

# Constructive learning through experiments utilization of pandan leaf fiber as a strengthening of composite material

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**Abstract.** This research was aimed at examining constructivist learning through experiments examining the feasibility of pandan leaf fibers as reinforcement of composite materials. The method used in the study was an experiment, namely conducting an experimental activity of the tensile strength of pandan leaf fibers compared to glass fiber, to obtain new knowledge as an alternative material for reinforcing composite materials. In this case, the pandan leaves studied were taken from the Kepuharjo area of Cangkringan Sleman DIY. Data analysis techniques used were qualitative descriptive, and quantitative descriptive. The results of this research indicated that; (1) constructivist methods were feasible as alternative paradigms for learning science and technology built through the Input-Process-Output pattern; (2) tensile fiber strength was 1.5 times the tensile strength of glass fiber. The tensile strength of pandan fiber was 39,036 kg / mm<sup>2</sup> while the tensile strength of glass fiber was 21,65 kg / mm<sup>2</sup>; (3) the tensile strength of natural composites was lower than synthetic composites. Natural composite tensile strength was 3.03 kg / mm<sup>2</sup> while tensile strength of synthetic composite was 3.77 kg / mm<sup>2</sup>; (4) the increase in formalin concentration for pandan fiber immersion media in the range 0 - 35% had an effect on decreasing tensile strength with the equation  $y = -640.05x^3 + 285,12x^2 - 36,358x + 39,105$  and  $R^2 = 0.9641$ . In conclusion, fiber from pandan leaves is suitable to be used as a composite material, but a suitable matrix and suitable treatment have not been found.

## 1. Introduction

The rapid development of technology occurs in the era of the industrial revolution 4.0 which aims to help humans meet their daily needs more efficiently and comfortably. Such rapid technological progress cannot be separated from the technical development of materials indicated by the discovery of composite technology. This technology has produced a revolution in the event of material technology so that obtained properties of an excellent material that is not owned by conventional materials before.

Composite is an alternative metal replacement material that has several beneficial properties, including having a high corrosion resistance, a small weight to strength ratio, lightweight, high strength, strength related to weight, high impact strength, design flexibility, part consolidation, dimensions stability, nonmagnetic, transparent radar, low thermal conductivity, durable and more comfortable manufacturing control [1]. The composite structure is composed of two kinds of components, namely reinforcement, and reinforcement (matrix). The reinforcing material in the composite material can be classified into two according to [2], namely in the form of fiber (fiber) and the structure of particles. Fiber can be distinguished between continuous fibers (continuous) and fibers that are discontinuous (discontinuous), based on its origin fiber can be derived from natural and artificial fibers (synthetic).

In general, the strength of natural fibers (natural fibers) is not as good as the strength of synthetic fibers, but natural fibers have some advantages not possessed by synthetic fibers. This is interesting to



develop, considering that in Indonesia there are many types of fibrous plants that are potential to be developed to replace synthetic fibers which have been used more for making composites.

Pandan leaves are available quite a lot in Indonesia, the addition of pandan leaf fibers in a concrete mortar can add concrete flexural strength of 18.01% -16.51% [3]. Pandan leaf fiber can be used as a textile material because it has 46% crystallization, thermal stability up to 270 °, cellulose content 44%, and excellent tensile strength [4]. Based on preliminary studies of pandan leaf fiber, it is feasible to study the possibility to be used as a composite reinforcing material from natural fiber types. This will be a new study material as a medium for developing appropriate technology, especially for students to explore and develop the scientific fields they have learned. Meanwhile, at the same time, it is also necessary to study the use of appropriate learning methods for students in building their knowledge. Learning will occur if there is a change in someone as desired. Changes according to the philosophical approach will occur, if someone constructs what they experience. This change can change existing constructs or improve existing constructs. This construct occurs from several schemes, according to Piaget. Therefore, the construct of an object seen or experienced from one person to another can be different.

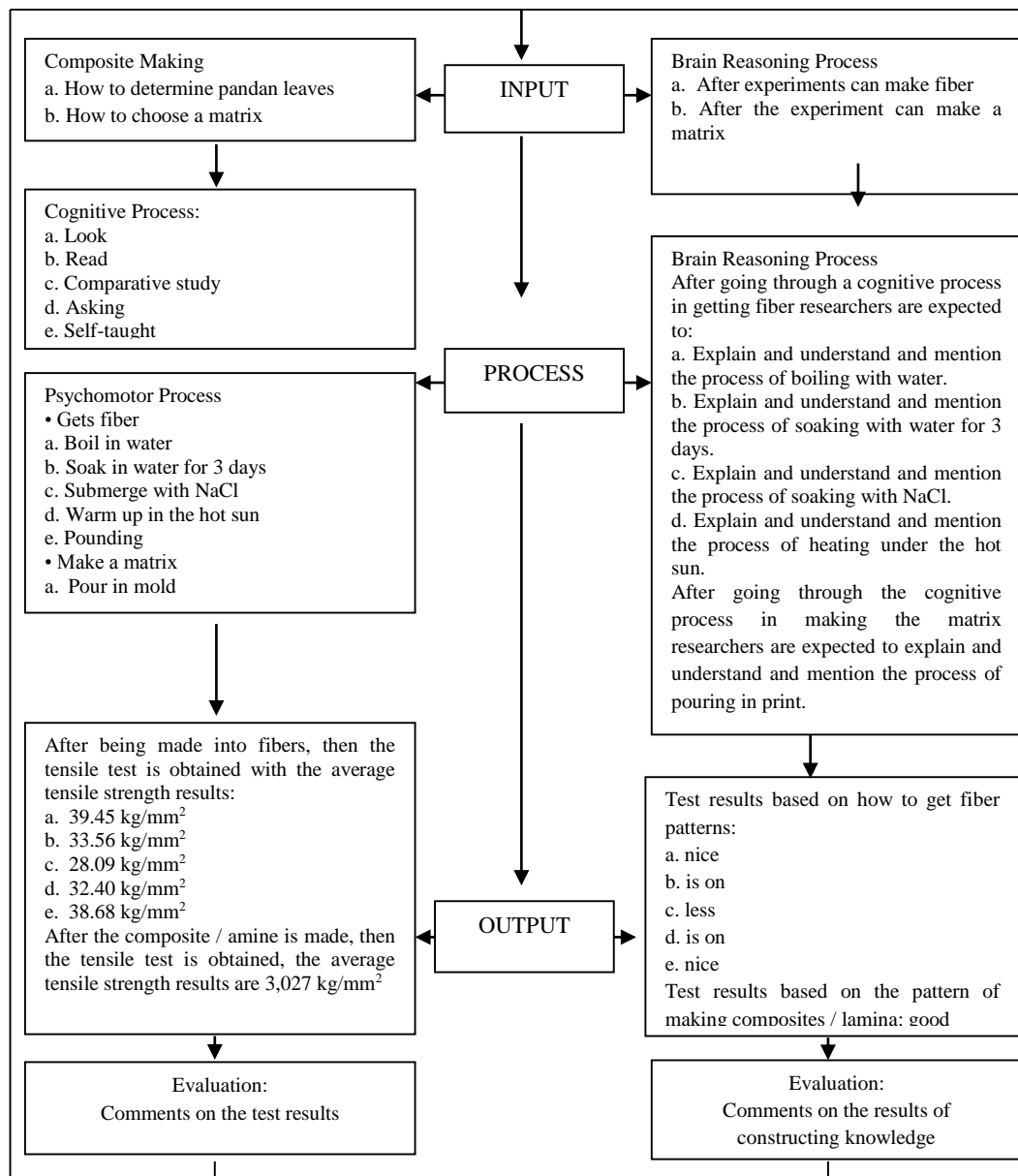
One method of learning that is the crucial word in almost every discussion about learning in various circles is constructivist. Constructivism arises based on the flow of constructivism, which is one of the philosophies of knowledge that emphasizes that knowledge is the product of its construction [5]. In constructivism, it accommodates calls and trends that arise in the world of learning such as the need for students to actively participate in the learning process, the need for students to develop independent learning abilities, the need for students to have the ability to develop their abilities, and the need for teachers or lecturers to play roles as facilitators, mediators and managers of learning process.

The application of constructivist learning methods is starting to be relevant to the demands of the 21<sup>st</sup> century that require learning not only to emphasize mastery of the material taught but rather to emphasize internalization of what is learned embedded and function as a change in life. This learning method also emphasizes how students can learn how to learn (learning how to learn). Constructivist learning places more educators as facilitators who manage to learn and create a climate that allows students to construct their knowledge [6].

The basic principle of constructivism is that in the learning process, it is the students who must actively construct their knowledge so that learner-centered learning can be widely accepted by the education community [7]. Thus in the learning process, instructors are required to appreciate the critical way of thinking of students in gaining knowledge and giving students space to express ideas, ideas, and interpretations of what they learn. The teacher's task is to create a pleasant, conducive climate for learning towards meaningful learning.

Constructivism is the basis for various appeals and trends that arise in the world of learning such as the need for students to actively participate in the learning process, the need for students to develop independent learning abilities, the need for students to have the ability to develop their abilities through their ideas, learning is social and rooted in a way culture, and the need for instructors or lecturers to play the role of facilitators, mediators and managers of the learning process [8]. In order for students to be able to construct knowledge, it is needed [9]:

1. Student's ability to recall and express experiences. This ability is essential because the experience is formed based on the interaction of individual students with these experiences.
2. The ability of students to compare and make decisions about the similarities and differences of things. The ability to compare is essential so that students can draw on the more general (close) nature of unique experiences and see their similarities and differences to classify and construct their knowledge.
3. The ability of students to prefer one experience over another (selective conscience). This will give rise to the student's assessment of experience and become the foundation for the formation of his knowledge.

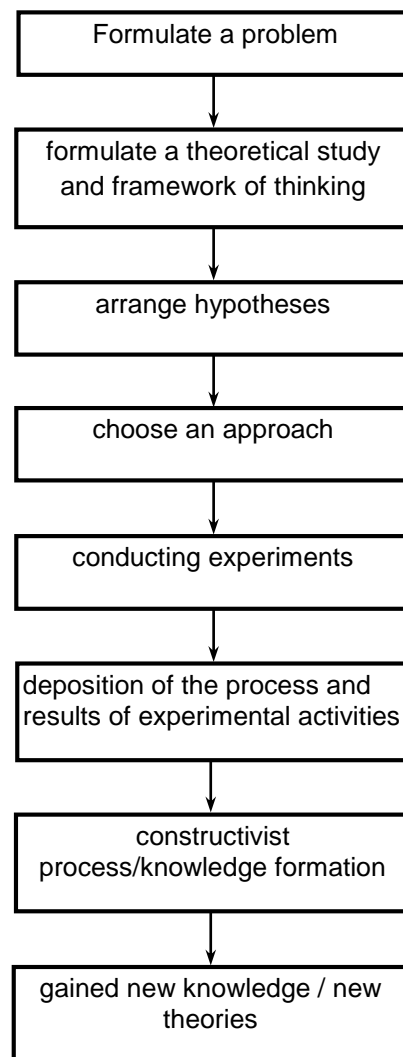


**Figure 1.** The science construction pattern

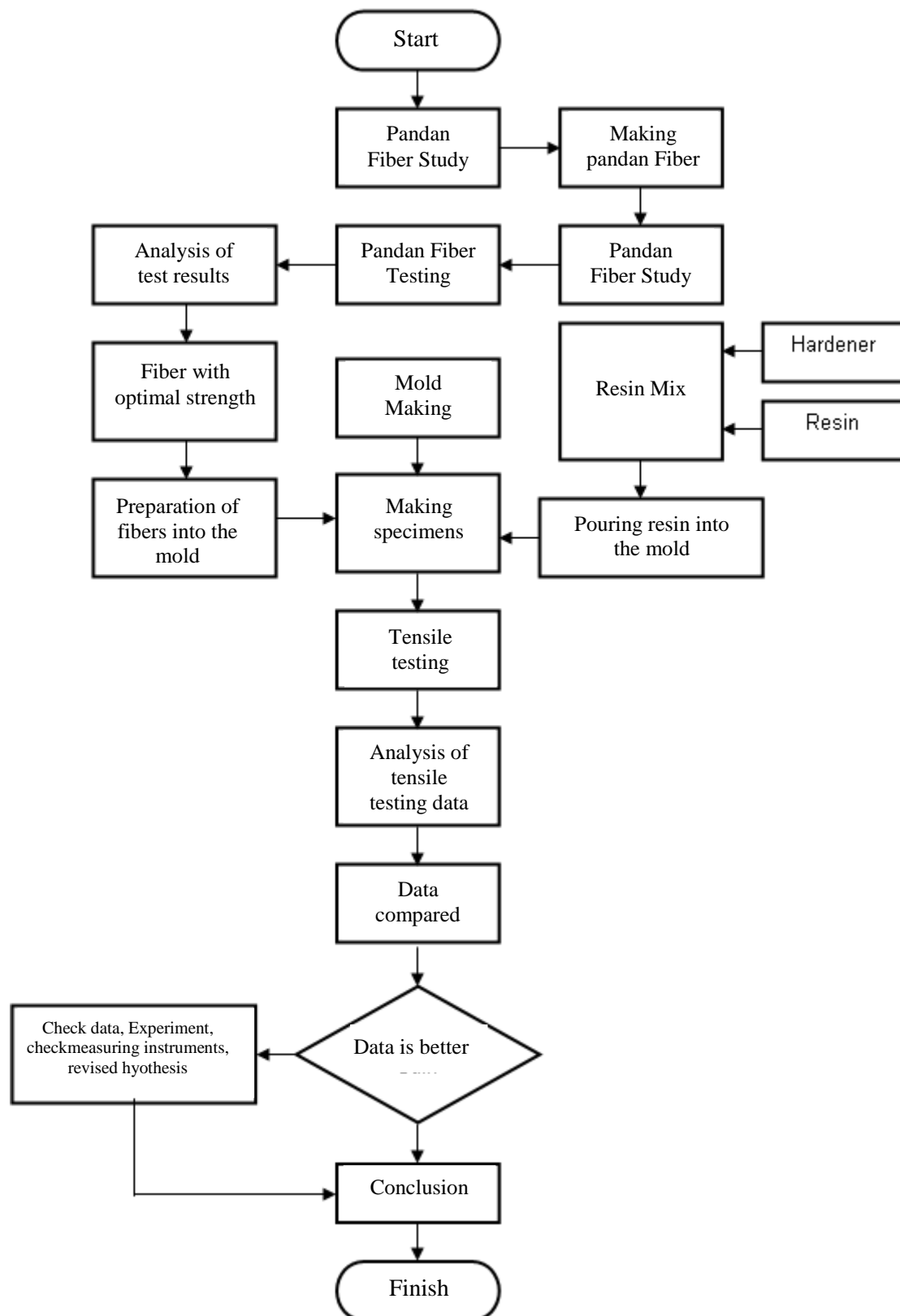
Based on the description above, the purpose of this study was aimed at finding out: (1) the role of constructivist learning theory in constructing knowledge gained through experiments; (2) the feasibility of pandan leaves as alternative materials for reinforcing composite materials; (3) the feasibility of the strength of the composite material determined by the volume fraction.

## 2. Methods

The experimental research method used in this study follows the experimental research procedure with the following steps:



**Figure 2.** Constructivist research procedures



**Figure 3.** Flowchart of experimental activities

### 3. Results and discussion

#### 3.1 New knowledge gained through studies

The role of constructivist learning methods through this experimental method was that students could construct in shaping their knowledge through experiments conducted, making meaning and looking for clarity by referring relevant references.

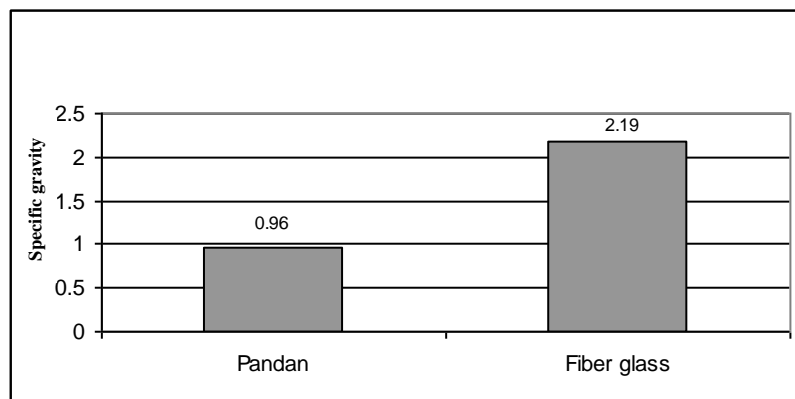
In this research, building new knowledge gained was a composite material, which was part of material science. Students finally could construct new knowledge obtained through research that pandan fiber could replace glass fiber (glass fiber) because of its higher tensile strength. It was just that the binding matrix could not be combined with the natural fibers so that for natural composite materials the properties had not been obtained superior to natural fibers mechanically.

Through constructivist learning, several essential things could be constructed, including; (1) achievement of meaningful concepts because students were directly involved in the implementation of learning activities through experimental activities carried out; (2) social interactions within students; (3) a concept application in daily life so as to make lessons more reasonable and; (4) constructivists' emphasizing hands-on activities (skills) and minds-on (thinking skills) so they could encompass the processes and products of science as well.

Based on these experiments, the constructivist philosophy was successfully applied in experiments using pandan fiber as a composite reinforcing material and could be used for exploitative learning or research on natural phenomena that had not been revealed.

#### 3.2 Physical properties of composites

From the research results, it is known that the specific gravity of pandan fiber is 0.96 while the glass fiber (fiberglass) is 2.19 so that it can be concluded that the specific gravity of pandan fiber is lower than that of fiber.



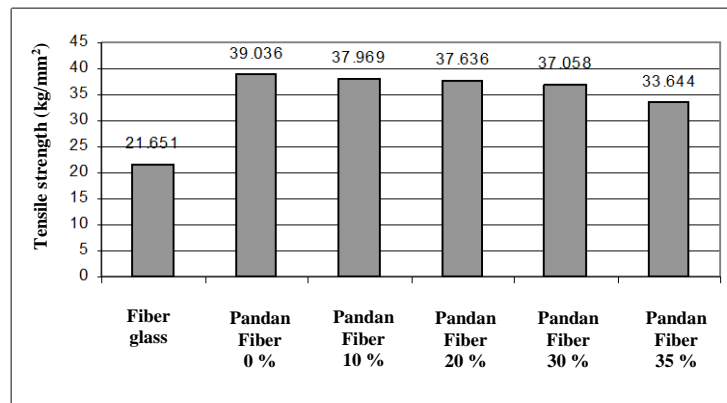
**Figure 4.** Comparison of specific density of Pandanus and glass fiber

#### 3.3 Mechanical properties of composites

##### a. Mechanical properties of pandan fiber and glass fiber

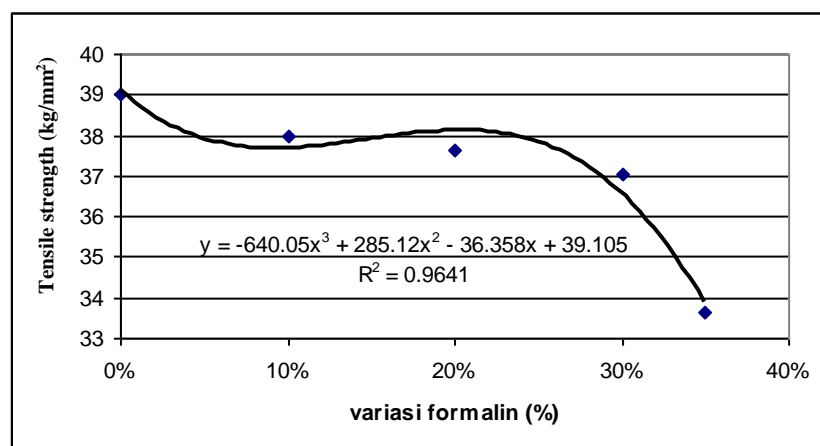
From the results of the study, it can be noted that the tensile strength of Pandan fiber is higher than that of glass fiber (glass fiber). The strain of broken pandan fibers is higher than that of glass fiber (glass fiber). Modulus of elasticity of pandan fiber is higher than glass fiber (glass fiber). The average tensile strength of pandan fiber is 37.06 kg / mm<sup>2</sup>, while glass fiber (glass fiber) is 21.65 kg / mm<sup>2</sup>. The average strain of pandan fiber is 2.36 while the glass fiber is 1.8. Average modulus of elasticity of pandan fiber is 1618.86, while a modulus of elasticity of fiber glass (glass fiber) is 1165.16.

Based on the research data, it turns out that pandanus fiber has twice the tensile strength compared to glass fiber (glass fiber) as shown in Figure 5.



**Figure 5.** Comparison of the tensile strength of Pandanus fibers with glass fiber

The 10% pandan fiber listed in the graph is defined as pandan fiber that is immersed in formalin at a rate of 10%, while the 0% pandan fiber is pandan fiber that is not immersed in formalin.



**Figure 6.** Effect of Formaldehyde Concentration on Tensile Strength of Pandan Fiber

Pandan fiber is a natural fiber that is susceptible to decay due to bacterial activity. One way to prevent decay is by soaking pandan fibers into formalin. However, the concentration of formalin must be considered because the tensile strength of pandan fiber decreases when the concentration of formaldehyde used to soak is added, as shown in Figure 6. The decrease of tensile strength due to immersion into formalin is caused by changes in the structure of the fiber which become harder. The relationship of the tensile strength of pandan fiber with formalin concentration can be formulated:

$$y = -640,05x^3 + 285,12x^2 + 36,358x + 39,105 \quad \dots\dots\dots(1)$$

$$R^2 = 0,9641$$

$y$  = tensile strength ( $kg/mm^2$ )

$x$  = formalin variation (%)

$R^2$  = significance number

#### a. Mechanical properties of polyester matrices

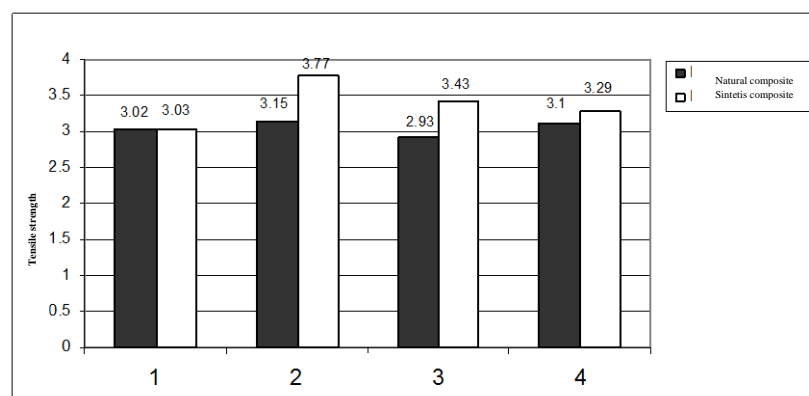
When compared separately, Pandan fiber was superior to glass fiber, but it was to make composites that had relatively high strength which required a more in-depth matrix study. Polyester resins were polymers selected as matrices to make composite materials with pandan fiber and glass fiber

reinforcement materials. The main reason underlying the selection of the resin was the availability of quite a lot in the market and easy to obtain. However, after being printed into a composite, it turned out that polyester resin was only suitable for glass fiber. The polyester resin was suitable for glass fibers in cold work. As for pandan fiber, it was hot, but it could not be done due to limited equipment and cost. This resin could not adhere strictly to pandan fibers when the printing was cold.

From the results of the study, the average tensile strength of the polyester matrix is 2.30 kg / mm<sup>2</sup>. The polyester matrix strain is 0.29, while the polyester matrix elastic modulus is 5.01.

#### b. Mechanical properties of synthetic composites and natural composites

From the results of tests conducted, synthetic composites are higher than natural composites. Natural fibers still need a suitable matrix and resin material to obtain strong bonds and obtain superior mechanical properties.



**Figure 7.** Graph of the tensile strength of natural composites (pandanus fibers) with synthetic composites

## 4. Conclusion

Based on the data from the research and discussion, it can be concluded that the constructivist method is feasible as an alternative paradigm for learning science and technology, and fiber from pandan leaves is suitable for composite materials, however no suitable treatment has been found.

## 5. References

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