



## Development of Mini Hydroponic Teaching Modules to Improve Critical Thinking Skills in Early Childhood

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### Abstract

Hydroponics is a farming activity without soil which has an important role in building critical thinking skills for young children. The role of mini hydroponics is outlined in the form of teaching modules which were developed to make it easier for teaching staff to present material to improve critical thinking skills for young children. The aim of this research is to determine the development of mini hydroponic teaching modules in improving the critical thinking skills of young children and to analyze the feasibility of mini hydroponic teaching modules. This research uses research & development methods with product development in the educational sector and uses a qualitative approach and is carried out at the Carsa Kids Tarakan Kindergarten from November 2023 to February 2024. The results of the research show that this mini hydroponic teaching module is suitable for use to improve thinking skills. critical for young children. The feasibility of this teaching module product is generated from validation scores from experts such as material experts, media experts and also language experts and critical thinking material experts. This ajat module could be an alternative material for young children to improve their critical thinking skills.

**Keywords:** *Mini Hydroponic, Critical Thinking, Learning Module, Early Childhood*



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### INTRODUCTION

Early childhood education is an educational effort intended for young children, from newborns to 6 years old, to provide intensive learning to stimulate physical and spiritual growth, thus paving the way for advanced education (Musbikin, 2012). Various studies have concluded that education for children aged 2 to 10 years is crucial for developing cognitive skills. For instance, language acquisition and skills learned from adults, as well as interactions with peers, contribute to their progress and development.

These early years serve as a foundation for their emotional and intellectual development. Although later experiences may modify this foundation, if subsequent development does not benefit from educational environments, it can result in disadvantages. The scholarly basis for the urgency of Early Childhood Education is

rooted in experts' discoveries about children's development, particularly their brain structure. Dendritic growth, synaptic relationship complexity, and neuron cell division are three aspects crucial to brain development. These aspects play a crucial role in human brain capacity development. According to Teyler, at birth, the human brain contains between 100 billion to 200 billion neurons (Taylor, Whalen, & Norris, 2023), which can develop and increase in capacity with appropriate stimulation from their surroundings. Children enter the golden age during this period, which is characterized by rapid brain development and information absorption (Ramdhani & Dea, 2021). Each child possesses unique abilities, and every individual has the potential to require nurturing and developmental programs tailored to their needs (Wahyuni & Azizah, 2020).

One such crucial ability is critical thinking, an inherent potential in every child that must be cultivated early. If left undeveloped, this talent may not reach its full potential (Apriliani et al., 2024). The appropriate method for developing critical thinking is through enjoyable learning activities such as play-based learning (Hamzah, Vega, Rahayu, MS, & Pattiasina, 2023). This approach stimulates and enhances critical thinking skills and fosters creativity appropriate for their age. Critical thinking involves rational decision-making and belief formation. Developing critical thinking skills involves providing appropriate learning methods based on children's concrete thinking stages (Ramdhani & Dea, 2021). Critical thinking abilities in early childhood differ from those of adults due to differences in knowledge structures between young children and adults. Essentially, those who can think critically can analyze their surroundings (Rositawati, 2019).

Developing creativity and critical thinking from an early age equips children to face future challenges (Ciolan, 2013). In today's globalized era, individuals must think critically to create solutions that support their lives and communities (Nadiia et al., 2022). This requires discernment rather than accepting everything indiscriminately. Hence, developing critical thinking skills, especially in early childhood, is crucial (Maftutah, Jannah, & Utama, 2021). Children's inclination toward critical thinking arises from curiosity. However, observations at TK Carsa Kids Tarakan School indicate that educators are not sufficiently engaging in activities to enhance critical thinking. This is evident in young children's lack of involvement in thinking processes, seeking, and applying knowledge in the classroom.

Furthermore, not all educators can effectively manage learning activities to enhance critical thinking in young children. Interviews with several educators at TK Carsa Kids Tarakan reveal their limited understanding of incorporating activities to improve critical thinking in teaching materials. Therefore, the author develops teaching modules to assist educators in enhancing critical thinking skills in young children through hydroponic vegetable gardening. Based on the observations, the environment plays a crucial role in providing knowledge to learners. To realize the vision of nurturing and developing critical thinking skills in young children, developing mini hydroponic teaching modules could be a solution. Hydroponics is a soilless cultivation method where plants grow in water or other porous materials like gravel or sand. Vegetables such as bok choy, lettuce, water spinach, and mustard greens can be grown using this method.

Previous studies have explored the development of teaching modules using hydroponics for early childhood education. Fauziah et al. (2021) from the University of Riau studied the development of hydroponic planting media for NFT pictorial

systems to enhance science knowledge in 5-6-year-old children at Pembina 2 Kindergarten in Pekanbaru (Fina Fauziyah, Guru Pendidikan Anak Asia Dini, & Keguruan dan Ilmu Pendidikan, 2021). Meanwhile, Sarah Jessica and Kartika Rinakit Adhe (2020) in the "EDUKIDS" journal developed the Botanica-Project learning module to stimulate fine motor skills in early childhood (Jessica & Adhe, 2020), also incorporating hydroponics. Furthermore, Novi Eka Nuryanti (2023) from the Indonesian University of Education conducted research on the development of a Project-Based Learning teaching module for hydroponic planting activities to facilitate scientific skills in early childhood (Nuryanti, 2023). Although all these studies involve using hydroponics in early childhood education, this research focuses more on developing mini hydroponic teaching modules and enhancing children's critical thinking skills, unlike the scientific skills discussed in previous studies.

Students will be taught the process from planting to harvesting in the development of these teaching modules. Therefore, the researcher aims to analyze the development of mini hydroponic teaching modules in enhancing critical thinking skills in young children with the study titled "Development of Mini Hydroponic Teaching Modules to Enhance Critical Thinking Skills in Early Childhood." This research faces simplification and stage limitations due to time and cost constraints, thus only reaching the practicality testing stage. From this problem background, the formulated problem consists of how the development of mini hydroponic teaching modules can be a solution to enhance critical thinking skills in young children, and whether the mini hydroponic teaching modules are feasible for use. The research objective is to understand the development of mini hydroponic teaching modules in enhancing critical thinking skills in young children and to analyze the feasibility of these teaching modules. The benefits of this research include theoretical benefits in expanding insights and references in Early Childhood Education related to module development and practical benefits for educators to broaden knowledge about children's critical thinking skills and for learners in developing critical thinking for their future.

## METHODOLOGY

The research method used in this study is the Research and Development (R&D) method with a qualitative approach. The R&D method is chosen to produce specific products and test their effectiveness in education, aligning with the research goal of developing mini hydroponic teaching modules to enhance critical thinking skills in young children (Sugiyono, 2010). The model development steps follow Borg & Gall's model, involving ten systematic steps (Uin, Maulana, & Banten, 2017). This research was conducted at TK Carsa Kids Tarakan, located on Mulawarman Street Gang Rahmat RT 44, Karang Anyar Village, Tarakan Barat Sub-district, Tarakan City, North Kalimantan. The research location was chosen because it represents a place that serves the target population of the study, namely young children. Data sources used in this study include quantitative and qualitative data. Quantitative data were obtained from respondents' questionnaire responses, including educators and learners. Meanwhile, qualitative data were obtained through interviews with educators, observations of the learning process, and evaluations from experts involved in product validation (Sugiyono, 2020).

The research process begins with problem identification through interviews with educators at TK Carsa Kids Tarakan, followed by data collection, product design,

design validation, product design revision, product testing, product revision, retesting, further revision, and mass production. However, this research simplified and limited stages due to time and cost constraints, only reaching the product's practicality testing stage. The data analysis technique used includes collecting quantitative and qualitative data through interviews and questionnaires. The data are then descriptively analyzed to obtain a clear picture of the responses and research results. Systematically structured validation instruments are used to measure relevant aspects of the module, such as feasibility, content clarity, acceptability, and relevance. The results of this data analysis will serve as a basis for further evaluation and revision of the developed module. Through this process, it is hoped that the mini hydroponic teaching module produced will meet educational standards, fulfill the needs of early childhood learning, and significantly (Okpatrioka, 2023)

## RESULTS AND DISCUSSION

### Mini Hydroponic Teaching Module

A module is defined as a small unit derived from a learning process that can operate and work independently. In a more detailed sense, it refers to the implementation of learning that runs smoothly without the direct presence of a teacher or educator in the classroom learning process (Yaumi, 2018). Furthermore, Tjiptany, As'ari & Muktsar (2010) define a module as a learning tool that contains materials and methods with limitations in systematically evaluating the learning process, which can draw conclusions on the learning process (Kristianto, Susetyo, Utama, Fitriyono, & Jannah, 2023).

Meanwhile, Purwanto (2018) states that a teaching module is defined as a packaged program that is already formed and established as learning material for students within their school environment. A module is a learning program studied with the assistance of a teacher or other educators who present goal planning to clearly present the learning material. Providing learning materials, equipment, media, and technology are benchmarks for the success of learners in studying the taught material (Sahronih, Purwanto, & Sumantri, 2019). The definition of a teaching module by Prastowo in Tjiptany (2016) is a systematic teaching material created to be understood by students, structured with organized languages. This teaching module must, of course, be suitable for the age and level of knowledge of the learners to facilitate easier learning. The use of modules in the teaching-learning process aims to enable students to learn independently (Saptono, Herwin, & Firmansyah, 2023). From the definitions provided by experts, it can be concluded that a teaching module is defined as an effective and efficient teaching material to assist educators in the learning phase. Modules present learning materials systematically (Utama, 2017). All information and teaching methods are carefully arranged in the teaching module. Modules serve as systematic evaluation tools for learning objectives. Modules function as learning media and also as a very effective and efficient way in the teaching and learning process in early childhood education environments (Fawzi & Dodi, 2022).

Early Childhood Education becomes education with the philosophical foundation of religion and also science capable of developing critical thinking skills of individuals. From a jurisprudential perspective, there is a correlation between legal foundations based on authority and the creation of regulations issued by the government according to Taufiq's thinking (2015). Early childhood education is defined as education provided to children aged 0 to 6 years with appropriate norms

inherent in their environment. This is relevant to culture, social norms, etiquette, and critical thinking abilities appropriate to their age (Rochanah, 2021).

Early childhood has different characteristics. In early childhood, they exhibit egocentric traits, which are a form of their growth to the next level. In addition, there is a great curiosity in the minds of children. Early childhood children have extraordinary fantasies with short attention spans and potential learning periods (Ramli, 2022). Early Childhood Education (ECE) is an educational level before primary education, which is training aimed at children from birth to 6 years old, carried out through formal, non-formal, and informal pathways. Early childhood education is religious and moral education, psychomotor, cognitive, linguistic, socio-emotional, and artistic education in accordance with the characteristics and developmental stages of early childhood age groups (Nur Tanfidiyah & Ferdian Utama, 2019). The implementation of child education has two objectives, namely: - The main objective: to shape quality Indonesian children, namely children who grow and develop according to their developmental stages, Additional objectives: to assist children in preparing for further school readiness learning. This readiness needs to be supported by a safe, enjoyable, and enjoyable learning process, as a form of utilizing mini hydroponic APE (Ramdhani & Dea, 2021).

Hydroponics is one model in developing plants in the agricultural world. By using water media and not using soil in developing a new farming system, it can overcome problems with small agricultural land. In addition, it is more environmentally friendly and plant-friendly because it utilizes water. Hydroponics is essentially agricultural activities that use water as a substitute for soil to grow plants and provide nutrients to them. The term hydroponics comes from the Latin word meaning "water works." Hydroponic techniques have many advantages, such as water saving, environmentally friendly, and more effective in maximizing space. There are several hydroponic systems that can be used, such as the Nutrient Film Technique (NFT) system, Fertigation system, Wick system, Aeroponics, and Floating Hydroponics. Hydroponic techniques can also be applied in early childhood science learning. This hydroponic activity is implemented in the learning process for early childhood.

The results of the development research of the mini hydroponic teaching module are compiled based on assessments from material experts, critical thinking experts, media experts, and language experts. The validation results from material experts indicate that this module is suitable for use in early childhood education, with average scores ranging from 3.50 to 3.60 out of a total maximum score of 4. Assessment from critical thinking material experts also confirms the suitability of the module, with an average score of around 3.40, which also falls into the "Suitable" category. Furthermore, the validation results from media experts indicate that this module can be well-received, with average scores ranging from 3.67 to 3.75. Similarly, the validation results from language experts show the suitability of the module with average scores ranging from 3.60 to 3.75. Thus, the overall validation results confirm that this mini hydroponic teaching module is suitable for improving the critical thinking abilities of early childhood.

Based on the data in the table of material expert validation results, there are assessments from 2 material experts regarding the mini hydroponic teaching module. The first material expert gave a total score of around 35 out of a maximum score of 40 from the 10 assessed indicators. With an average score of about 3.50, it falls into the

valid category and is at the "Suitable" level. Meanwhile, for the assessment from the second material expert, a total score of 36 out of the maximum score of 40 was given. From this score, an average score of 3.60 was obtained. With this score, this teaching module concludes as "Suitable" for early childhood learning materials. Based on data from the assessment of critical thinking material experts, the first expert obtained a total score of 17 out of a total of 20. And the average score obtained is 3.40. And from the total, it is interpreted as the Valid category and also at the "Suitable" level. Meanwhile, on the second expert, a total score of 17 out of the maximum score of 20 was given. And the average score obtained is 3.40. With this score, it is concluded that from the assessment of Expert 2 it falls into the "Suitable" category. Based on the data from the assessment of the first media expert, a total score of 22 out of the total maximum of 24 was obtained. With an average score of 3.67, the conclusion from the validation results of this media expert falls into the "Suitable" category. While the second expert gave the same score for the developed teaching module. A total score of 23 with an average score of 3.67 is evidence that this teaching module falls into the "Suitable" category. Based on the data from the assessment of language experts, the first expert gave a total score of 15 out of the total of 16 and with an average of 3.75. Then from this validation result, it obtained a "Suitable" score. Meanwhile, for the second expert, a score of 15 out of a total score of 16 was given. And obtained an average of 3.60. The results fall into the "Suitable" category. Thus, the overall validation results confirm that this mini hydroponic teaching module is suitable for improving the critical thinking abilities of early childhood.

### **Improving Early Childhood Critical Thinking through Mini Hydroponic Teaching Modules**

Through research results obtained from expert validation of the material, there are 10 indicators that present assessments from these material experts. For the indicator of material suitability with the competency of children's developmental achievements, validation was obtained valid from two material experts in the mini hydroponic teaching module with a score of 3 from expert 1 and a score of 4 from expert 2. This assessment is based on the content of the teaching module, which is deemed sufficient to support the competency of children's developmental achievements. Meanwhile, for teaching module material that is in line with the learning objectives, material experts give a score of 3, which means the teaching module is sufficient to develop critical thinking skills for early childhood. This teaching module about mini hydroponics contains material that aligns with the learning objectives to develop critical thinking skills for children. This score is valid and worthy to be a teaching module for early childhood.

The mini hydroponic teaching module also has a flow that is in line with the objectives of the learning process. This is evident from the validation results from expert 1, who gave a score of 4, categorized as Valid. Meanwhile, expert 2 gave a score of 3 for this indicator. The material from the developed teaching module is in line with the flow in developing critical thinking skills for children. This indicator falls into the Valid category. In addition, the mini hydroponic teaching module is also in line with the current curriculum. A score of 3 from the first material expert falls into the Valid category. Meanwhile, the second material expert gave a score of 4 for this indicator, indicating that the teaching module on mini hydroponics has material that is suitable for developing critical thinking skills for early childhood.

For the 5th indicator, which is sentences that are easy for teachers to understand, both material experts gave a score of 3. This means that the content of this teaching module is valid and worthy to be a guideline and reference in making mini hydroponics to develop critical thinking skills for early childhood. This teaching module can explain the material well and in a structured manner. Meanwhile, there is the 6th indicator, which is orientation to the learners, a score of 4 is given to this indicator, which places this teaching module in the Valid and Worthy category by 2 material experts. The pictures used in this teaching module are suitable for the plants used in mini hydroponic training in Early Childhood Education. For the indicator of encouraging children to think critically, the first material expert gave a score of 4 for this indicator. Meanwhile, the second material expert also gave a perfect score for this indicator. The theme and material in getting to know nature fall into the Valid and Worthy categories. The theme of the material is in line with the development of critical thinking skills for early childhood.

For the next indicator regarding the completeness of the introduction section, both material experts gave a score of 3. This makes the teaching module fall into the Valid and Worthy categories. The teaching module material has been adjusted to the understanding of early childhood about hydroponics and critical thinking skills. Meanwhile, the next indicators regarding the Completeness of the Content Section and the Completeness of the Conclusion Section, both material experts gave perfect scores for both indicators. This means that both indicators received a score of 4 from each material expert. Then for the validation results from critical thinking material experts, there are 5 indicators that receive assessments that fall into the valid category. The teaching module on mini hydroponics can support children by presenting attitudes that can explore objects about the hydroponic world. And this can make the critical thinking skills of children develop. A score of 3 with the Valid category is given for this indicator by expert 1. Meanwhile, the second expert also gave the same score.

Meanwhile, this teaching module can easily make children identify differences in objects used in mini hydroponics. Not only that, a brief explanation of the form and type of hydroponics can also be identified by young children. A score of 3 is given by the first critical thinking material expert for this category. Meanwhile, the second expert gave a perfect score of 4. With these two scores, the indicator obtains the status of Worthy and Valid. Children can also explain and describe in detail about mini hydroponics after reading and getting explanations from educators. This teaching module makes it easy for children to understand the concept of mini hydroponics. With this result, this indicator receives a score of 3 from both critical thinking material experts and falls into the Valid and Worthy categories.

Furthermore, children can also understand the process of making mini hydroponics. By understanding this process, of course, it can support the critical thinking skills of children. This indicator receives a score of 3 with the status of Worthy and Valid from the first expert. Similarly, the second expert also gave a score of 3. This teaching module can explain the process of mini hydroponics easily so that it can be fully understood by children. And this indicator makes the teaching module fall into the Valid category. This mini hydroponic teaching module can facilitate children in building basic skills for early childhood and also can stimulate critical thinking skills for children. This indicator receives a score that is Worthy and Valid by achieving a score of 3 from both critical thinking material experts. Then what about the media contained in this mini hydroponic teaching module? For the indicator of the suitability

of media size with the content of this teaching module, it receives a score of 4, which falls into the Valid category from the first expert. Meanwhile, the second expert gave a score of 3, which means this teaching module media can support critical thinking skills for early childhood. And it is "Worthy" enough to be used as teaching material.

The second indicator is the selection of colors for the title and contrasting background colors so that it can be seen by children quite well. This is seen from the scores given by media experts 1 and 2 to the content of images or photos in the mini hydroponic teaching module, which gives a perfect score of 4. This score means that the media in this module is valid and suitable for use, thus improving critical thinking skills for early childhood. In addition to the title, the sentence writing in the mini hydroponic teaching module is very good and well-organized. In addition, the writing of standard Indonesian spelling and grammar in this teaching material is quite good, and there are no errors in writing foreign terms to explanations of foreign terms used in the teaching module material. This is evident from the readability assessment of sentence writing, which receives a score of 3 from the first expert and falls into the Valid category. Meanwhile, the second media expert gave a perfect score of 4, which falls into the Valid and Worthy categories.

This mini hydroponic teaching module must be able to be an alternative material in the teaching and learning process. With the suitability of size and content, as well as the title colors, images, photos, backgrounds, and sentence writing that are in accordance with the standard Indonesian spelling and grammar, this teaching module can certainly be used as learning material for early childhood. And a score of 4 is given by both media experts for this indicator. This score falls into the Valid category. In addition, this teaching module can increase the motivation of educators in providing learning material to early childhood. The ability to increase teacher motivation is evident with a score of 3 from both media experts, which falls into the Valid or Worthy category. With this achievement, the mini hydroponic teaching module is very suitable for improving critical thinking skills for children. The suitability of media with learning resources receives a perfect score. The first media expert gives a score of 4 for this indicator. Similarly, the second media expert also gives a score of 4. With these two perfect scores, the teaching module for this indicator falls into the Valid and Worthy categories.

The next validation results are the results of assessments from language experts for the mini hydroponic teaching module. After writing sentences that match standard Indonesian spelling and explanations of foreign terms, the grammar used is quite easy to understand by young children who are still in the stage of recognizing language, sentences, and words. And the selection of words and grammar falls into the Valid category with a score of 4 from expert 1. Similarly, expert 2 also gives a score of 4, which falls into the Valid category. In addition to grammar, punctuation and terms used are quite supportive of the mini hydroponic teaching module. A score of 4 is given for validation results from language experts, which is evidence of how the content of this teaching module already uses punctuation and terms that are appropriate. Meanwhile, expert 2 gives a score of 3, which is lower than expert 1. However, with this score, it still obtains the Valid and Worthy status for the teaching module.

The third indicator that receives an assessment is the suitability with the development of learners. This is related to words, grammar, and terms that must be adapted to the learners. Because this teaching module is for early childhood, the use



of words, language, and terms must also adjust to the age and level of the students. And this teaching module meets the requirements by getting a score of 4 from expert 1 with the Valid and Worthy categories. Similarly, Expert 2 gives a score of 4 for the Valid and Worthy categories. In addition to grammar, words, and terms, the sentences used are also easily understood by children. So that the material content in the mini hydroponic teaching module can be conveyed well and easily understood. For this indicator, it receives a score of 4 with the status of Worthy and Valid from media expert 1. Meanwhile, expert 2 gives a score of 3 for the Accuracy of letters and pictures used in the teaching module. With both scores, it falls into the Valid and Worthy categories.

The purpose of this research is to see the extent to which the development of this mini hydroponic teaching module can be a very effective solution and also be able to provide opportunities to improve critical thinking skills for early childhood. This is certainly related to the assessment of children's involvement in the thinking process and also applying the knowledge they have learned. With the arrangement of material content, sentences, grammar, pictures or photos, and explanations, this mini hydroponic teaching module can provide critical thinking skills for early childhood. This research also presents elements of the design of mini hydroponic teaching modules that can be facilities in developing critical thinking skills for early childhood by using this mini hydroponic teaching module. Validation results from material experts, language, and media show that the mini hydroponic teaching module can be one way to improve critical thinking skills for early childhood. The design of the mini hydroponic teaching module can be an alternative learning for early childhood with designs and material content that support the teaching and learning process.

The results of this research are in line with the research conducted by Fauziah, et al., (2021) on the Development of NTF Pictorial Hydroponic Plant Media for Science Knowledge for Children Aged 5-6 Years in TK Pembina 2 Pekanbaru. The research by Fauziah, et al. (2021) found that hydroponic media supports knowledge in the field of science for children aged 5 to 6 years who are starting to understand the world of science with this method. Meanwhile, this ongoing research can get media expert validation results with a score of 18 out of a total of 20. And has an average of 3.60. From these results, it is found that mini hydroponics can improve critical thinking skills for early childhood. Meanwhile, the research by Sarah Jesika (2020) on the Development of Botanica-Project Learning Modules to Stimulate Fine Motor Skills in Early Childhood, also agrees with the research conducted. The research by Sarah Jesika (2020) states that Botanica-Project meets the standards of feasibility and effectiveness for stimulating fine motor aspects of children aged 4-5 years. Meanwhile, this research found that mini hydroponics is quite effective in improving critical thinking skills for early childhood. With the mini hydroponic teaching module media, children can get complete and comprehensive material. While the research by Novi Eka Nuryanti, (2023) regarding the Development of Project-Based Learning Teaching Modules in hydroponic planting activities to facilitate scientific skills for early childhood has findings that the educational modules designed are considered valid, practical, and effective in application. Its validity can be proven through verification results by experienced verifiers, and the effectiveness of using teaching modules can be proven through the results of two experiments and the teaching modules are worthy to be used to provide learning for early childhood.

## CONCLUSION

This research can be concluded that the mini hydroponic teaching module is worthy to be used for enhancing critical thinking skills in early childhood. Validation from experts, including subject matter experts, media experts, language experts, and critical thinking material experts, provides strong support for the suitability of this module. The scores given by the experts indicate consistency in assessing the quality of the module, with average results falling into the "Worthy" category. Therefore, this teaching module is expected to be one of the effective learning resources for early childhood, providing them with opportunities to develop critical thinking skills independently. Through this research, it is suggested that future researchers consider several aspects. First, the teaching module can be enriched with more varied content tailored to the needs of learners and their learning environments. Second, further development of the research subject is needed to be relevant to the learning objectives of early childhood. Additionally, researchers can explore the use of different research methods to obtain a more comprehensive understanding of the effectiveness of the mini hydroponic teaching module in enhancing critical thinking skills in early childhood.

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