becomes harder for educators to make a significant influence on information recipients. Goal 4 of the Sustainable Development Goals (SDGs) emphasizes excellent education. Quality education, often known as deep learning, uses appropriate pedagogical tools to help students learn.

Our society's constant change requires students to use a variety of methods and technology to be more creative and productive. SDG 4 target 4.7 requires a concerted effort to ensure that all learners acquire the skills and knowledge needed to enable sustainable development by 2030. This includes education for sustainable development, improved lifestyle, civil rights, gender equality, the appreciation of cultural diversity, peace and nonviolence, internationalization, intercultural dialogue, and culture's participatory nature. The pursuit of knowledge and its implementation empowers people to solve individual, cultural and social, national, and international problems without overdependence on the government, which can only be achieved by successfully implementing Economics curriculum in any country (Oleabhiele & Oko, 2018).

As a consequence of its significance, in Nigeria, Economics inhabits a pride position in the senior secondary school curriculum. However, under the newest National Policy on Education, it remains one of the choice courses to be taught at the Senior Secondary School (SSS) level. The proper Economics curriculum is essential to the people's political and economic prosperity. It is recognized because it understands Economics and can utilize it to solve huge problems, which are essential to active citizenry in a democratic society like ours (Infante & Smirnova, 2016). According to Ede et al (2016), the new National Policy on Education is noteworthy not only because of its framework but also because of the substance of education,

particularly that of Economics. They argued that the new Economics curriculum promotes self-reliance among secondary school graduates via comprehension, mastery, and skills, even if they cannot find paid jobs after graduation. Despite Economics' importance, research reveals that WASSCE Economics students' academic performance has steadily declined over the years (Adio et al., 2021; Mohammed & Pitan, 2022; Aliyu et al., 2021). Any student who wants to study management sciences (Business Administration, Industrial Relation and Personnel Management, etc.), social sciences (Economics, Political science, criminology, geography, etc.), and education must pass O-level Economics with a credit (Economics education, geography education, accounting education, business education, etc.). Despite these conditions, WAEC Economics students performed averagely. In 2002, 2003, May/June 2009, and November/December 2004 WASSCE, the chief examiner found the applicants' performance to be fair, with certain shortcomings (WAEC, 2017).

Figure 1: A table showing the results of Economics students in WASSCE from 2008 - 2017

Years	Candidates that sat for the Subject	Candidates with pass at Credit Level (Grades 1-6)	% with pass at Credit Level	Candidates with Non-Credit passes (Grades 7-8)	% with Non-Credit passes	Candidates with Failure (Grade 9)	% with Failure
2008	1,204,515	592,588	49.20%	409,988	34.04%	201,939	16.77%
2009	1,270,557	592,939	46.67%	519,693	40.90%	157,925	12.43%
2010	1,228,401	690,949	56.25%	373,075	30.37%	164,377	13.38%
2011	1,413,886	841,258	59.50%	402,764	28.49%	169,864	12.01%
2012	1,540,902	864,273	56.09%	444,308	28.83%	232,321	15.08%
2013	1,532,194	1,025,703	66.94%	346,564	22.62%	159,927	10.44%
2014	1,363,994	698,669	51.22%	362,863	26.60%	302,462	22.17%
2015	1,476,122	687,983	46.61%	460,605	31.20%	327,534	22.19%

2016	1,403,907	627,546	44.70%	407,274	29.01%	369,087	26.29%
2017	1,435,801	677,698	47.20%	472,379	32.90%	285,724	19.90%

Source: WAEC Statistics Division, Yaba, Lagos (2017).

From 2010 to 2017, almost 40% of all Economics students who enrolled for the final test failed, according to WAEC data. In 2013, 1,025,703 (66.94%) passed at the credit level, and the failure rate dropped to less than 40%. Students' Economics performance was average to below-average in the subsequent years (WAEC Statistics Division, 2017).

Economics students may struggle due to many factors. Amuda, Ali, and Durkwa (2016) and Muhammad, Bala, and Ladu (2016) blamed school features, teaching methods, and gender for students poor academic performances. Onuoha et al. (2016) as well as Robert and Owan (2019) ascribed this to numerous factors, including a lack of grasp of some subjects, a lack of syllabus coverage, rubric disobedience, and an inability to accurately design or label diagrams. Several scholars attributed this to new methodologies that did not incorporate learners' prior experience and reasoning to arrange their information. According to scholars such as Arop et al (2020) and Isa et al (2020), one of Nigeria's most persistent and fascinating challenges is low teaching quality. To corroborate this viewpoint, Oleabhiele and Oko (2018) stated that the responsibility of teachers in achieving excellent education is at the heart of curriculum implementation. These academics also stated that instructors are considered the "hub" around which all other factors impacting educational excellence revolve. According to Aslan et al (2020), what learners learn is inextricably linked to how they are taught. Thus, teaching techniques have a major influence on students' academic performance, and academics and educators worldwide are interested in this strategy. The implementation of any approach to achieve defined educational goals necessitates the instructor's innovation and creativity.

Economics teachers must implement innovative strategies to help students fully understand any principle, concept, or topic in order to meet SDG 4 target 4.1, which is reasonable and achievable of quality secondary education contributing to relevant and effective learning outcomes. Among the numerous such methodologies are Socratic, demonstration, lecture, idea mapping, and discussion methods. According to Jamshidovna and Bahodirovich (2021), innovative strategies are tactics and principles that are used in education. They are recognised as instructors' tools for accomplishing educational aims and objectives. However, any approach adopted by the instructor must take into account the maximising of students' concentration as well as interest, which Ausubel (1963) refers to as Advance Organizer. This just serves as a link between old and fresh information. The advance organiser provides students with vital previous information to help them understand and implement the next topics. Ideas as links between facts were first taught here.

Novak and Cañas (2014) explain that “concept” comes from the Latin word “conceptum,” meaning “obtained or formed,” and is used to conceive thoughts or ideas about real or abstract subjects. Novak and his colleagues at Cornell University developed concept mapping in 1972 to make the curriculum more rigorous as students' progress. Idea maps show concept connectedness. According to Micheli et al (2019), concept maps may assist address ambiguities, inconsistencies, and rigours in empirical understanding representation. Subandi et al (2018) found that excellent concept maps that move from teacher to student-generated help students identify knowledge gaps and simplify their views, resulting in true innovation. It is important to note, however, that concept mapping can be done manually or with the use of computer software (computer-based) or a computer application (computer-assisted).

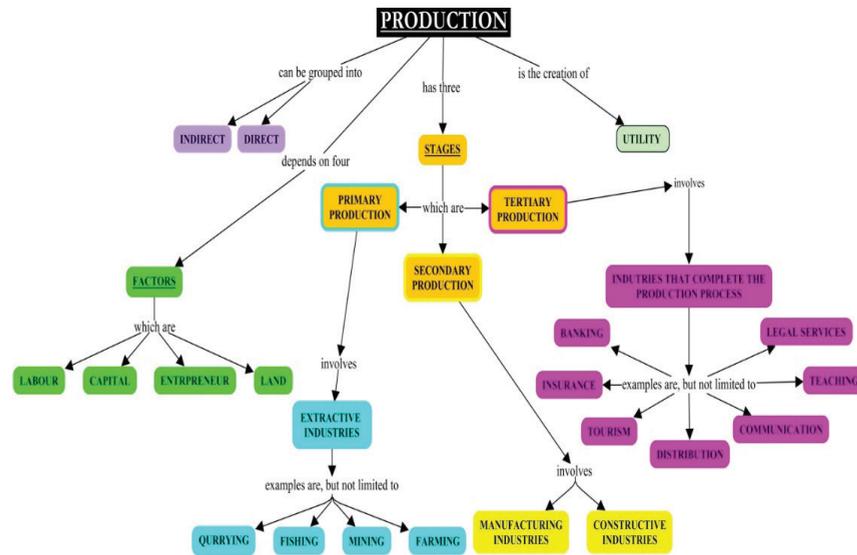
One form of concept mapping innovation strategy is manual-based concept mapping (MBCM). It is essentially the usage of a pen and paper in the creation of idea maps. Students need to create new idea maps, as well as revise old ones by adding, deleting, and rewriting information (Keiler, 2018). The MBCM may be used in teaching regardless of students' computer interest, which is a huge advantage. The map modification using the MBCM may prove uncontrollable, mussy, and clunky when upgrading the concepts as needed.

Computer-Based Concept Mapping (CBM) is a graphical, visual, and spatial creative inventive method that assists users in finding their problem-solving routes (Hsu, 2019). This research has been going on for a while, but computer-based tools made concept map creation and modification easy. This is utilised in education as a research tool, communication tool, and effective teaching and learning approach, especially for creating idea linkages. Computer-based concept mapping software (CBCM) may be useful if learners want to make own maps. Among the computer tools utilised in this method are Smart Draw®, CMAP®, Concept Map EDitor®, and Inspiration®. CBCM allows easy corrections, changes, and adaptation without expunging or condemning previously mapped work, addressing MBCM's main flaws.

Source: Researchers

Despite these new initiatives, Nigeria is still struggling to shift education from teacher-centred to learner-centred. Traditional teaching techniques may save time, but studies demonstrate that spoken words alone will not work. For example, according to Pozo-Sanchez et al (2019) and other scholars, the conventional teaching methods may not effectively foster the creation of novel ideas among students.

Figure 2: A CMAP structured to explain the concept of production



Divya and Usha (2015) found that the experimental treatment, Computer-based Concept Mapping, improves secondary school students' self-regulation more than the placebo (Constructivist instructional strategy). Adu and Enumemu (2008) found that neither problem solving nor idea mapping improved students' Economics grades. Pozo-Sanchez et al (2019) claims computer-based teaching increases schooling. According to Onuoha et al. (2016), students who were taught Economics using concept mapping had a higher interest rate and performed better than those who were taught via lecture.

Erdoan (2016) claims concept mapping improves Turkish students' academic performance. In a study, Auta (2015) found that concept mapping and inquiry approaches improve preservice teachers' academic achievement when teaching physics concepts, while Adu and Enumemu (2008) found that neither problem solving nor concept mapping creative methods affected students' academic progress in Economics. Furthermore,

many academics believe that the question of gender and student academic performance remains uncertain. For example, Adeosun and Owolabi's (2021) findings, gender discrimination persists in Nigeria and potentially across the African continent. Although Wu et al (2020) discovered that there is no significant difference in male and female performance. Many writers, including Titus et al. (2016), have found a gender disparity in Economics academic achievement. Onuoha (2010), Yusuf, Odutayo, Omoragbon, and Amali (2014), and Ogoing toya et al. (2016) found no gender interaction effect on concept mapping creative solutions. While Abuseji (2007) found an interaction impact between gender and idea mapping creative methodologies, Zheng et al (2020) validated it.

This study arose from an interest in the centre of all learning, preservice Economics teachers (a major factor in Economics curriculum implementation). The National Policy on Education (FRN, 2013) states that teachers' credentials are crucial to educational growth and that the Nigeria Certificate in Education (NCE) is the minimum requirement for teaching (FRN, 2013). According to Adebile (2009), well-trained and experienced personnel are essential for providing high-quality education. Since they are the game-changer of any nation's education, there is a need to completely study the influence of manual-based and computer-based concept mapping innovative methodologies on pre-service teachers in Kwara State Colleges of Education.

Purpose of the Study

The purpose of the study was to investigate the effects of Manual-Based Concept Mapping (MCM) and Computer-Based Concept Mapping (CBCM) Innovative Strategies on the academic performance of pre-service teachers in Kwara State Colleges of Education. Specifically, the study:

1. Determine the general academic performance of Kwara state colleges of Education pre-service teachers in Economics
2. Probe the effect of Manual-Based Concept Mapping and Computer-Based Concept Mapping innovative strategies on academic performance of Kwara state colleges of Education pre-service teachers in Economics
3. Ascertain the effect of Manual-Based Concept Mapping, Computer-Based Concept Mapping innovative strategies on academic performance of Kwara state colleges of Education pre-service teachers in Economics based on gender
4. Investigate the significant interactive effect of Manual-Based Concept Mapping, Computer-Based Concept Mapping innovative strategies and gender on academic performance of Kwara state colleges of Education pre-service teachers in Economics

Research Questions and Hypothesis

The following research questions were answered in this study:

What is the general academic performance of Kwara state colleges of Education pre-service teachers in Economics?

The following null hypotheses were tested:

HO1 - There is no significant effect of Manual-Based Concept Mapping and Computer-Based Concept Mapping innovative strategies on the academic performance of Kwara state colleges of Education pre-service teachers in Economics

HO2- There is no effect of Manual-Based Concept Mapping, Computer-Based Concept Mapping innovative strategies on academic performance of Kwara state colleges of Education pre-service teachers in Economics based on gender

HO3 - There is no significant interactive effect of Manual-Based Concept Mapping, Computer-Based Concept Mapping innovative strategies, and gender on academic performance of Kwara state colleges of Education pre-service teachers in Economics

Methodology

This study has a quasi-experimental design. The study used a non-randomized pre-test post-test control group design. The study is a two-by-two factorial with two treatments (MCM and CBCM) and two degrees of gender (Male and female). Intact classes were used in their entirety. The research population consisted of all year one Economics pre-service teachers from Kwara State's three colleges of education. The research included 270 pre-service teachers—144 men and 126 women. The research collected data using Economics Performance Tests (EPT I Pre-test and EPT II Post-test) based on West African Senior School Certificate Examination (WASSCE) previous questions. EPT I, the pre-test, included 20 multiple-choice questions with four answer options on topics pre-service educators had learned from their lectures.

For six (6) weeks, the two experimental groups were taught utilising Manual-Based Concept Mapping (MBCM) and Computer-Based Concept Mapping (CBCM) Innovative Strategies, respectively. Also, for six weeks, the control group was taught using the traditional style of teaching (lecture approach). The researchers with MBCM creative approach taught the experimental group 1 ECO 111 (Principles of Economics I)

for two hours each contact, using the researcher's lesson procedures. The respondents were asked to identify a notion and connect it to the most appropriate prepositions. The subjects were allowed to independently map out their ideas on cardboards after linking concepts to the most applicable prepositions. Define, describe, generate, etc. Computer-Based Concept Mapping, a novel method, was used in experimental group 2 with the same course ECO 111 (Principles of Economics I), which also lasted two hours each contact following the researcher's lesson protocols. In CBCM experimental group II, CMAP software was employed. This programme was taught and acquainted with the topics in this group. After learning about the subject and examples from the researcher using CMAP, participants were asked to draw their maps in notebooks and then use CMAP on the computer.

After construction, the group was requested to show their results to the class. Production subtopics included an introduction to production, forms of production, factors of production, and flexibility of factors of production. The three groups were post-tested with 30 multiple-choice questions on production using the EPT II (Economics Performance Test II). WASSCE items are already standardised, however two scholars in Educational Measurement and Evaluation from the University of Ilorin, Nigeria, and two Economics Lecturers from the Kwara State College of Education confirmed them. The mean and standard deviation answered the study question, whereas the Analysis of Covariance (ANCOVA) tested the three hypotheses at the 0.05 alpha level.

Results

Research Question One: What is the general academic performance of Kwara state colleges of Education pre-service teachers in Economics?

Respondents' pre-test and post-test scores (both in experimental and control

groups) in Economics were subjected to descriptive statistics as shown in Table 2

Table 2: Pretest and Post-test Mean and standard deviation of respondents' general academic performance in Economics

Variable	N	Mean		S.D	
		Pretest	Posttest	Pretest	Posttest
General Performance in Economics	270	35.93	44.47	11.72	10.72

Source: Researchers

Table 2 showed a mean of 35.93 and 44.47 of respondents' performance in Pre-test and Post-test respectively. This indicated that Kwara state colleges of Education pre-service teachers in Economics performed poorly before treatment (Pre-test) but improved marginally after treatment (Post-test). A mean gain of 8.54 was recorded.

Research Hypotheses

The following hypotheses were postulated and tested in the study:

Hypothesis One: There is no significant effect of Manual-Based Concept Mapping and Computer-Based Concept Mapping innovative strategies on the academic performance of Kwara state colleges of Education pre-service teachers in Economics.

ANCOVA was used to analyse participants' Economics scores to identify the impact of Manual-Based Concept Mapping and Computer-Based Concept Mapping creative methodologies. Table 3 shows the results.

Table 3: Analysis of Covariance showing the effect of Manual-Based and Computer-Based Concept Mapping innovative strategies on the pre-service teachers' academic performance in Economics

Source	SS	df	M e a n Square	F	p-value (sig)
Corrected Model	15522.633	6	2587.105	31.202	.000
Intercept	16571.111	1	16571.111	199.856	.000
Pretest	4890.386	1	4890.386	58.981	.538
Group	10169.230	2	5084.615	61.323	.000
Gender	20.748	1	20.748	.250	.617
Group*Gender	156.747	2	78.374	.945	.390
Error	21806.686	263	82.915		
Total	571374.000	270			
Corrected Total	37329.319	269			

Source: Researchers

Table 3 shows that the F (2, 269) for the groups (treatments) is 61.323 with a p-value of 0.000, which is significant because the p-value 0.000 is less than the 0.05 alpha level. The treatments' unique methodologies (Manual-Based Concept Mapping and Computer-Based Concept Mapping) improve pre-service instructors in Economics at Kwara State Colleges of Education. Hypothesis one was rejected. A post-test means score test was done to locate the significant influence. Post-test Table 4 displays the four groups' mean scores.

Table 4: Scheffe Post-hoc test of significance of treatments on participants' academic performance in Economics

Group	N	Subset	
		1	2
Experimental II (CBCM)	130		50.8462
Experimental I (MCM)	90	39.4000	
Control (LM)	50	37.0400	

Table 4 shows that the post-test mean score of pre-service teachers in the three groups differed, with experimental I (MCM) and control (LM) groups having below-average scores (39.40 and 37.04) in subset 1 and experimental II (CBCM) participants scoring 50.84 in subset 2. Table 4 shows that the post-test mean score of pre-service teachers in the three groups differed, with experimental I (MCM) and control (LM) groups having below-average scores (39.40 and 37.04) in subset 1 and experimental II (CBCM) participants scoring 50.84 in subset 2.

Hypothesis Two: There is no effect of Manual-Based Concept Mapping, Computer-Based Concept Mapping innovative strategies on the academic performance of Kwara state colleges of Education pre-service teachers in Economics based on gender.

Table 3 reveals that a F (1, 269) of 0.250 with a gender probability value (sig./p-value) of 0.617 is not significant since the p-value above the 0.05 alpha criterion ($0.617 > 0.05$). The null hypothesis was not rejected. This demonstrates that Manual-Based Concept Mapping and Computer-Based Concept Mapping do not affect the academic performance of pre-service teachers in Economics at Kwara state colleges of education by gender. It signifies that there is no statistically significant difference between male and female pre-service teachers' academic performance in Economics.

Hypothesis Three: There is no significant interactive effect of Manual-Based Concept Mapping, Computer-Based Concept Mapping innovative strategies, and gender on academic performance of Kwara state colleges of Education pre-service teachers in Economics

Table 3 shows that a $F(2, 269)$ of 0.945 with a p-value of 0.390 is not significant since the p-value is bigger than the 0.05 alpha threshold ($0.390 > 0.05$). Thus, Manual-Based Concept Mapping, Computer-Based Concept Mapping, and gender do not interact to affect the academic performance of pre-service teachers in Economics at Kwara State Colleges of Education. As a result, hypothesis three was accepted.

Discussion of Findings

According to the findings of this study, preservice teachers' general academic performance in Economics was low prior to intervention but increased marginally after treatment. The innovative treatments (Manual-Based Concept Mapping and Computer-Based Concept Mapping) also improved pre-service instructors in Economics at Kwara State Colleges of Education. This is congruent with Onuoha et al. (2016), who found that students taught Economics using a concept mapping teaching technique performed better and had a higher interest rate than those taught using a lecture instructional strategy. It also supports Erdoan (2016)'s findings that concept mapping improved Turkish students' academic performance. It undermines Adu and Enumemu's (2008) findings that neither problem solving nor concept mapping improved students' Economics grades. The data indicated that the impact of the CBCM innovative approach is greater than that of the MBCM innovative strategy. This is corroborated by Divya and Usha (2015), who found that computer-based Concept Mapping improves secondary school students' self-regulation more than Constructivist education. This statement aligns with the findings of Pozo-Sanchez et al (2019), which indicate that computer-based instruction leads

to incremental improvements in education.

The findings also showed that Manual-Based Concept Mapping and Computer-Based Concept Mapping did not significantly affect the academic performance of male and female pre-service teachers in Economics. This is consistent with Onuoha's (2010) results showing there is no gender difference in the academic success of students taught using the concept mapping instructional approach, while it contradicts the findings of Ntibi et al (2020) showing that students' academic achievement was significantly affected by gender.

Finally, the findings show that the two innovative strategies (MBCM and CBCM) and gender had no significant interaction effect on pre-service teachers' academic performance in Economics. Gender did not affect pre-service teachers' academic performance in Economics when combined with MBCM and CBCM creative techniques (post-test scores). Thus, students' post-test scores increased due to teaching methods, not gender (MBCM and CBCM). This is consistent with the findings of Onuoha (2010), Yusuf et al (2014), and Ogonnaya et al (2016), that discovered no significant relationship between gender and concept mapping creative methodologies. It contrasts the findings of Abuseji (2007) and Ezeudu (2013), Zheng et al (2020), who found a strong interaction impact between gender and concept mapping creative methodologies.

Conclusion and Recommendations

The study found that the CBCM innovative strategy had a substantial impact on the academic performance of pre-service teachers in Economics. The innovative CBCM technique appeared to be significantly more successful than the MBCM and traditional educational strategies. However, the task of generating computer maps posed greater difficulty than anticipated, as a result of the apparent deficiency in computer skills among the students. The researchers allocated additional time to provide instruction to the

experimental group of the CBCM study. Also, the potential influence of varying levels of computer literacy among the student participants on the outcomes of the study warrants consideration.

The study also discovered that CBCM is gender-neutral. This would imply that using CBCM to educate pre-service teachers will improve student performance and gender equality. Over-reliance on conventional teaching techniques, a dearth of well-equipped computer labs in schools of education, and a shortage of human resources, notably technical support systems, make new approaches difficult to deploy. These innovations, such as CBCM, rely heavily on the availability of skilled individuals, making staff training and retraining essential.

On this note, the following recommendations were made;

The availability of relevant Information and Communications Technology resources for schools to enhance teaching and learning in the classroom is not up for dispute or modification in the drive for sustainable development. The federal government should enhance the Federal Ministry of Education to make this a reality.

Once access to sufficient ICT facilities is addressed, the Federal Ministry of Education shall monitor and supervise the ICTs already given to make them accessible to professors and students. This requires a dependable power supply from the Federal Ministry of Education.

Curriculum planners (NCCE, NUC, etc.) should include CBCM innovative strategy in Economics pedagogy of Colleges of Education, Faculty of Education, or Institute of Education to equip pre-service teachers to use this method to maximise learning.

Since education is a two-way street, teachers should be prepared to learn new skills. Colleges of Education should provide competent orientation programmes for lecturers and pre-service Economics teachers to appropriately utilise the CBCM creative style in teaching Economics to attain global aims.

SDG 4 proponents should adopt an innovative CBCM approach to include students and teachers, school and post-secondary institution leaders and their representative organisations, communities, parents, civic society, and academics at all stages of SDG 4 progress.

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