

Article

Learners' Perceptions of Computer-Assisted Instruction Approach Teaching and Learning of photosynthesis in Biology Lessons

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Abstract: The purpose of the study was to investigate the effect of computer-assisted instruction approach to the teaching and learning of photosynthesis on the performance of second year Senior High School (SHS 2) Biology students in science. The design for the study was a quasi-experimental research. This study was carried out in Sefwi Wiawso SHS and Asawinso SHS all at Sefwi Wiawso Municipal Assembly in the Western North Region of Ghana. They are all mixed institution. The purposive sampling techniques was used to schools, classes and students for the study. One-hundred one (101) electives biology participants were purposively selected, they consist of SHS 2 Science of (55) fifty-five students from Sefwi Wiawso SHS and SHS 2 Home economics of (46) forty-six students also from Asawinso SHS. The third years were not selected because they were preparing to write their WASSCE. The main instrument for data collection was questionnaire. The study collected only quantitative data and employed quantitative method of data analysis. Data obtained from participants in both experimental and control groups on the Test 2 were analysed statistically using independent-measures t-test. The independent-measures t-Test was used to investigate whether any differences existed between experimental and control groups' mean scores on the Test 2. The study further revealed that computer-assisted instructions gives feedback to learners to have the opportunity to master computer-assisted instructional package tool used. It is recommended that, computer-assisted instruction method should be encouraged in many Biology classes in Wiawso Municipal Assembly, since it gives students opportunity to see links between concepts, summarise and organise their works, thoughts logically and sequentially. Both genders must be encouraged to use computer-assisted instruction method to studying Biology.

How to cite this paper:

Arthur-Baidoo, F., Azumah, D. A., Osei-Manu, F., & Annan, M. K. (2022). Learners' Perceptions of Computer-Assisted Instruction Approach Teaching and Learning of photosynthesis in Biology Lessons. *Online Journal of Microbiological Research*, 1(1), 8–16. Retrieved from <https://www.scipublications.com/journal/index.php/ojmr/article/view/324>

Keywords: Biology, Computer-Assisted Instruction, Photosynthesis

Received: April 26, 2022

Accepted: June 3, 2022

Published: June 5, 2022



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1. Introduction

Biology concepts which learners have difficulties in have been explored by quite many researchers. A study stated that water transport in plants and genetics were amongst the most difficult biology topics to be learnt by secondary school and university students [1]. A scientific study revealed that Mendelian genetics, photosynthesis, cellular respiration, protein synthesis, and cell division (mitosis and meiosis), were difficult but important topics for students to learn [2]. Respiration, photosynthesis and gaseous exchanges are difficult for students to learn [3]. Physiology content areas are mostly abstract and microscopic and involve many fine processes that require proper explanation to aid learners to understand them [4]. To the researcher, these are some of the reasons why teachers and learners usually find physiology content areas such as photosynthesis, cell division, cellular respiration, etc., difficult to deal with [4].

A lot of researches have been carried out on computer-assisted instruction and the learners' performance in Biology. A study on the effect of using computer technology in economics classes and found that traditional teaching is important for transmitting information about economic theory, but computer-assisted instruction holds the potential of enhancing dramatically students learning of economic theory [5]. Computer-assisted instruction provides a good base for learners to work at their own pace with immediate feedback [6]. Animated graphs and flow-charts help the learners understand better the shift of the curves or the relationship between different sectors of the economy [7]. The actual use of computer technology in biology education is still limited due to obstacles related to teaching staff members and learners, technical potentials and available financial resources. The use of computer technology in education has many advantages that support the quality assurance of biology education and increases its effectiveness [6]. Some researchers also investigated how students' attitudes toward class presentation and the instructors were affected by three independent variables interactions: gender, presentation mode, and use of mental imagery [8]. They also investigated the effect of using PowerPoint in lectures on students' attitude. They found out that those who use mental imagery did better in quizzes if they were in the PowerPoint group [8].

Other researcher also developed an interactive, multimedia compact disc (CD) for use in a computerized economics system and analysis class. They reported the results of student evaluations of teaching and focus groups, concluding that students benefited from the use of the CD [9]. The use of computers, the internet, and related technologies, given adequate teacher training and support, can indeed facilitate the transformation of the learning environment into a learner-centred one [10]. But this study is criticized for being mostly exploratory and descriptive and lacking in empirical rigour. What does exist are qualitative data based on observations and analysis of student and teacher perceptions that suggest a positive impact on learning. On the other hand, claims that there is no significant difference between the test scores of learners taking computer-based distance learning courses and those receiving face-to-face instruction [11]. A study claim that such generalizations are inconclusive, pointing out that a large number of articles on computer-based distance learning does not include original experimental research or case studies [12]. Other critics such as Potashnik and Capper, argue that dropout rates are much higher when instruction is delivered at a distance via CBL. Commenting on access to CBL, Potashnik and Capper stated that it is difficult to quantify the degree to which computer-assisted instructions has helped expand access to basic education since most of the interventions for this purpose have been small-scale and under-reported [13].

However, the impact of educational radio and television broadcasts on the quality of basic education remains an under-researched area, but what little research there is, suggests that these interventions are as effective as traditional classroom instruction [14]. Hannafin and Savenye after their investigation asserted that, of the many educational broadcast projects, the interactive radio instruction project has been the most comprehensively analyzed. Findings provide strong evidence of the project's effectiveness in raising the quality of education as demonstrated by increased scores on standardized tests as well as improved attendance [14]. A similar study seems to support the claim that the use of computers enhances and amplifies existing curricula, as measured through standardized testing [15]. According to Yusuf and Afolabi, Specifically, research showed that the use of computers as tutors, for drill and practice, and instructional delivery, combined with traditional instruction, results in increases in learning in the traditional curriculum and basic skills areas, as well as higher test scores in some subjects compared to traditional instruction alone. Students also learn more quickly, demonstrate greater retention, and are better motivated to learn when they work with computers. But some claim that these represent modest gains and, in any case, much of the researches on which these claims are based are methodologically flawed [15].

One of the most critical problems in trying to assess the effectiveness of computer-assisted instructions as transformational tools is that standardized tests cannot capture the kinds of benefits that are expected to be gained in a learner-centred environment. There is ample evidence for the effectiveness of computer-assisted instruction in various subject areas and at various grade levels. Yusuf and Afolabi also found computer-assisted instruction as an effective mode of instruction for teaching biology to secondary school students both in individualized and cooperative settings [15]. A research demonstrated that the simulation model is more effective than tutorial and drill and practice modes of computer-assisted instruction for teaching science to 9th-grade students [16]. Science teaching through computer-assisted instruction more effective for high IQ students than low IQ students of 9th grade [17]. Testing the effectiveness of computer-assisted instruction for teaching general science at the secondary level also found positive results in favour of computer-assisted instruction as compared with the conventional method [18]. Computer-assisted instruction more effective as compared to the traditional method for teaching science at the primary school level [19]. Computer-assisted instruction as an effective method for teaching mathematics to 7th-grade students as compared with the traditional method [20]. A study reviewed fifty-nine research studies exploring the effectiveness of computer-assisted instruction and concluded that computer-assisted instruction utilized as a supplement to the teacher-directed instruction, resulted in superior students' achievement [21]. A research conducted a meta-analysis of the studies comparing computer-assisted instruction, traditional methods of instruction and traditional method of instruction plus computer-assisted instruction. It was found that students receiving traditional method of instruction supplemented with computer-assisted instruction attained higher academic achievement than those receiving only traditional instruction or computer-assisted instruction. Moreover, since technology use is fully integrated into the larger learning system, it is very difficult to isolate the technology variable and determine whether any observed gains are due to technology use or some other factor or combination of factors [22].

On the integration of computer-assisted instruction techniques with technology, a study revealed that students' reactions were positive. Improving the quality of education and training is a critical issue, particularly at a time of educational expansion [23]. Computer-assisted instruction can enhance the quality of education in several ways: by increasing learner motivation and engagement, by facilitating the acquisition of basic skills, and by enhancing teacher training. Computer-assisted instructions are also transformational tools which, when used appropriately, can promote the shift to a learner-centred environment [24].

Basically, some of the ways computer-assisted instruction has improved teaching/learning in the educational system include: motivating to learn; computer-assisted instruction, such as videos, television and multimedia computer software that combine text, sound, and colourful, moving images can be used to provide challenging and authentic content that will engage the student in the learning process. Digital-age literacy which is functional literacy, ability to interpret the meaning and express ideas in a range of media, inventive thinking, adaptability; ability to adapt and manage in a complex, interdependent world curiosity; desire to know creative ability to use imagination to create new things, risk-taking; ability to take risks. Also, Higher-order thinking: creative problem-solving and logical thinking that result in sound judgments. [24] Effective communication: teaming ability to work together; collaboration and ability to interact smoothly with others and work effectively with other interpersonal skilled personals and also, boys and girls learn differently, and prefer to learn in a different environment and different instructional approach [24, 25].

Based on the theories of Jean Piaget and Lev Vygotsky, a conceptual model (Figure 1) was settled on for the study. When students are exposed to difficult, confusing and complex concepts, they are thrown into a state of disequilibrium. Computer-assisted

instruction (administered in cooperative or individualised learning settings) however, seems to enable students to develop cognitive structures or mental models or reorganize their already existing ones to better understand difficult, confusing and complex concepts, such as photosynthesis [26]. Some investigators noted that the constructivists' position that, students should have access to multiple viewpoints and representations for information is partially satisfied by well-constructed simulations [27]. Simulations have the potential to make the learning of confusing, complex and difficult concepts, more interactive, authentic, and meaningful. Computer-assisted instruction, therefore, seems to give learners experiences that would facilitate conceptual development leading to increased understanding of difficult concepts [28, 29]. Again, with dynamic group support in cooperative learning environments, learners seem to perform at higher intellectual levels, which enable them to better comprehend complex, confusing, difficult or abstract biology concepts [26]. This is because a researcher orated that, the claims made for computer-assisted instruction and cooperative learning strategies in some respects are rather similar [30]. For, according to him, they both emphasize the role of learners' interactions in enhancing a wide range of school outcomes, including academic achievements, cognitive processes, meta-cognitive skills, motivation toward learning, self-esteem and social development. Computer-assisted instructions seem to provide learners with experiences that facilitate conceptual development, which leads to an increased understanding of difficult concepts. Evaluation of the instructional processes, however, reveals learning outcomes, which could serve as evidence of the attainment of the curriculum objectives or a basis of the need to refine the curriculum objectives [30].

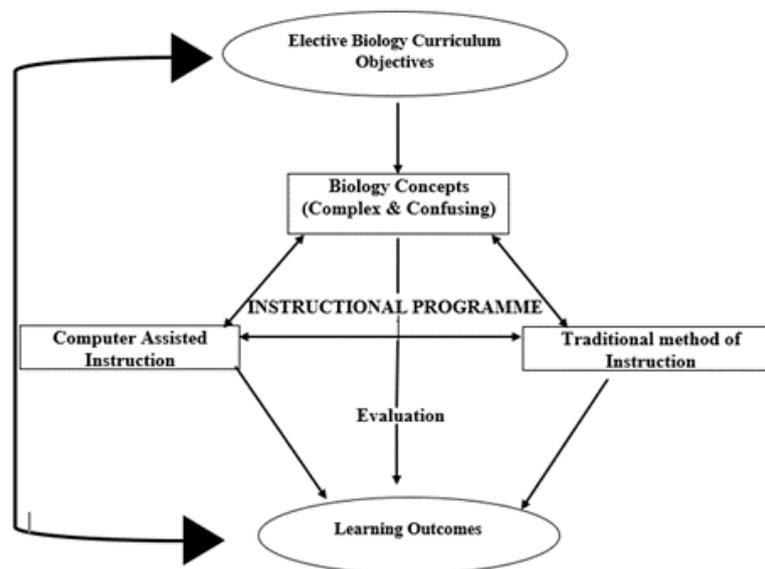


Figure 1. Conceptual framework of the study

The effect of computer-assisted instruction as a tool for classroom instruction has been well-known by many scholars. Computer-assisted instruction is good additional tools for classroom instruction and in science laboratories, as they allow learners to see a real-world experience and interact with it. Computer-assisted instructions are also good tools to improve learners' hypothesis construction, graphic interpretation and prediction skills [31]. It is therefore, seems that the incorporation of computer-assisted instruction in the teaching and learning processes improves the understanding of learners. This study, therefore, seeks to determine the effect of computer-assisted instruction in the learning of difficult, complex and confusing biology concepts, like photosynthesis, in some Senior High Schools in the Western North Region of Ghanaian. The purpose of the study was to investigate the effect of computer-assisted instruction approach to the teaching and

learning of photosynthesis on the performance of second year Senior High School (SHS 2) students in science. The study was guided by the research question - What are the learners' perceptions of computer-assisted instruction for biology lessons?

2. Materials and Methods

The design for the study was a quasi-experimental research. This study was carried out in Sefwi Wiawso SHS and Asawinso SHS all at Sefwi Wiawso Municipal Assembly in the Western North Region of Ghana. They are all mixed institution. The purposive sampling techniques was used to schools, classes and students for the study. One-hundred one (101) elective biology participants were purposively selected, they consist of SHS 2 Science of (55) fifty-five students from Sefwi Wiawso SHS and SHS 2 Home economics of (46) forty-six students also from Asawinso SHS. The third years were not selected because they were preparing to write their WASSCE.

The main instrument for data collection was questionnaire. The questionnaire consists of sixteen (16) items that elicited information on respondents' perception of the effectiveness of CAI in teaching and learning biology. A Likert scale with five options (Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), and Strongly Disagree (SD)) was used to score the questionnaire items.

To ensure validity in the study, participants' scores from the Test 1 and Test 2 make sense, are meaningful and enable good conclusions to be drawn from the sample studied to the research population (Creswell, 2008), instrument was presented to two SHS elective biology teachers with considerable teaching experience in the Sefwi Wiawso Municipal Assembly for their comments and suggestions to correct the errors that were associated with items on the test. Also to ensure Reliability of the research instrument, the test was piloted using 20 SHS elective biology students of Methodist SHS in the Sekondi Takoradi Metropolis in the Western Region of Ghana. Data from the pilot test were statistically analysed to determine the reliability of the test instruments using the Spearman-Brown prophecy formula since all items on both Test 1 and Test 2 were dichotomously scored. The analysis yielded reliability coefficients of .6 and .70 for the Test 1 and Test 2 respectively. The study collected only quantitative data and employed quantitative method of data analysis. Data obtained from participants in both experimental and control groups on the Test 2 were analysed statistically using independent-measures *t*-test. The independent-measures *t*-Test was used to investigate whether any differences existed between experimental and control groups' mean scores on the Test 2. This was done to answer the research question.

3. Results and Discussion

What are the learners' perceptions of computer-assisted instruction approach for biology lessons?

Table 1 discloses the perception of learners towards computer-assisted instruction approach, 41.3% of the respondents strongly agree that CAI makes biology class interesting, 45.7% of them supported the idea, 6.5% and 6.5% of them strongly disagree and disagree respectively. Moreover, 41.3% and 41.3% of the respondents strongly agree and agree respectively that CAI links the various topics together and 4.3% of the respondents were undecided, 4.3% and 8.7% of the respondents disagree and strongly disagree respectively to the idea. Again, 61% of the respondents strongly agree that CAI summarizes the topic, 24% of them agree, whilst 4% of them were undecided, 7% and 4% of the respondents disagree and strongly disagree that CAI summarizes the topic respectively. Again, majority of the respondents strongly agree and agreed that Students are much involved in CAI representing 41.3% and 30.4% respectively and 17.4% of the respondents disagreed to the idea that students are much involved in CAI, 54.3% of the

respondents strongly agreed that CAI bring out the meaning of the abstract concept better, 28.3% of the respondents agreed and 13.0% were disagreed.

Table 1. The Perception of Learners towards Computer-assisted Instruction Approach

Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
CAI makes biology class interesting	41.3% (19)	45.7% (21)	0.0% (0)	6.5% (3)	6.5% (3)
CAI links the various topics together	41.3% (19)	41.3% (19)	4.3% (2)	4.3% (2)	8.7% (4)
CAI summarizes the topic	61% (28)	24% (11)	4% (2)	7% (3)	4% (2)
Students are much involved in CAI	41.3% (19)	30.4% (14)	2.2% (1)	17.4% (8)	8.7% (4)
CAI bring out the meaning of the abstract concept better	54.3% (25)	28.3% (13)	0.0% (0)	13.0% (6)	4.3% (2)
CAI provide aids for expanding what has been learned	45.7% (21)	41.3% (19)	0.0% (0)	4.3% (2)	8.7% (4)
CAI demand a lot of thinking	52.2% (24)	45.7% (21)	2.2% (1)	0.0% (0)	0.0% (0)
CAI assignments help me prepare for my exams	41.3% (19)	50.0% (23)	2.2% (1)	2.2% (1)	4.3% (2)
CAI facilitate making interconnections among sub-concepts	58.7% (27)	32.6% (15)	0.0% (0)	8.7% (4)	0.0% (0)
It is worthwhile using CAI for other topics in biology	37.0% (17)	45.7% (21)	4.3% (2)	4.3% (2)	8.7% (4)
Sharing CAI with friends helps me address my misunderstandings	45.7% (21)	41.3% (19)	4.3% (2)	6.5% (3)	2.2% (1)
Sharing CAI help me identify the relations amongst the concepts	43.5% (20)	45.7% (21)	0.0% (0)	6.5% (3)	4.3% (2)
CAI helps me to understand information better	54.3% (25)	39.1% (18)	4.3% (2)	0.0% (0)	2.2% (1)
Using CAI is not time-consuming	54.3% (25)	34.8% (16)	2.2% (1)	4.3% (2)	4.3% (2)
CAI can be used for other courses	50.0% (23)	39.1% (18)	0.0% (0)	8.7% (4)	2.2% (1)
CAI provides me with better understanding of complex issues	45.7% (21)	39.1% (18)	2.2% (1)	6.5% (3)	6.5% (3)

Source: Field data, 2020

Moreover, 41.3% of the respondents strongly agree that CAI provide aids for expanding what has been learned, 47.5% of them strongly supported the idea, and 4.3% and 8.7% respectively disagree and strongly disagree that CAI provide aids for expanding what has been learned. Furthermore, 52.2% of the respondents strongly agreed that CAI demand a lot of thinking, 45.7% agreed that CAI demand a lot of thinking, whilst 2.2% of them were undecided that, CAI demand a lot of thinking. Moreover, 41.3% and 50.0% of the respondents strongly agree and agreed respectively that CAI assignments help me prepare for my exams and 2.2% of the respondents were undecided, 2.2% and 4.3% disagree and strongly disagree respectively to the idea. Again, 58.7% of the respondents strongly agree that CAI facilitate making interconnections among sub-concepts, 32.6% of

them agree, whilst, 8.7% of the respondents disagree and strongly disagree that CAI facilitate making interconnections among sub-chapters.

Notwithstanding, 45.7% and 37.0% of the respondents agreed and strongly agreed that it is worthwhile using CAI for other topics in biology, 4.3% were undecided and 8.7% strongly disagree. Again, majority of the respondents strongly agree and agreed that sharing CAI with friends helps me address my misunderstandings representing 45.7% and 41.3% respectively, and 6.5% of the respondents disagreed to the idea that sharing CAI with friends helps me address my misunderstandings, 2.2% of the respondents strongly disagreed that sharing CAI with friends helps me address my misunderstandings. Moreover, 43.5% of the respondents strongly agree that Sharing CAI help me identify the relations amongst the concepts, 45.7% of them strongly supported the idea, and 6.5% and 4.3% respectively disagree and strongly disagree that sharing CAI help me identify the relations amongst the concepts.

Furthermore, 54.3% of the respondents strongly agreed that CAI helps me to understand information better, 39.1% agreed that CAI helps me to understand information better, whilst 4.3% of them were undecided, 2.2% strongly disagreed CAI demand a lot of thinking. Moreover, 54.3% and 34.8% of the respondents strongly agree and agreed respectively that using CAI is not time-consuming and 2.2% of the respondents were undecided, 4.3% and 4.3% disagree and strongly disagree respectively to the idea. Again, 50.0% of the respondents strongly agree that CAI can be used for other courses, 39.1% of them agree, whilst 8.7% and 2.2% of the respondents disagree and strongly disagree that CAI can be used for other courses respectively. Lastly, 45.7% and 39.1% of the respondents strongly agreed and agreed that CAI can be used for other courses, 2.2% were undecided and 6.5% and 6.5% of the respondents respectively disagree and strongly disagree.

Again, findings in [Table 1](#) in relation to research question discloses the perception of learners towards computer-assisted instructions as approach. In it, 41.3% of the respondents strongly agree that computer-assisted instruction (CAI) makes biology class interesting, 45.7% of them supported the idea, 6.5% and 6.5% of them strongly disagree and disagree respectively. Moreover, 41.3% and 41.3% of the respondents strongly agree and agreed respectively that CAI links the various topics together and 4.3% of the respondents were undecided, 4.3% and 8.7% of the respondents disagree and strongly disagree respectively to the idea. Again, 61% of the respondents strongly agree that CAI summarizes the topic, 24% of them agree, whilst 4% of them were undecided, 7% and 4% of the respondents disagree and strongly disagree that CAI summarizes the topic respectively. Again, majority of the respondents strongly agree and agreed that Students are much involved in CAI representing 41.3% and 30.4% respectively and 17.4% of the respondents disagreed to the idea that students are much involved in CAI, 54.3% of the respondents strongly agreed that CAI bring out the meaning of the abstract concept better, 28.3% of the respondents agreed and 13.0% were disagreed.

However, very low percentage of students responded to 'disagree or strongly disagree to the use of CAI approach [\[32\]](#). Another similar study also indicated that, greater percentage of the students responded to 'agree' or 'strongly agree' to computer-assisted instructions as approach [\[33\]](#). These findings are consistent with this study showing that students have positive perception towards computer-assisted instructional approach. This study is consistent with earlier studies that students who showed positive attitudes and perception towards computer-assisted instruction, achieved higher in their post-tests [\[32, 34\]](#).

The whole experimental group was more positive about the usefulness of computer-assisted instruction in enhancing learning effectiveness after they took the computer-assisted instruction programme. Almost all students in the experimental group, articulated the view that the computer-assisted instruction strategy was really helpful for learning photosynthesis. Furthermore, most students pointed out that adopting the

computer-assisted instructional approach helped them reduce the barriers in learning abstracts concept in photosynthesis and promote their interests in learning biology. The overwhelming majority of the students were of the opinion that computer-assisted instruction can be a viable instructional approach. Most of the students adored, and felt pleased with adopting computer-assisted instruction as an assistive learning method. The students in the computer-assisted instruction group also believed that computer-assisted instruction could be easily applied to other subjects. These opinions are consistent with the successful examples of using computer-assisted instruction in other disciplines [35, 36]. However, nearly half of the students indicated that, they could not quickly adjust to the approach of computer-assisted instruction. The result points out the importance and difficulty of preparing and training students for computer-assisted instruction method. Studies of student mapping have indicated that a lack of familiarity with the technique can be frustrating for novice learners [37].

4. Conclusion and Recommendation

The study indicated that computer-assisted instructions were successful tools in helping experimental group improve their scores. The study further revealed that computer-assisted instructions gives feedback to learners to have the opportunity to master computer-assisted instructional package tool used. It is recommended that, computer-assisted instruction method should be encouraged in many Biology classes in Wiawso Municipal Assembly, since it gives students opportunity to see links between concepts, summarise and organise their works, thoughts logically and sequentially. Both genders must be encouraged to use computer-assisted instruction method to studying Biology.

Author Contributions: Conceptualization FAB; methodology, FAB, DAA, FOM and MKA; validation, FAB, and MKA; formal analysis, FAB and FOM; investigation, FAB, DAA, FOM and MKA; resources, FAB, DAA, FOM and MKA; data curation, FAB, DAA, FOM and MKA; writing—original draft preparation, FAB, DAA, FOM and MKA; writing—review and editing, FAB and DAA.; visualization, NAB, AB, and MFM; supervision, FAB. and FOM; project administration, FAB, DAA, FOM and MKA; All authors have read and agreed to the published version of the manuscript.

Funding: “This research received no external funding”

Data Availability Statement: Data is available on request from the corresponding author.

Acknowledgments: we acknowledge the participants in this study.

Conflicts of Interest: “The authors declare no conflict of interest.” “No funders had any role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results”.

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