Grooming Future Scientists and Engineers from the Root through Fun Learning Concept

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Grooming Future Scientists and Engineers from the Root through Fun Learning Concept

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Abstract. The development of the Fun Learning Toy Library is beneficial in many ways. The STEM concept Fun Learning Toy Library provides a conducive environment for pre-school children to develop their interest in science and technology at a very young age. It is hoped that with the facility in place at rural areas, these young children will be motivated to develop a deep interest in science, technology, engineering and mathematics (STEM) education for their future endeavour. This paper describes the development of Fun Learning Toy Library (FLTL) at a rural school in Kelantan, and to evaluate its impact on the preschool students especially in learning STEM. The enjoyable and fun learning concept of learning 'difficult' subjects like sciences and mathematics has also overcome the trauma effect of the natural disaster that the students face. It was reported that many of these young children lost their homes and had difficulty going to school; some for the fear of being separated from their families after their homes and village were badly hit by flood. Having the toy library in school, these children become excited and motivated to attend school every day. Additionally, analysis from the observations shows other intangible benefit of this project, which are the networking and bonding that was developed among the volunteers, partners and the local community, particularly the school teachers and students alike. The teachers' participation in the implementation of STEM activities is dynamic and promising.

1. Introduction

In the late December 2014 had witnessed the destruction of most parts of Kelantan which was badly hit by the big flood. The destruction has caused trauma to the community in Kelantan, more so to those living in the rural areas, namely Kuala Geris, Dabong in Kuala Krai District of Kelantan. The disaster has affected the livelihood of the villagers; homes, schools and all infrastructures were destroyed and damaged. A group of lecturers from Universiti Teknologi Malaysia (UTM) Kuala Lumpur teamed up and formed a social responsibility group named Adopt a Kampung to help rebuild the community in Kuala Geris.

Apart from other social work carried out in the area, Sekolah Kebangsaan Kuala Geris (SKKG) was adopted as a recipient for the rebuilding project. Based on a preliminary study, the students' attendance to school was reported to be very poor, especially among the pre-school students. It was reported that many of these young children lost their homes and had difficulty going to school; some for the fear of being separated from their families after the flood traumatic experience. Some of the students had to

travel from their houses in the palm estates by tractor-towed transport, some by small boats across the river and then on foot to school. The location of the school is shown in Figure 1.

Figure 1. Location of Sekolah Kebangsaan Kuala Geris (SKKG) from the river.

2. Education and Learning

The following are brief descriptions of early childhood education and learning, and STEM education.

2.1 Early Childhood Education: Preschools, Montessori or Kindergarten?

A Malay proverb "*Melentur buluh biarlah dari rebung*"; Ugandan and English proverbs respectively "A stick is straightened while still young" and "You cannot teach an old dog new tricks" emphasize the importance of human development from a very young age. Preschool, Montessori and Kindergarten aim to provide basic education exposure to children but according to Early Childhood Education (ECE) [1] which each has different concepts.

Preschool focuses on cognitive and social development by stimulating a child's curiosity and imagination. Children learn through play and they acquire important social skills through sharing toys, taking turns, and interacting with others. The classrooms are lively, brightly decorated with posters of the alphabet, maps, number tables and student artwork, must be interactive and stimulating to foster an exciting learning environment. Despite increasing public interest in early childhood education, preschools are usually operated as private schools.

Montessori offers "child centred" approach to education, differs from traditional methods in several major ways. The most notable feature of Montessori schools is the classroom itself, where multiple age groups learn within one environment. Children in Montessori classrooms range from age two and above, with no distinction in education levels but education simulate a real-life social environment and promote peer learning. Montessori classrooms are designed to foster independence and exploratory learning where students are given the freedom to choose what to learn and to set their own pace. The classrooms have multiple interactive spaces, each dedicated to a different academic area, such as language, arts, math and science.

Kindergartens is described as the beginning of formal education that is fully integrated into the elementary school system. Kindergarten is public education and subject to state law (therefore, kindergarten teachers must be properly licensed and certified), though it is not mandatory in every state. Children enter kindergarten during age of five to six, and many states do not begin mandating education until age seven. Though kindergarten is more formal, it still qualifies as early childhood education because students are less than eight years old. They are still developing at a rapid pace, and kindergarten is important to easing their transition into elementary school. Kindergarten focuses heavily on social development and peer-to-peer interactions, though there is greater emphasis on fundamental academics than there is in preschool. Whereas in preschool they learned the alphabet, kindergarten teaches them how to spell and string basic words into simple sentences. Kindergarten lays the groundwork for their

formal education by introducing new concepts that develop into the different academic subjects they will learn throughout the rest of their educational career.

2.2 Early Childhood Learning

During the first few years of life, a child learns a lot about themselves and the world around them, and parents are their first teachers. However, for healthy development, children need active stimulation and interaction with others. This is where; early childhood education is the most beneficial. It is in these classrooms where children have their first interactions with people outside of their family. Early childhood education focuses on "learning through play" by providing a hands-on, interactive atmosphere where children learn about themselves through playing with other children. Referring to Paul Leseman [2], preschool programs provide early childhood education and care for children and help them develop a range of skills that make them ready to learn when they start school. Such skills include (i) Social skills; (ii) Language skills; (iii) Executive function skills; (iv) Emotional self-regulation skills; and (v) Self-regulation in learning skills. In fact, the years from birth to age five are viewed as a critical period for developing the foundations for thinking, behaving and emotional well-being [3, 4].

Peter and Anthony [5] stated that play is often defined as an activity done for its own sake, characterized by means rather than end, flexibility and positive affect. These criterion contrast play with exploration, work, and games. Games with rules tend to be common for children above 6 years of age, whereas play is frequently for 2 to 6 year olds. Research repeatedly finds that play is more than just fun; it is a valuable educational tool [6]. Most experts in play research believe that a balanced approach is the best [6]. Linda et al. [3] said that academic performance increased for children who are provided with high-quality early learning.

2.3 STEM Education

Historically, the development of science, technology, engineering and mathematics (STEM) education starts after the launch of Sputnik by Soviet Union in 1957. United States developed the science curriculum and initiatives to ensure the sustainability of creation of scientists and engineers for future usage. Rapid change of business challenge and globalization especially after the World War II required the world to produce generations of scientists and engineers, who are creative and innovative. One of the methods is introducing the STEM education. The needs for STEM education become essential as the requirement of new skills and expertise to face new challenge of globalization and knowledge-based economy.

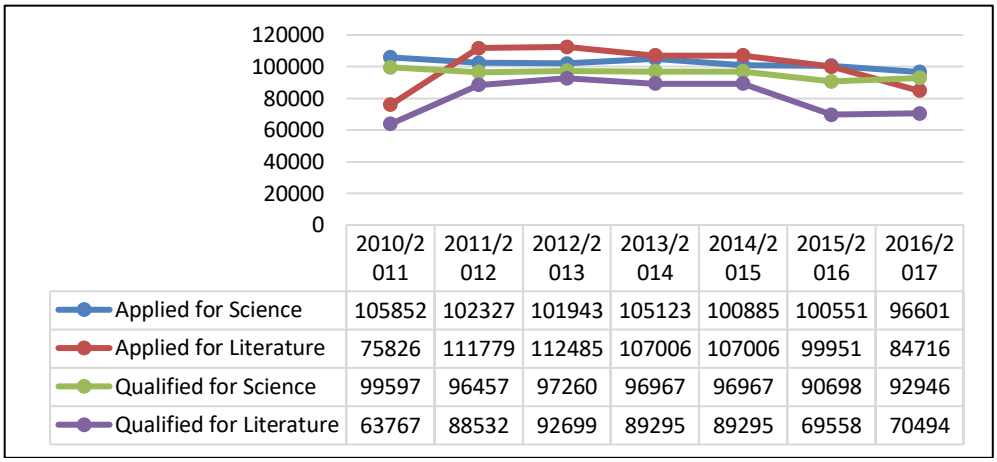
The STEM education encompasses the fields of science, technology, engineering, and mathematics. The main aim of STEM education is to produce human capital that is able to utilize interdisciplinary knowledge and an applicative approach in problem solving. It is evidenced that STEM education teaching and learning processes are able to enhance critical thinking and problem-solving skills in the learners [7, 8, 9, 10]. These skills are necessary to ensure that learners are able to think critically and creatively which will eventually stimulate their innovative thinking. By educating learners from early childhood may help them solve and create possible solutions not only in school but also later in their life.

Due to the rapid change in globalization and economy, it is very crucial for students to acquire the 21st century skills. The 21st century requires digital age literacy, which encompasses communication competency, analysing and interpretation of data, understanding and assessment of models, task management and task prioritization, involvement in problem solving, and ensuring wellbeing and safety [11,12]. The changes demand a society that are able to think outside the box and able to create their own career; and not just able to grab or choose the available and limited vacancy in the industry.

2.4 STEM Education in Malaysia: Implementation and Impact

In Malaysia, as an effort to enhance the implementation of STEM education, the government has officially used the K-12 STEM notion in education planning which is documented in the Malaysia Education Blueprint 2013-2025 (Preschool to Postsecondary Education) [13]. One of the main agendas

is to boost the element of STEM in the national school curriculum. Even with the magnitude of initiatives by the Malaysian government related to STEM education, Malaysia is still facing a deficiency of students having an interest in STEM field [14], and in industry-skilled workers. Malaysia's STEM education framework targeted 40:60 (Science to Non-Science) policies on STEM talent. However, currently Malaysia is still on 30:70 [15]. A decline interest in Science may be the contributing factor to STEM talent depletion [16, 17]. The statistic shows a decline in supply of science students; in both secondary and tertiary education levels as shown in Figure 2 and Figure 3. Similar trend is also shown for the private institute of higher learning.



	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017
Applied for Science	105852	102327	101943	105123	100885	100551	96601
Applied for Literature	75826	111779	112485	107006	107006	99951	84716
Qualified for Science	99597	96457	97260	96967	96967	90698	92946
Qualified for Literature	63767	88532	92699	89295	89295	69558	70494

Figure 2. Statistic for supply of science student in Secondary school level in Malaysia (2010-2017). (Source: Ministry of Education (MOE) [15])

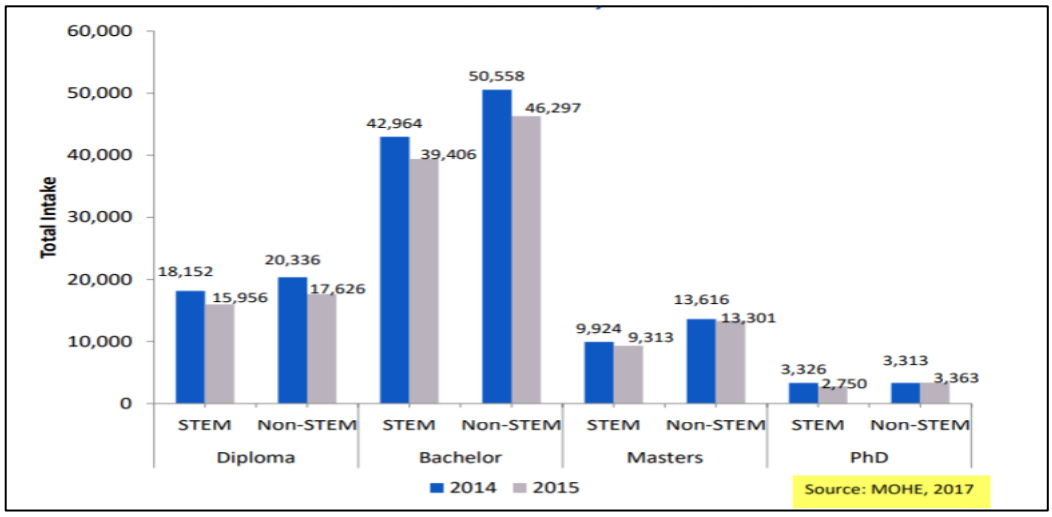


Figure 3. Statistic for total intake for Public Institute of Higher Learning (IHL) in Malaysia (2014-2015) (Source: Ministry of Higher Education (MOHE) [18]).

Early exposure to STEM education is critical to later academic achievement [7]. The blueprint also emphasizes on the "cradle to career" framework where the process starts from pre-school (cradle) to career as depicted in Figure 4. The main objectives in the childhood stage are to nurture and inspire the interest [10]. It is a very important stage to be able to trigger and foster students' interest through activities that can stimulate their curiosity. The decline of interest in STEM in secondary and tertiary

levels of education shows that there is still a gap in the early stage of the framework, which is at the preschool level.

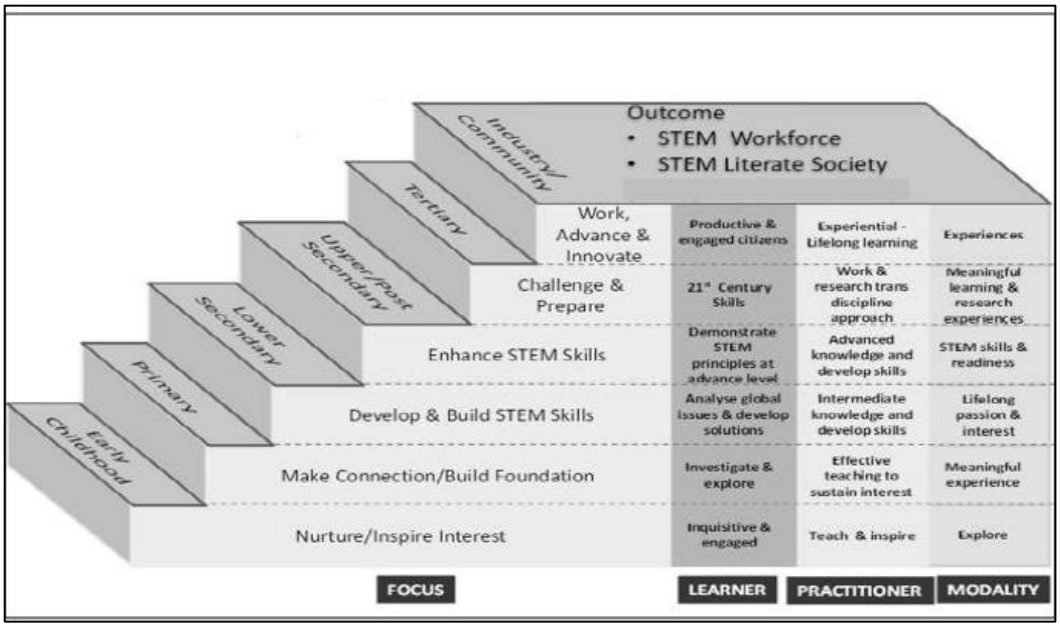


Figure 4. STEM Education Framework in Malaysia. (Source: Ministry of Education (MOHE)) [13].

Combining playing and educating for preschool children before they enter primary school through fun learning concept is what the Fun Learning Toy Library (FLTL) is developed for. The key concept that is being promoted is the STEM elements integrated with the important skills mentioned earlier for human development at a very young age. It is evidenced that STEM education is able to stimulate the interest in learners to pursue their study and have a career in STEM related fields [11, 12]. Exposing children to STEM at an early age can help instil a love for the subject and increase the likelihood for them to fill up the ever-expanding pool of STEM jobs in the future [5]; thus, grooming scientists and engineers from the root. The objectives of this paper are to elaborate on the FLTL development at a rural school in Kelantan and to evaluate its impact on the preschool students' learning of STEM.

3. Methodology

SKKG is one of 39 preschools in the area of Kuala Krai District of Kelantan [19]. SKKG has two (2) preschool classes, Class Arif and Class Bijak, with 25 students each. The students are in the ages of 5 and 6 years old. Each class has a teacher and a teacher assistant.

Figure 5 shows the operational framework of the FLTL development and implementation at SKKG where data were collected through observations, interview and document review. Analysis of the data collected elaborates the development of FLTL and shows the impact of the FLTL, expressed in terms of students' motivation, attendance, performance, and in the networking established.

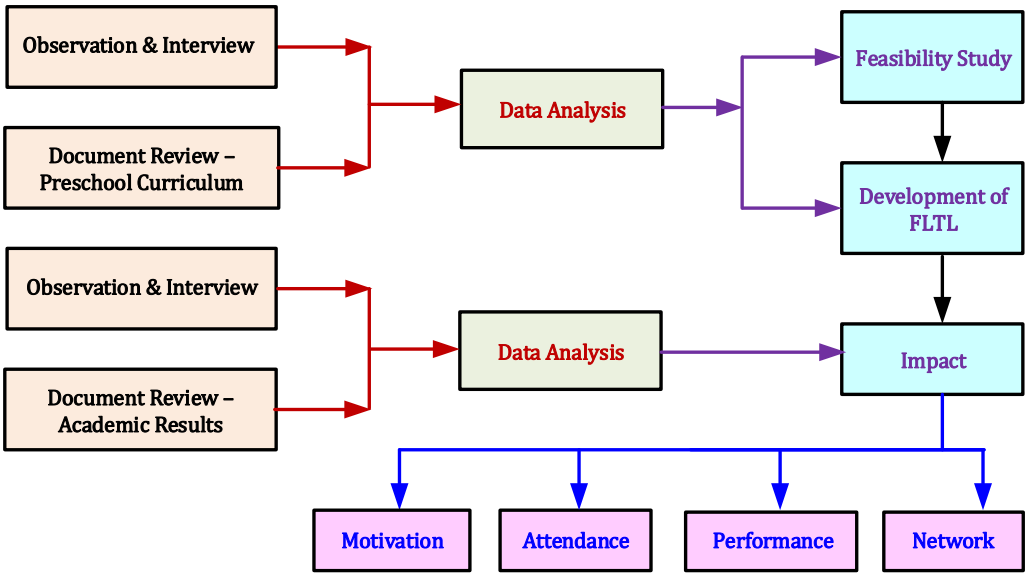


Figure 5. Operational framework of FLTL development at SKKG.

4. Development of Fun Learning Toy Library

During the first visit to the school from 7 to 8 March 2015, a feasibility study was conducted through observations and interviews. The researchers observed the environment of the classes in terms of the learning activities, available spaces and lacking facilities. Figure 6 shows the classroom environment that was observed. An interview session with the teachers and preschool students were also conducted to further understand their needs and identify the problems they face. Documents related to the syllabus were reviewed to identify the objectives, courses, programs and activities for the government-operated preschools. The documents include those published by the Ministry of Education (MOE) for preschools in Malaysia and the teaching plans prepared by class teachers.

Figure 6. Observation and interview sessions during feasibility study visit.

One of the outcomes of the feasibility studies and analysis of the documents show that the teaching and learning facilities, which include tables and chairs for the students, computer, projector, bookshelves, racks, storage and filing cabinets are lacking. Additionally, the teaching aids and books are minimal.

The other outcome is related to the syllabus, modules and content delivery. The review of documents from the Ministry of Education (MOE) shows six (6) thrusts for the pre-school curriculum. The thrusts are: i) Humanities, ii) Communication, iii) Spirituality Attitudes and Values, iv) Self-skill, v) Physical

and Aesthetic Development and vi) Science and Technology. There are nine (9) modules in the MOE syllabus, which are the Malay language, English, Islamic Education, Self-Appearance, Physical Development and Health Care, Creativity and Aesthetics, Early Science, Early Mathematics, and Humanity. Document review based on the teaching plans revealed the conventional delivery method.

Based on these analyses, five (5) themes are identified. The five themes are Science, Engineering and Technology; Mathematics; Arts, Language and Creativity; Physical, Spiritual and Wellbeing; and Multimedia. These five themes are abbreviated as STEAM (Science, Technology, Engineering, Arts and Mathematics) for the STEM education at the preschool level. Based on the STEAM themes, the teaching and learning tools and the classroom layout were developed. Toys appropriate for each theme were purchased.

The concept of FLTL is learning through play; learning while having fun; and the library concept of the toys and books. The focus is to provide toys to support the preschool students learning process of STEM. From 24 to 26 February 2015, the team went to the SKKG to set-up the FLTL. Figure 7 shows some of the team members' work-in-progress; from arranging the furniture until organizing the toys at dedicated areas according to the five themes.

Figure 7. The development of FLTL.

5. Impact of Fun Learning Toy Library

After the development and setting-up of FLTL completed, teachers are requested to carry out the implementation and help with data collection during the on-going school semesters. Observations on students' learning interest and quantitative evaluation of their performance in STEM subjects are reported to us quarterly. Additionally, an impact study visit to FLTL by the team was conducted on the 2nd August 2015. Teachers and pre-schoolers were interviewed to evaluate the impact of the FLTL on the students. The outcome from the impact study is analysed in terms of student motivation and performance, the attendance to school and networking among teachers and parents. Therefore, there are two sources of data collection for identifying the impact of FLTL: reports from the teachers and interviews carried out during the impact study visit.

5.1 Motivation, Attendance and Academic Performance

The most used communication medium with teachers is via social media. As shown in Figure 8, the teachers highlighted that students are very creative in exploring the toys. Although the teachers had to put more effort in monitoring and supervising them, the toys are a great tool that helps the teaching and learning process. The students were reported to enjoy the hands-on activities, and that over 50% of them met the practical skills objectives. The teacher also reported that attendance to school show an improvement.

Figure 8. Social Media Communication with Teachers.

The student performance was analysed in terms of their understanding of STEM subjects before and after FLTL was implemented. One example was based on a video submitted by the class teacher. Assessment on technology that produces energy was documented in the video. The video shows a group of students observing a moving object stopped when the solar panel attached to the toy was blocked. Asked about what affected the movement of the object, the students could respond that it was about energy and the source of energy is the solar. This implies that the toys in this specific example has impacted them to appreciate the application of science and technology, and understand the concepts of kinetic energy.

Certain toys can be used for more than one themes. As an example, for mathematics and science lessons, the pre-schoolers can use the shopping trolleys to buy fruits and vegetables at the toy market, where they make payments at the cashier using paper money. The teachers can teach the students how to add and subtract (Mathematics); type of fruits (Science); and the different colours of fruits (Arts). Additionally, the interaction during the role play caters for the communication skill. The fun shopping activity can be the platform for the teachers to access the students' understanding and the skills acquired.

Based on the interview data that was recorded and transcribed, the preschool students are happy to come to school, looking forward to play with the toys and not worried about being away from home to go to school. They are able to provide answers to STEM questions and expressed that the learning environment is conducive. The students also show confidence in communicating with us, being 'an outsider' to their remote community. Although the teachers are concerned with the over enthusiastic preschool students that require more attention, on the whole, the FLTL has a very positive impact on students' performance and motivations.

5.2 Networking and Bonding

The process of developing FLTL has served as a good networking platform for the researchers and the community, namely parents and the school community, and between the team and the public. The process of getting funds and donations for the FLTL from the public, other institutions and organizations has created a positive network. The funders and parents were invited as representatives attended the FLTL launching event at the school.

The parents expressed their gratitude for the opportunity for their children to have such a conducive fun learning environment. Most of them have never had the privileged to have such toys at home, unlike the children in the urban areas. Additionally, the children had never stepped out of their village, not even to the capital of Kelantan. The parents added that they are happy their children are no longer feeling fearful to go to school.

The networking and bonding between the school children, teachers and UTM team extended to another level when the group from SKKG came to visit Kuala Lumpur. They managed to collect some contributions and sponsorship to make their way to Universiti Teknologi Malaysia (UTM) Kuala Lumpur (KL) from 3 to 5 November 2015. UTM sponsored their accommodation at the hostel, some meals and transport while they are in Kuala Lumpur. Educational visits and activities were also arranged. Bearing in mind that most of the students had never gone out of their village, the visit had a great impact on the students. The exposure to technology and development gave them a lifetime experience. The effect of these experiences and FLTL on their further education and career choices will be investigated in future follow-up visits.

6. Conclusion

The project is in line with the national agenda, strategies and education plan to increase the number of human resources in science, technology, engineering and mathematics (STEM). The impact of FLTL to the students and teachers were seen immediately upon completion of the installation. The analysis of data collected show that students were motivated to attend school, and had overcome their fear to be separated temporarily from their families during school hours. The FLTL has also successfully created students' awareness in the everyday life applications of science, technology and math. The concept of fun learning environment that the FLTL provides has contributed to the success of this project. Additionally, the teachers' motivation and commitment to use the toys creatively in delivering lessons are seen as added values to the outcomes of the project.

Thus, this project of developing and implementing the Fun Learning Toy Library seems to fill in the gap of the national aspiration. By inculcating motivation and interest in STEM education at the pre-school level, it is hoped that these students will be embarking into STEM for their future endeavour. The long-term benefit of the FLTL implementation at preschool level is grooming future scientists and engineers from the root.

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