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ORIGINAL

Improving Students' Cognitive Abilities and Motivation in Kinematics Material Through Egamerasi Media

Mejorar las habilidades cognitivas y la motivación de los estudiantes en el material de cinemática a través de Egamerasi Media

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ABSTRACT

Introduction: kinematics is considered as difficult material. Learning media greatly supports the achievement of learning objectives. Educational games have been proven to be an attraction for students to learn, easy to use in learning. However, in a preliminary study, the use of educational games, students' conceptual understanding was still in the moderate category. While the presentation of material with a multiple representations approach has been proven to make it easier for students to understand science concepts. The purpose of this study was to test the results of the development of Educational Game Based Multiple Representations (EGAMERASI) as a science learning media to improve students' understanding and motivation in learning.
Method: this study is an experimental study in the testing activity of using EGAMERASI media on a limited scale. The research instruments include cognitive ability tests and student learning motivation questionnaires. Data analysis used descriptive quantitative to determine the effectiveness of increasing EGAMERASI, and students' ARCS motivation levels.
Results: the results of this study are 1) EGAMERASI has been proven to increase the average cognitive ability in the high category and is effective in the domains of knowledge, understanding, application, and analysis. Moreover, at the cognitive level of evaluation and synthesis are included in the category of quite effective, and 3) the increasing of ARCS motivation scores are attention 89 %, relevance 90 %, confidence 85 %, and satisfaction 88 %, including overall 87 %.
Conclusions: all of indicators were responded by students and included in the category of making students very motivated in learning.

Keywords: Educational Games; Multiple Representations; Cognitive Abilities and ARCS Motivation.

RESUMEN

Introducción: la cinemática se considera un material difícil. Los medios de aprendizaje apoyan en gran medida el logro de los objetivos de aprendizaje. Se ha demostrado que los juegos educativos son un atractivo para

que los estudiantes aprendan y son fáciles de usar en el aprendizaje. Sin embargo, en un estudio preliminar, el uso de juegos educativos hizo que la comprensión conceptual de los estudiantes todavía se encontrara en la categoría moderada. Si bien se ha demostrado que la presentación de material con un enfoque de representaciones múltiples facilita que los estudiantes comprendan los conceptos científicos. El propósito de este estudio fue probar los resultados del desarrollo de juegos educativos basados en representaciones múltiples (EGAMERASI) como un medio de aprendizaje de ciencias para mejorar la comprensión y la motivación de los estudiantes en el aprendizaje.

Método: este estudio es un estudio experimental en la actividad de prueba del uso de los medios de EGAMERASI en una escala limitada. Los instrumentos de investigación incluyen pruebas de capacidad cognitiva y cuestionarios de motivación de aprendizaje de los estudiantes. El análisis de datos utilizó un método cuantitativo descriptivo para determinar la eficacia del aumento de EGAMERASI y los niveles de motivación ARCS de los estudiantes.

Resultados: los resultados de este estudio son 1) EGAMERASI ha demostrado aumentar la capacidad cognitiva promedio en la categoría alta y es eficaz en los dominios de conocimiento, comprensión, aplicación y análisis. Además, en el nivel cognitivo de evaluación y síntesis se incluyen en la categoría de bastante eficaz, y 3) el aumento de las puntuaciones de motivación ARCS son atención 89 %, relevancia 90 %, confianza 85 % y satisfacción 88 %, incluido el 87 % general.

Conclusiones: todos los indicadores fueron respondidos por los estudiantes e incluidos en la categoría de hacer que los estudiantes estén muy motivados en el aprendizaje.

Palabras clave: Juegos Educativos; Representaciones Múltiples; Habilidades Cognitivas y Motivación ARCS.

INTRODUCTION

Standardization of Primary to Secondary Education, stated in the regulation states that in improving efficiency and effectiveness in learning, learning principles are needed, by utilizing information and communication technology.[1] Learning becomes an effort to convey information, by creating a learning environment carried out by teachers.[2,3,4] One of the way to facilitate a basic understanding of learning is by using learning media.

Kinematics material requires special solutions, for prospective science teachers, 71 % of the material is quite difficult.[5,6] With an average value of 51,81 %, the evaluation findings for the straight motion kinematics material fall into the intermediate category.[7] The results of a preliminary study of the Kinematics subject at the junior high school level were only able to have an average of 57,78 which is included in the low category.[8]

Digital media has been proven to optimize students' understanding of the kinematics of motion material.[9,10] The media used by students in learning abstract material using computers, for example, computer-assisted games.[11] One of these educational tools is a game that encourages students to participate and offers a range of learning opportunities.[12] This game offers some benefits, including the ability to be made tough, enjoyable, and relatable to pupils.[13]

Educational games on temperature and heat materials have been developed to determine the appeal and convenience for students to use in learning.[14,15] The results of the study showed that the appeal of educational games for students was 81 %, including in the very good category. The results of this study confirm the research. The CHEBO COLLECT GAME educational game was responded positively as a medium for learning chemical bonds.[16] Likewise, the Mobile Enthalpy Game (MEGA) application can improve the interest of students in learning physics.[17] Students might become more motivated and engaged in the process thanks to technology, which sharpens their focus.[18,19,20,21]

The results of the total average research on the convenience of use of educational games were able to reach 87 % which is included in the very good category. With details of 96 % of students said that educational games can achieve learning goals. Educational games are easy to use in learning reaching 97 %. Educational games can achieve 67 % understanding of the material, learning is included in the moderate category.[14] The material understanding indicator confirms that classes that only use educational games without reflection and support from teachers make students more stressed.(22–24) Playing computer games while learning gives kids the opportunity to experience conceptual uncertainty.[16] Similar to other media, the use of educational games also allows for misconceptions in students.[16]

The success of educational games in building conceptual understanding needs to be well-designed.[17,25] Educational games highlight the importance of designing games that not only engage students but also deeply integrate academic content to enhance learning outcomes.[26] Well-designed games will provide the ability to achieve goals.[27,28]

An alternative solution to improve conceptual understanding in educational games is to provide multiple representations when revealing scientific phenomena. The chief proposer has conducted research in 2023, on the use of multiple representations in electrical materials. Through this media, students can use it anytime and

anywhere when they want to use it. Moreover, this media has been proven to facilitate independent learning due to the presence of multiple representations. Various representations greatly help students to understand the concept of electricity.[29]

Educational games have been proven to influence students' learning interest.[13,14,16,17] Meanwhile, the presentation of multiple representations influences the independence and understanding of science concepts.[14,30,31,32] In this study, Educational Game Based Multiple Representations (EGAMERASI) application will be developed as a science learning media to improve the concepts and learning interests of junior high school students in Bangkalan Regency.

METHOD

This research is quasi-experimental with a one-group pre-test post-test research design.[33,34] This study examines the impact of the use of EGAMERASI on students' cognitive abilities. EGAMERATION has been declared valid by media experts by 90 % and declared valid by material experts by 94 %. The subjects of this study were 30 students of grade 8 at SMPN 2 Bangkalan. This activity was carried out in the laboratory of SMPN 2 Bangkalan, each student used a computer to use EGAMERASI. The research instrument included a cognitive ability test consisting of 12 multiple-choice questions. The questions consist of 6 levels according to Bloom's taxonomy on the kinematics of motion material.[35,36,37] Knowledge (C1) as many as 2 questions, understanding (C2) as many as 2 questions, application (C3) as many as 2 questions, analysis (C4) as many as 2 questions, evaluation (C5) as many as 2 questions, and synthesis (C6) as many as 2 questions, and the ARCS motivation questionnaire consists of 11 statements representing indicators of attention, relevance, confidence, and satisfaction.[38]

The test result data will be measured for improvement with normalized N-Gain. The N-gain score acquisition categories are (<g>) > 0,7 = high; 0,7 > (<g>) <0,3 = moderate; (<g>) <0,3 = low, and the N-gain score effectiveness interpretation category in 0 % - 40 % = ineffective; 40 % - 50 % = less effective; 56 % - 75 % = quite effective; and >76 % = effective. EGAMERASI is said to be effective if the minimum increase in the minimum category is 76 %.[39,40]

RESULTS

The discussion and the results should be succinctly and clearly presented in the same section. The advantage of the research findings, not the duplicate results, should be covered in the discussion section. To cut down on lengthy quotations, the results and discussion sections can be written in the same section. Different outcomes must be displayed in tables and graphs. In order to address research issues, data analysis findings must be trustworthy. The references in the introduction should not be repeated in the discussion references. It is necessary to provide comparisons to the results of earlier research.

Egamerasi Media

Desktop-based educational game application with the title "EGAMERASI" which focuses on learning motion material has been successfully developed. When the application is first activated, the user must press the play button to go to the menu page. On the menu page there is a learning and playing menu, as shown in figure 1.

Figure 1. Game Menu Page Display Image

Figure 1 is an example of Menu page display. There is material presented by providing information in the form of written text. To make the students understand more, the examples of applications in everyday life are given.

While on the play page, there are 2 choices of play levels on different materials and there are cognitive questions from C1, C2, C3, C4, C5, and C6. Here is an example of the play page display as shown in figure 2.

Figure 2. Display image of level selection

While each level has almost the same appearance, it is only different in the questions that will appear. Here is an example of the appearance of the game page as shown in figure 3.

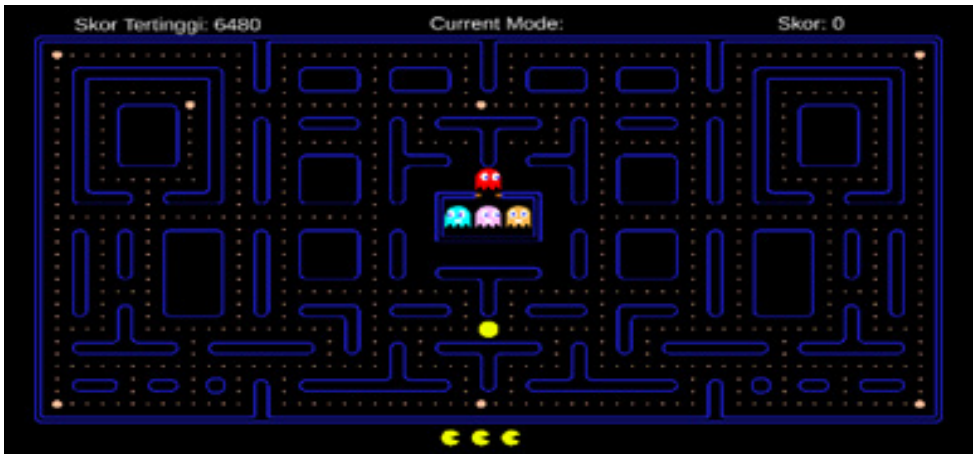

Figure 3. Image of play page

Figure 3 is an example of a play page. The play page displays a maze that contains several questions to be answered by students by moving the main character to the right, left, up, and down to eat the large circle to get out of the question. The following is an example of the appearance of the question page (figure 4).

Figure 4. Image of question display

Figure 4 is an example of a question page on the play page. The play page contains 6 levels of questions, from knowledge, understanding, implementation, analysis, evaluation, and synthesis. Each question contains a verbal representation, consisting of information text that needs to be understood by students. In image representation, students need to move the image of the object according to the information. In mathematical representation, students need to fill in the number value obtained after doing activities on the image representation.

Cognitive Abilities

The learning evaluation questions are given to students which consist of 12 multiple choice questions. The questions consist of 6 levels according to Bloom's taxonomy (Bloom, 1956) on the kinematics of motion material. Knowledge (C1) consists of 2 questions, understanding (C2) consists of 2 questions, application (C3) consists of 2 questions, analysis (C4) consists of 2 questions, evaluation (C5) consists of 2 questions, and synthesis (C6) consists of 2 questions. The results of cognitive abilities as shown in table 1.

Table 1. Effects of using EGAMERASI

Variables	N	Min score	Max score	Average	Std.
Pre-Test	30	0	6	2,33	1,58
Post Test	30	4	12	9,47	2,56

Based on table 1, the number of respondents is 30 students, the minimum score is 0 and the maximum is 6 with an average pretest score of 2,33 with a standard deviation of 1,58. In the posttest with the same students with a total of 30, the minimum score is 4 and the maximum is 12, the average score is 9,47 and the standard deviation is 2,56. The details of the score distribution is shown in the following figure 5.

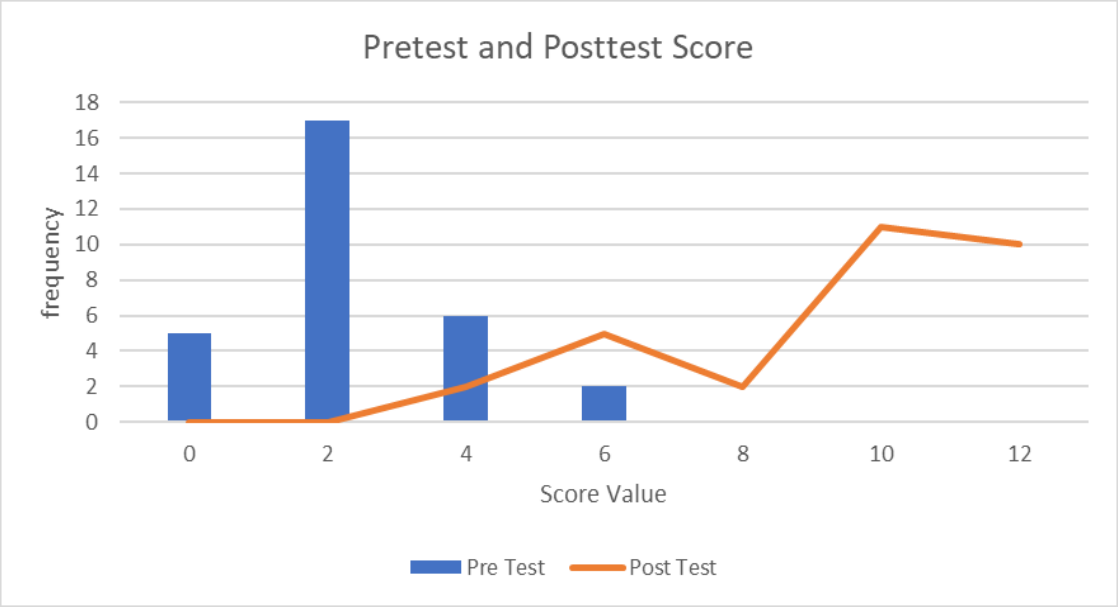

Figure 5. Pretest and posttest score distribution graph

Based on figure 5, during the pretest, the results obtained a score of 0 was 5 students, a score of 2 was 17 students, a score of 4 was 6 students, and a score of 6 was 2. During the pretest, the majority of students with a score of 2 were 17 students. While during the posttest, students with a score of 4 were 2 students, a score of 6 was 5 students, a score of 8 was 2 students, a score of 10 was 11 students, and a score of 12 was 10 students. So, the majority of students during the post-test were at a score of 10, as many as 11 students. With these data, it can be seen that N-Gain scores of students are shown in table 2 and the distribution of N-Gain is shown in figure 6.

Table 2. Average score of students' cognitive abilities

Student	N	Gain	Category
Overall	30	0,73	High

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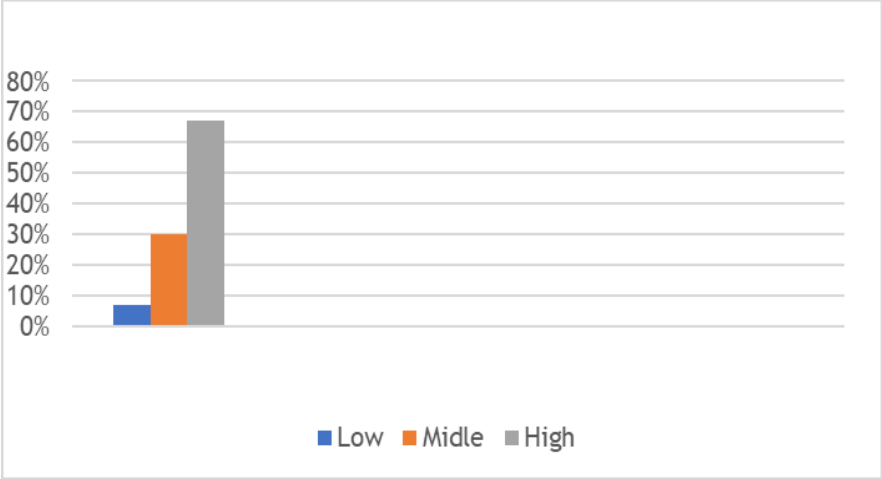

Figure 6. Distribution of cognitive ability improvement results

Based on table 2 and figure 6, the distribution of N-Gain cognitive abilities of 30 students obtained a result of 0,73, including the high category. The distribution of students who experienced an increase in N-gain in the low category was 7 %, an increase in the medium category was 30 %, and an increase in the high category was 67 %. The level of effectiveness of N-gain for each indicator of students' cognitive ability is shown in table 3.

Table 3. Table of EGAMERASI effectiveness based on question cognitive level

No	Cognitive level	N-Gain	Category
1	Knowledge (C1)	95 %	Effective
2	Comprehension (C2)	81 %	Effective
3	Implementation (C3)	89 %	Effective
4	Analysis (C4)	77 %	Effective
5	Evaluation (C5)	51 %	Quite Effective
6	Synthesis (C6)	52 %	Quite Effective

Based on table 3, for questions at the knowledge level (C1), students were able to achieve an N-Gain percentage of 95 %, which is included in the effective category. For questions at the understanding level (C2), students were able to achieve an N-Gain percentage of 81 %, which is included in the effective category. For questions at the application level (C3), students were able to achieve an N-Gain percentage of 89 %, which is included in the effective category. For questions at the analysis level (C4), students were able to achieve an N-Gain percentage of 77 %, which is included in the effective category. For questions at the evaluation level (C5), students were only able to achieve an N-Gain percentage of 51 %, which is included in the fairly effective category. For questions at the synthesis level (C6), students were only able to achieve an N-Gain percentage of 52 %, which is included in the effective category.

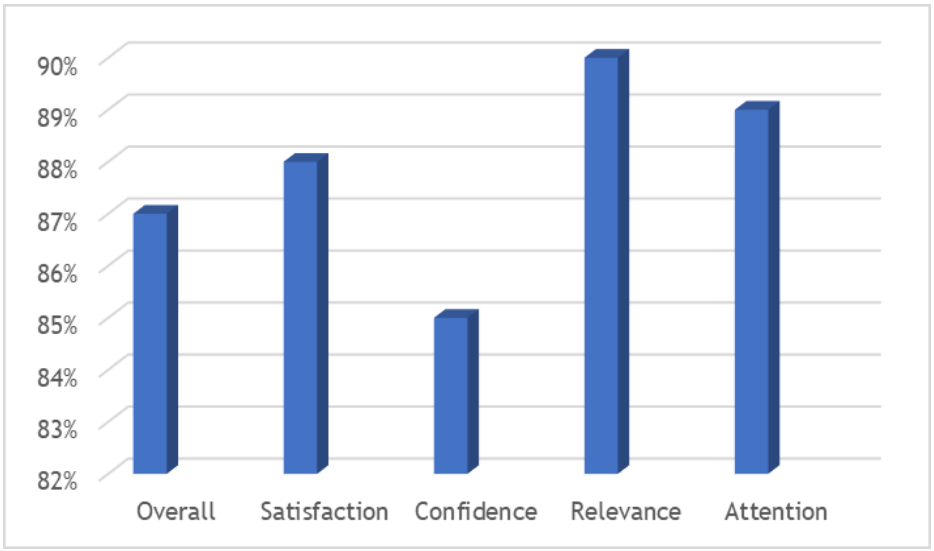

Figure 7. Students' response to EGAMERASI

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Motivation

The ARCS motivation questionnaire was given to students with a rating scale of 1-4, a higher score indicates a better level of motivation. The results of filling out the motivation questionnaire were processed to determine the level of student motivation before and after using the product. The summary of ARCS motivation scores is shown in table 4, while the percentage level of ARCS motivation after using EGAMERASI media is shown in figure 7.

Based on figure 7, students' responses to EGAMERASI on attention indicator obtained a score of 89 %, including highly motivated. The relevance indicator obtained a score of 90 %, including highly motivated. The confidence indicator obtained a score of 85 %, including highly motivated. The satisfaction indicator obtained a score of 88 %, including highly motivated. And all indicators obtained a score of 87 %, including highly motivated. Thus, both all indicators and each indicator of ARCS motivation were responded to highly motivated by students after using EGAMERAS

DISCUSSION

The trial of EGAMERASI implementation at SMPN 2 Bangkalan was supported by the school. This is proven by the researchers being given laboratory facilities and students being allowed to use EGAMERASI as shown in figure 8.

Figure 8. The atmosphere of students using EGAMERASI at computer laboratory

Cognitive ability was measured before and after using EGAMERASI. The average N-Gain score was 0,73, included in the high category. This result is reinforced by the distribution of N-Gain 7 % low, 30 % medium, and 67 % of students in the high category. This result reinforces previous research that technology can increase student motivation and make students more active in the process. So, it can make students more focused.[18] In addition, educational games can achieve learning objectives.[14]

The application of multiple representations is very important to be implemented. This is because previous research without multiple representations has the potential for students to feel stress.[22]Moreover, educational games also have the potential for students to experience conceptual ambiguity. Likewise, educational games allow for misconceptions in students.[16,42] Other studies also support this finding where the use of technology in learning, both learning management systems and games, can support students' critical thinking skills.[43,44]

The design of providing multiple representations confirms that well-designed educational games can successfully achieve the expected goals.[17,45,46] Providing multiple representations confirms previous research, being able to improve understanding of the concept of Hess's law.[26,30,47] In addition, the role of multiple representations helps the students understand abstract concepts.[48,49]

Kinematics material requires multiple representations, and becoming a guide in game development in the content has proven to be very important in designing educational games.[26,27] Various representations are very helpful for students to understand the concept of electricity.[29,50] On the same hand, previous studies reported that systematic learning designs that encourage active learning and provide continuous feedback are essential for developing thinking skills.[51] Teachers play a very important role in helping students understand so that they can represent scientific concepts.[52]

Previously, kinematics material was considered difficult process skills in kinematics material only reached a moderate level.[7] Cognitive ability only reached an average of 57,78 which was included in the low category.

[8] Through the application of EGAMERASI, there was an increase in cognitive abilities including in the effective category in the domains of knowledge (C1), understanding (C2), application (C3), and analysis (C4). While at the cognitive level of evaluation (C5) and synthesis (C6) it was included in the fairly effective category. So, the design of EGAMERASI media has contributed to optimizing students' cognitive abilities in kinematics material.

Future research needs to focus on optimizing cognitive abilities in the evaluation (C5) and synthesis (C6) domains. One step that needs to be taken is to prepare the right design.[17] Moreover, it would be better if there was a role for teachers to reflect at the end of learning after using EGAMERASI.[27]

Even though, the measurement of motivation questionnaires started with attention scores of 89 %, relevance of 90 %, confidence of 85 %, and satisfaction of 88 %, including overall 87 %. All of them were responded to by students and included in the category of making students very motivated to learn. Educational games have been proven to be able to challenge and enjoy students.[13] Moreover, it also makes students more interested in learning.[14] These results also confirm that educational games are responded to positively by students, as well as increasing interest in learning.[16,17,53,54] Educational games have been proven to influence students' interest in learning.[13,14,16,17] In line with the research results which stated that android-based educational games have been proven to increase students' interest in learning.[55,56,57]

CONCLUSIONS

Based on the research data and discussion, it can be concluded that: EGAMERASI can increase the average cognitive ability in the high category and is effective in the domains of knowledge (C1), understanding (C2), application (C3), and analysis (C4). Furthermore, at the cognitive level of evaluation (C5) and synthesis (C6), it is included in the fairly effective category and the increase in ARCS motivation obtained a score of 89 % attention, 90 % relevance, 85 % confidence, and 88 % satisfaction, including an overall of 87 %. All of them were responded to by students and were included in the category of making students very motivated to learn.

This study is limited to the number of respondents, which is only 30 students. Future research related to teacher reflection in the learning process, especially on questions at the evaluation level (C5), and the synthesis level (C6) can be conducted by other researchers. Moreover, it is also necessary to check the contribution and relationship between ARCS motivation and students' cognitive abilities.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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