



# Ethnoscience in Pacu Jalur Kuantan Riau: Exploring Local Cultural Traditions as a Context of Teaching Physics in School

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**Abstract.** The cultural traditions of a community group are usually attached to the life of that community. Most of the cultural traditions can be explained scientifically. The *Pacu Jalur* tradition is a famous long boat race event on the Kuantan River in Riau, Indonesia, and is held every year. This long boat or *Jalur* boat is unique because it is made of a long tree that can accommodate 40 to 60 boat crew. To reach the race, several stages of boat preparation have become a tradition in Rantau Kuantan community. In this paper, we report the results of our exploration of the potential of science in the *Pacu Jalur* tradition based on a survey study that we have conducted. In-depth interviews with cultural practitioner and boatmen, as well as direct observations of *Jalur* boats and *Pacu Jalur* race events in the Kuantan River area, are the stages of the research that we have gone through. Our exploration results show that the cultural tradition of *Pacu Jalur* has great ethnoscience potential that can be utilized as a context for teaching physics in schools. The potential for ethnoscience lies in the traditions of selecting and cutting down the suitable tree for *Jalur* boat, making the *Jalur* boat, *Melayur Jalur*, *Maelo Jalur*, *Jalur Turun Mandi*, and the *Pacu Jalur* race itself. The content of science especially physics in this tradition includes kinematics and dynamics of straight motion, rotational dynamics, heat and heat transfer, and static and dynamic fluids.

**Keywords:** Ethnoscience, *Pacu Jalur* Tradition, Riau Culture, Science Context, Physics Learning.

## 1 Introduction

In science teaching, the teacher should start learning from a context that is close to the students' lives and apply the physics concepts found in that context. Teaching with a contextual approach like this will connect content with the daily experiences of students. If students can explain natural phenomena from a scientific perspective, then students will find learning science useful [1, 2]. Many things can be used as the context for teaching physics, starting from objects or events in the student's home environment, events in the area where students live, to natural phenomena that are observed directly or observed through mass media such as television and or the internet.

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However, the teacher must choose a context that is relevant to the physics content that students will learn and adapt it to the characteristics of students according to their age [1].

One of the things that teachers rarely integrate into their teaching is their local cultural traditions. Local cultural traditions in general have the potential to be used as interesting teaching contexts. The elements of science contained in the cultural traditions of society are known as ethnoscience [3]. Ethnoscience can be defined as a collection of knowledge possessed by the community which is obtained using methods and procedures that are part of the community's traditions and have been tested for truth [4]. By implementing this ethnoscience-based learning, it can improve students' scientific abilities, because in essence learning will be meaningful if the material being studied is coherent with what students find in their environment such as culture traditions [5].

In Indonesia recently, there have been many studies exploring the potential of local cultural traditions to be used as a context for teaching science in general, for example, research about the development of student worksheets integrated with ethnoscience is useful for increasing thinking skills of students and can help students be actively involved in the learning process [6]. In addition, research conducted by Suprpto [7] also states that ethnic culture-based learning will encourage students to make direct observations so that students can identify scientific questions, explain phenomena, and make conclusions about the problems encountered. Apart from being able to explore the potential of science in local cultural traditions, making learning based on culture and local wisdom can help preserve the wealth of the archipelago that has existed for generations [7].

*Pacu Jalur* is an original tradition of the Rantau Kuantan people of Riau, Indonesia, who inhabit the area around the Kuantan River. The Kuantan River is the name of the local community on the upper reaches of the Indragiri River on Sumatera Island, Indonesia. The *Pacu Jalur* tradition existed around 1900, and this tradition began with a large canoe rowing race as an expression of happiness for the people of Rantau Kuantan after harvesting their agricultural produce [8]. Gradually the tradition developed into a long boat rowing competition loaded by 40 to 60 boat crews. Until now, the *Pacu Jalur* tradition has become a local event and an annual national event which is very popular with the people of Kuantan Singingi and the people of Riau in general. Tens of thousands of people packed the left and right banks of the Kuantan River as natural stands along about 1 km in Tepian Narosa, Teluk Kuantan City, Riau, Indonesia, to watch the national race event *Pacu Jalur*. Prior to the national event, there were district level events as warm-up competitions in several places in Rantau Kuantan, such as Lubuk Jambi, Gunung Toar, Pangean, and Baserah.

The *Pacu Jalur* Kuantan tradition is not only in the form of a traditional long boat rowing competition but also in the cultural tradition of the process of making the long boat. Starting from the *Banjar* meeting, choose and cut down suitable wooden tree, building the boats and the *Melayur Jalur* tradition, the *Maelo Jalur* tradition, the *Jalur* down-bath tradition, to the *Pacu Jalur* race tradition. It takes a lot of community members to prepare the boats to take part in *Pacu Jalur* racing competitions. The *Jalur* boat itself is a symbol of pride for a village in Rantau Kuantan, so every village

has at least one *Jalur* boat. Outside of the *Pacu Jalur* event, the boats are stored and properly cared for ahead of the following year's event [9].

Seeing how popular *Pacu Jalur* is in the Rantau Kuantan community, the researchers in this study intend to explore the potential of ethnoscience in this tradition. The research questions that will be answered through this study are about the potential of ethnoscience in the *Pacu Jalur* traditions and the prospect of *Pacu Jalur* as a context of teaching physics in schools?

## 2 Methods

This research is a qualitative study of the potential of ethnoscience in the *Pacu Jalur* Kuantan Tradition of Riau, Indonesia. Methods of in-depth interviews with Riau Malay cultural figures who are experts in the *Pacu Jalur* tradition were carried-out to obtain deep-information about *Pacu Jalur* from a cultural aspect. The information we will obtain through this stage includes the history of the *Pacu Jalur* tradition, the stages of *Pacu Jalur*, and the importance of the *Pacu Jalur* tradition for the people of Rantau Kuantan, Riau Indonesia. However, in this paper, we only report on the *Pacu Jalur* tradition which is related to aspects of science and technology.

We also conducted in-depth interviews with boat-building experts in Rantau Kuantan to gain information on *Jalur* boat-building techniques. The information we will obtain from this stage includes techniques for selecting appropriate tree trunks, techniques for felling trees, techniques for making boat bodies, techniques for pulling boats from the forest to the village or known as *Maelo Jalur* tradition, techniques for heating *Jalur* boats or known as *Melayur Jalur* tradition, and techniques for finishing boats. Apart from interviews, we also made direct field observations to obtain information about the *Jalur* boat and the *Pacu Jalur* race. Observations have been made on Gunung Toar, Lubuk Jambi, and Pangean, Kuantan Singingi Regency, Riau Province of Indonesia. The information we will obtain from this stage includes the process of making a *Jalur* boat, the process of warming up a new *Jalur* boat, the parts of a *Jalur* boat and their functions, and the technique of the *Pacu Jalur* race.

In obtaining the necessary qualitative data, the instruments used in this study were interview protocols for the *Pacu Jalur* tradition and making boat process, observation sheets for the *Jalur* boat, and the *Pacu Jalur* race. In addition, we also reviewed the literature relevant to the *Pacu Jalur* Kuantan, Riau.

## 3 Results and Discussion

Based on in-depth interviews with experts on the *Pacu Jalur* cultural tradition and the *Jalur* boatmen, observations of the *Jalur* boat and the *Pacu Jalur* race, as well as a review of references to the *Pacu Jalur* and the science (physics) curricula for junior and senior high schools, findings regarding the perspective of science in the *Pacu Jalur* tradition were obtained. We have identified several activities in the *Pacu Jalur* tradition that have more dominant and relevant science (physics) content so that they are seen as appropriate as a context for teaching physics in schools. These traditional activities include: selecting a suitable tree in the forest, cutting down the tree, making

a new *Jalur* boat, the *Melayur Jalur* tradition, the *Maelo Jalur* tradition, the tradition of lowering the new *Jalur* boat to the river for the first time, and the *Pacu Jalur* race tradition itself.

### 3.1 Ethnoscience in Selecting and Felling Trees for *Jalur* Boat

One of the uniqueness of the *Jalur* boat is its long size and made from a single tree. In accordance with the tradition of the *Pacu Jalur* Kuantan, the boat will be occupied by many boat crews. Therefore, consideration is needed in choosing the wood as a *Jalur* boat. The local wisdom of the Rantau Kuantan people has determined the appropriate type of wood. In this case, the local wisdom of Rantau Kuantan community in selecting the right wood for the *Jalur* boat can be explained scientifically. There is a traditional procession in selecting and cutting down wooden trees to make *Jalur* boat. However, in this paper, we only discuss aspects of science. The potentials of ethnoscience in the tradition of selecting and cutting down a tree for *Jalur* boat are shown in Table 1.

**Table 1.** Ethnoscience in selecting and felling trees for *Jalur* boat

Stages in Pacu <i>Jalur</i> Tradition	Activity	Physics concepts	Suitable for	
			JHS	SHS
Selecting tree	Meranti-Merantian ( <i>Dipterocarpaceae</i> ) wood was chosen by community as a <i>Jalur</i> boat wood	Mass density		
		Bouyancy	√	√
Cutting down trees	The logger makes an incision on only one side first to direct a fallen tree in a certain direction	Force		
		Torque		
		Center of gravity		√

(JHS: Junior High School, SHS: Senior High School)

A *Jalur* boat has a payload of 40-60 crew members. Each row of seats is occupied by two crew members. At the front of the boat (prow), there is a place for *Tukang Tari* (a boat dancer) to stand or sit. At the rear of the boat, there is a place for the *Tukang Onjai* (pressure builders) to stand. Meanwhile, most of the *Jalur* boat crews were rowers. To accommodate many crew members, the boat must be long. *Jalur* boats can be about 25–30 meters long by about 1.25 meters wide [8]. According to tradition, boats must be made from a single tree, they cannot be made continuously. Therefore, we need a tree with a net length of about 32 m before the branches and a diameter of about 1-1.5 meters (interview with Hamidy on May 28, 2022; Syofyan Suri on July 5, 2022).

Besides size, the type of wood is a requirement for a *Jalur* boat. The family of *Dipterocarpaceae* or *Meranti-merantian* (local term) wood is generally used by the Kuantan people in making the *Jalur* boat. To get wood for this, the committee looked for it in the forest that still exists in the Kuantan area. Next, the appropriate tree was felled with modern equipment. The dominant scientific contents in selecting and cutting down the tree include mass density and buoyancy force because wood must be able to float; torque and center of gravity, because this quantity will determine the direction the tree falls. This science content is relevant to the curricula of both levels

of education, except for torque and center of gravity which is only relevant for high school.

### 3.2 Ethnoscience in Making and *Melayur Jalur* Tradition

After the tree is cut, the tree is then cut according to needs. The next step is to make a rough body of the *Jalur* boat. Making a rough boat body can be done in two places, namely in the forest, around fallen trees, or the boat is made in the village. The advantage of making a rough boat body in the forest is that it will be lighter to pull the boat body towards the village compared to the intact wood. The technique of making a *Jalur* boat is very important to ensure that the boat has good performance when on the surface of the river water and when the boat is being driven.

An important stage after making the rough boat body is to heat the long boat on a fireplace for several hours. This stage has become a tradition known as *Melayur Jalur*. In this paper we do not describe the customary processes in the *Melayur Jalur* tradition, but we only discuss the scientific aspects in that tradition.

The scientific perspectives in making and heating *Jalur* boat and their relevance are shown in Table 2.

**Table 2.** Ethnoscience in Making and *Melayur Jalur* Tradition

<i>Stages in Pacu Jalur</i> Tradition	Activity	Physics concepts	Suitable for	
			JHS	SHS
Making long boat	One surface of the wood is made flat and dredged to make the boat's belly cavity	Mass density	√	√
		Simple machines		
<i>Melayur Jalur</i> (Heat up the boat)	The boat is put on the hearth a few hours	Bouyancy Force	√	√
		Heat transfer		
	Liquid expansion and evaporation			
	Mass density			
The boatmen drilled many small holes in the walls of the boats	Widen the boat wall openings	Thickness measurement	√	√
		Solid expansion		
		Force and energy	√	√
		Mass density		

(JHS: Junior High School, SHS: Senior High School)

Before the boat is heated, the *Jalur* boat that has just been formed is placed on a hearth which is generally made from old coconut trunks as shown in Fig. 1.



**Fig. 1.** The new boat is ready to be heated (in the *Melayur Jalur* procession)

Apart from preparing the fireplace, this stage also prepared the special equipment to widen the distance between the two walls of the *Jalur* boat which was initially still in a closed state. The widening process of the boat is important to ensure the crew can occupy the boat.

In the tradition of the Rantau Kuantan Malay community, the *Melayur Jalur* procession is carried out at night, but nowadays this activity is carried out during the day because the heating process of this new long boat requires precision and hard work. Among the work that requires precision is ensuring that all the bodies of the *Jalur* boats are subjected to the same heat, ensuring that the two walls of the expanded boat form a symmetrical cavity. In this tradition, the boat is heated over a large fireplace for about 5 hours [8], [9].

In science, this traditional activity has several purposes. As a result of heating, the previously closed belly of the boat can be widened. Besides that, this heating also aims to dry (as an oven) the boat body so that the line boat becomes lighter. Another benefit of heating up a boat is that it makes the boat last longer.

In this Malay tradition, the dominant and relevant physics content as a context for teaching physics in schools includes heat and heat transfer, both in the form of convection, conduction, and radiation. Solid and liquid expansion occurs in the boat as a result of the applied heat. Expansion of the boat's wood causes the boat's cavity to be relatively easier to expand. Meanwhile, the expansion of the liquid in the wood of the boat causes the liquid to evaporate easily. The impact of boat heating is on mass density and buoyancy-force. Widening the cavity of a boat in principle is to increase the volume of air in the cavity of the boat which results in reducing mass density or increasing buoyancy. In addition, the concept of force and energy is needed in widen the opening of the boat's belly. All science content in this process is suitable for junior and senior high school education levels.

### 3.3 Ethnoscience in *Maelo Jalur* and *Jalur Turun Mandi* Tradition

Meanwhile, the scientific perspective on the tradition of pulling the *Jalur* boat from the forest to the village or known as the *Melayur Jalur* tradition is shown in Table 3. Table 3 also shows the scientific perspective on the tradition of *Jalur Turun Mandi*.

**Table 3.** Ethnoscience in the *Maelo Jalur* and *Jalur Turun Mandi* Tradition

Stages in <i>Pacu Jalur</i> Tradition	Activity	Physics concepts	Suitable for	
			J	S
			HS	HS
<i>Maelo Jalur</i> (Pull the new long boat to the village)	Arrange small logs on the ground as ball bearings to reduce friction	Friction and how to reduce it	√	√
	It takes a lot of people to pull a <i>Jalur</i> boat from the forest to the village	Newton's second law Resultant of Force	√	√
<i>Jalur Turun Mandi</i> (Put the boat into the river for the first time)	Lowering the <i>Jalur</i> boat to the river by lifting the boat together	Gravity Resultant of force	√	√
	Test the new boat's ability to float by loading a crew of 40-60 people	Archimedes' Law Mass density of boat + crew Mass density of river water	√	√
	Test the speed of the new boat	Kinematic and dynamic of straight motion	√	√

(JHS: Junior High School, SHS: Senior High School)

*Maelo Jalur* is a tradition carried out by residents of a village who own the new *Jalur* boat in pulling a (semi-finished) boat from the forest to the village. The *Maelo Jalur* tradition involves many villagers as boat owners for the route. Some of them were in charge of pulling the boat manually using ropes and some of them watched while encouraging. Physics content in this tradition includes the resultant of force, Newton's Laws of motion, friction, and how to reduce friction between objects and the floor. In recent years, *Maelo Jalur* is no longer carried out because track logs that have been cut to size are brought directly to the village using heavy equipment and heavy vehicles. Even so, the *Maelo* tradition is still carried out symbolically ahead of the *Pacu Jalur* event.

When the line boat is in the village, the work continues until it is finished. Then the boat was lowered into the river for the first time. This tradition is known as *Jalur Turun Mandi* or *Jalur* boat take a bath. In this tradition, a trial run is carried out known as *Godok* competition [8]. *Godok* is the name of a kind of local food made from banana or cassava which is eaten together after the boat trial competition. The content of physics in this tradition is related to gravitational forces, Archimedes' Law, mass density, kinematics, and dynamics of straight motion. All content is relevant to the science (physics) curriculum in junior and senior high schools.

### 3.4 Ethnoscience in *Pacu Jalur* Race Tradition

The end of the *Pacu Jalur* tradition is the *Pacu Jalur* race itself. There are several types of *Pacu Jalur* events in Rantau Kuantan which are held every year. Several warm-up *Pacu Jalur* race events (before the national event) were held in several districts in Rantau Kuantan. The national *Pacu Jalur* event is the culmination of a long boat rowing competition that is centered on the *Tepian Narosa*, in Teluk Kuantan city of Riau Province, Indonesia. Every *Pacu Jalur* event is always watched by thousands to tens of thousands of spectators who crowd the natural tribune on the banks of the river for about 1 km according to the length of the runway. The scientific perspective in this popular event is shown in Table 4.

**Table 4.** Ethnoscience in the *Pacu Jalur* race tradition

<i>Stages in Pacu Jalur</i> Tradition	Activity	Physics concepts	Suitable for	
			JHS	SHS
<i>Pacu Jalur</i> race	Row the boat at full power	Newton's Law Force, power, and energy	√	√
	The boat crew rowed compactly to get great acceleration	Resultan of force Straight motion Newton's second Law	√	√
	The <i>onjay</i> handyman gives rhythm to the boat	Water Friction Pressure	√	√
	A boat dancer sitting or standing with arms outstretched cheers the team	Center of gravity Balance of rigid body	-	√
	The helmsmen determine the direction of the boat using boat rower	Moment of force (torque)	-	√
	One race session is only followed by 2 boats	Bernoulli's principle (Fluid dynamics)	-	√

(JHS: Junior High School, SHS: Senior High School)

Spurring a *Jalur* boat requires muscle strength and proper rowing technique. The cohesiveness of the boat crew is important for the speed of the rowed boat. According to the *Pacu Jalur* Kuantan tradition, the crew of the boat consists of a *Tukang Tari* (boat dancer) who stands or squats at the bow of the boat, followed by two *Tukang Concang* (two persons in charge as oarsmen commando), a large number of oarsmen, a *Tukang Timbo Ruang* (a person in charge of removing the water that enters the boat), two rudders, and a *Tukang Onjai* (a person in charge of giving rhythmic to the boat). The naming corresponds to the roles of each boat crew (interview: UU. Hamidy, an expert of *Pacu Jalur*, 28 May 2022). The district-level longboat competition situation is shown in Fig. 2.





**Fig. 2.** Jalur boat competition (*Pacu Jalur*) at district level on the Kuantan River

Even though there are a quite number of long boats that will take part in the race, due to technical considerations such as the condition of the river that is not straight, the water current is uneven, the depth of the river is not the same, and other factors that can be detrimental to the *Jalur* boats that are competing, each race session is only may be followed by two *Jalur* boats with a knockout system [9]. The physics content, in this case, is for example Bernoulli's principle. In physics, if several boats are close together while speeding, then the fluid pressure between the boats becomes smaller, which has the potential to cause the boats approach each other. This will disrupt the running of the race.

In the *Pacu Jalur* event, there is quite a lot of scientific content. The prominent science content starts from mass density and Archimedes' law, kinematics, Newton's laws, force, power, energy, friction, the center of mass, and balance of rigid body, to Bernoulli's principle. This physics concept works on all *Pacu Jalur* activities, in addition to the spirit of the racers and the cheers of the audience. The energy and muscle strength of the rowers, the similarity of rowing pressure on the water, the rhythmic movements of the *Tukang Onjay*, and the aerodynamics body of the boat are scientific factors that determine the speed of the boat.

If studied in more detail, then all aspects can be studied scientifically including the bodies of the line boat crew. This physics content is very relevant to the science teaching curriculum in junior and senior high schools, except for some physics concepts such as the center of gravity, torque, and balance of the rigid body. Research conducted by [7] states that the local wisdom of the local community is a good science learning object. However, so far ethnoscience has not been optimized by teachers in teaching science. This problem is caused by many things, one of which is the teacher's weak ability to explain natural phenomena [10]. Building students' scientific literacy cannot be separated from context [11]. Research results showed that, even though the *Pacu Jalur* race competitions are watched by tens of thousands of people, including school students, unfortunately, the students still have difficulty identifying

and explaining the scientific aspects of this *Pacu Jalur* race tradition [12]. The researchers suggest that school science teachers in the Rantau Kuantan area use the *Pacu Jalur* tradition as an interesting context for science learning, especially in physics lessons [12].

## 4 Conclusion

*Pacu Jalur* is not just a tradition of long boat rowing competitions. Each stage of this long boat building is a unique cultural tradition in the Kuantan community of Riau, Indonesia. Because this tradition develops in accordance with the development of local wisdom in society, science, especially physics, takes a lot of roles in each of these processes. The ethnoscience potential in the *Pacu Jalur* tradition is quite large, starting from selecting and cutting down trees for the long boat, making and heating the boat (*Melayur Jalur* tradition), pulling the Jalur boat towards the village (*Maelo Jalur* tradition), lowering the new boat into the river (the *Jalur Turun Mandi* tradition), the form of the arrangement of the boat crew according to tradition, up to the tradition of the *Pacu Jalur* race itself. Physics concepts that are relevant and dominant in this tradition include kinematics and dynamics of straight motion, rotational dynamics, heat transfer, and static and dynamic fluids. The physics content contained in the *Pacu Jalur* tradition is seen as relevant to the content of physics lessons in schools, both for the junior and senior high school levels. The depth and breadth of physics content associated with the *Pacu Jalur* tradition are adjusted to the level of education.

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