

## **Effects of REACT Learning Model Based on Riau–Malay Culture Towards Mathematical Problem-Solving Ability and Achievement Motivation amongst High School Students**

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**Abstract:** This quasi-experimental study was conducted to determine the effects of the Relating, Experiencing, Applying, Cooperating and Transferring (REACT) teaching model, which was based on the Riau–Malay cultural context, on the ability of high school students to solve mathematics problem and their motivation to achieve high performance. A total of 287 high school students were involved in this study. The treatment group consisted of 143 students, whereas the control group comprised 144 students. Data were analysed using the SPSS 25.0 software. Findings showed that students in the treatment and control groups had significantly different abilities to solve mathematical problems and motivations to achieve high performance. Students who underwent the REACT teaching model had better ability and higher motivation than those who learned conventionally. Findings imply the importance of using the REACT model based on the Riau–Malay cultural context to enhance students’ mathematical problem-solving ability and motivation for improved performance.

**Keywords:** Achievement, Malay culture, motivation, problem solving ability, quasi experimental

### **1. Introduction**

Education enables a person to change and nurture his or her personality to conform to the same moral values and norms of a society or culture. The formal educational process involves teaching and learning. Learning is basically the key to all educational endeavours. Purwanto (1990) noted that learning empowers one to understand the things he or she is not familiar with. Education is a life guide, and knowledge enables a person to progress and compete internationally across all fields. According to Trianto (2012), national education is aimed at progression, particularly to develop competencies, characters and civilisation. Education provides life lessons and develops potentials for the nation. Moreover, education produces faithful and devoted human beings towards God, alongside producing noble, healthy, knowledgeable, efficient, creative, independent, democratic and responsible citizens.

Education in the current globalisation era aims to support the nation’s progress and future development. As such, education should develop students’ potential in many aspects. Potentials can only be developed when students are competent in several subjects or disciplines. Mathematics is one of the compulsory subjects in the 2013 curriculum that must be mastered by high school students (Depdikbud, 2014). Mathematics is one of the most important subjects in the field of science and technology. When viewed from the standpoint of scientific disciplines, mathematics is included in pure science, which requires more understanding compared with memorisation. Students are required to master concepts prior to solving the problems to understand topics in mathematics. They are expected to solve mathematical problems and implement mathematics in everyday life. The ability to solve mathematical problems is one of the goals of mathematics learning in schools.

According to the National Council of Teachers of Mathematics (NCTM) (2000) in Indonesia, one of the principles and standards of mathematics in schools is for students to have the ability to solve mathematical problems. The results of previous works show that Indonesian students still have low mathematical achievement. In studying trends in international mathematics and science, Wardhani et al. (2010) observed no considerable change year after year. The findings revealed that the mathematical ability of students in Indonesia is still low, and one aspect of which is their ability to solve problems. Such low ability is also present amongst high school students. In addition, Husna et al. (2013) determined that students’ ability to solve mathematical problems particularly amongst high school students was still low. Similarly, Rahayu and Afriansyah (2015) also observed the same low level of ability amongst high school students in terms of problem solving. However, Suherman et al. (2003) found that solving problems is one of the mathematical activities considered important by teachers and students from primary to high school. Fitria et al.

(2018) and Aisyah et al. (2018) stated that the problem-solving ability amongst high school students on the rectangular and triangular topics was still low. Hence, teachers must enhance students' ability on those two topics until students can solve problems on their own.

A good result reflects a student's performance. Motivating students' performance and achievement comprises several factors, such as learning motivation. Alderfer (1989) noted that learning motivation is students' tendency to perform all learning activities driven by a desire to achieve the best possible achievements. According to Ardhana (1992), motivation is an important factor in attaining achievements, either academic or extracurricular. Motivation refers willingness to carry out tasks to attain certain goals. One important motivation in work behaviour is achievement motivation. Students should have achievement motivation or the ability to concentrate and high motivation to obtain maximum results in learning. On the one hand, Uno (2009) suggested that certain efforts to improve students' motivation in learning are comprise encouraging curiosity, using samples or examples as teaching materials and connecting previous lessons with the current ones. On the other hand, Hamalik (2000) noted that students' motivation can be enhanced through acknowledgement, aspiration, compliment, competition, cooperation and support. Moreover, Posamentier and Stepelmen (2002) stated that students' problem-solving abilities can be improved by providing a learning environment that encourages freedom of expression and consequently respect of questions and ideas. This notion provides opportunities for students to search and find answers themselves, thus encouraging cooperative learning.

Working towards improvement is not a simple task, and possible approaches, models, strategies or methods are needed to train students' mathematical problem-solving abilities. Students have to be involved actively in their own learning to encourage independent learning and improved performance. An engaging and tangible learning experience is important for students to be active in their own learning process. Soedjadi (2000) defined mathematics as science based on reasoning abstract matters or mathematical objects. Hence, learning mathematics will be effective through contextual approaches which require real and relatable learning materials. One of the approaches is the Relating, Experiencing, Applying, Cooperating and Transferring (REACT) model, which provides real experience through exploration or discovery activities. Cahyono et al. (2017) stated that the REACT model is among the contextual learning developments and exploration and discovery models (Yuliati, 2008).

## **2. Literature Review**

### **2.1. Relating, experiencing, applying, cooperating and transferring (REACT) model**

Using the REACT model in teaching and learning Mathematics is one of the ways to foster performance motivation and train students to solve Mathematics problem through daily life experience. REACT is a learning model with five strategies, namely relating, experiencing, applying, cooperating and transferring. It focuses on teaching and learning context which is the core principle of constructivism learning. This model is suitable for mathematics lessons, enabling students to relate mathematical problems with daily life by making discoveries and applying mathematical concepts. Fauziah (2010) confirmed that REACT is a contextual learning model. Jhonson (2010) defined contextual learning as a learning system based on philosophy. That is, students can absorb lessons if they can comprehend the meanings of academic materials that they receive and capture in their school assignments. In addition, should be able to associate new information with their prior knowledge.

Learners acquire problem-solving skills before they move on to the relating and experiencing stages of REACT. In the relating stage, students can associate abstract mathematical learning with daily life. The associating process will make learning memorable and effective. According to the American Association for the Advancement of Science (Crawford, 2001), a learning process must begin with questions and phenomena that are interesting and familiar to students and not abstract matters. By contrast, in the experiencing stage, students learn through exploration, discovery and creation which motivate them because they feel challenged working on their own. Hence, this process improves students' problem-solving abilities because they are free to create and find answers in their own ways. A positive credit of REACT is supported by Yuliati (2008) who agreed that the REACT model enables students to have the power to discover their own concepts as well as to apply those concepts in their daily lives. Hence, REACT is a learning model that makes problem solving easy for students. Moreover, such a model absolutely helps teachers enhance achievement motivation amongst students.

The REACT model is a contextual learning model. It works in a certain learning context which provides and allows students to apply a familiar experience through meaningful interactions. One thing that is familiar to students is culture (Noah & Dardiri, 2016). Mathematical concepts must be thoroughly explored based on local cultural wisdom possessed by a cultural community (Hasanuddin, 2017). Based on the description above, the REACT model is best implemented based on the Malay cultural context to solve learning difficulties. Particularly, the REACT model improves students' achievement motivation and abilities to solve mathematical problems. Thus, the present study is conducted on the effects of using REACT model based on the Riau–Malay cultural context on students' ability to solve Mathematical problems and to enhance their motivation.

Putri et al. (2019) revealed that the use of the REACT model can improve high school students' achievement in mathematics. Moreover, Sulistyarningsih and Prihaswati (2015) discovered that the use of the REACT model can improve students' ability to connect 3D mathematical concepts. In addition, Novri et al. (2018), Anas and Fitriani (2018) found the advantages of applying the REACT model in enhancing the understanding of mathematical concepts amongst high school students. Purwosusilo (2014) found that REACT helps high school students improve their abilities to understand and solve mathematical problems. Based on these studies, the REACT model has positive impression on students. However, those previous studies did not involve cultural aspects. Therefore, the current study was carried out to investigate the effects of the REACT model that is based on the Riau–Malay culture. It aimed to understand the ability of students to solve mathematical problems and to encourage achievement motivation.

## 2.2. Malay culture

Ratna (2005) defined culture as comprehensive human activities, including knowledge, beliefs, arts, morals, laws, customs and other habits. Moreover, from the perspective of anthropology, Koentjaraningrat (1985) defined culture as a whole system of ideas, actions and results of human works in the context of human lives acquired by humans through learning. As such, nearly all human activities fall under culture. Hence, the Malay cultural context is a state of all human activities, including knowledge, beliefs, arts, morals, law, customs and other habits within the scope of a Malay society. The fields of cultural studies are divided into the following aspects: (i) Language (regional languages, *pantun*, poetry, novels, etc.), (ii) knowledge systems including science and humanities (literature, philosophy, history, etc.), (iii) social organisations (births, deaths, marriages, etc.), (iv) systems of living equipment and technology (clothing, food, ceremonial equipment and other technological advances), (v) systems of livelihoods (farming, sailing, etc.), (vi) religious systems (beliefs, worship, sacred objects, statues, etc.) and (vii) arts (paintings, dancing, music, etc.).

Cultural studies in knowledge systems, specifically mathematics, progress and develop due to the challenges of human life with diverse cultural backgrounds. Every culture develops its own mathematical concepts, resulting in the emergence of mathematics as the product of human thinking. This notion is in line with the opinion that mathematical cultures are the products of the abstraction of the human mind. This finding is in accordance with Sembiring (2008) who stated that mathematics is a construction of human culture. With regard to culture, Malay culture is one of the prominent cultures in Indonesia. This culture is closely related to the Riau culture because Riau is also known as the Malay nation. However, Malay culture is becoming unrecognised by younger generation of Malay people in Riau itself. The influx of immigrants and their new cultures impacted local culture. In the era of globalisation, the Malay culture in Riau is challenged by borderless global village and uncontrollable fusions of foreign cultures through print or electronic media (Dahlan, 2004). Several studies show the interrelation between culture and mathematics. However, in reality, they are seen as two different entities with various uncorrelated elements. In fact, literature reviews on cultural books never discussed any association with mathematics. The same can be said that the studies of Mathematics are never related to cultural features. Therefore, to restore this truth, cultural contexts can be associated with mathematical learning. As for the present study, the researchers treat the context of Malay culture as contextual learning. The context in discussion is in a form of Malay culture, particularly the traditional houses and special cuisines which are included in the REACT model for mathematics.

Yusra and Saragih (2017) succeeded in using the Malay culture to improve students' mathematical communication skills and self-motivation. Bahri et al. (2018) found that problem-based learning modules with nuances of the Malay culture can enhance learners' ability to solve mathematical problems. In addition, Kiptiyah (2016) concluded the same results on the influence of problem-based learning models based on ethno mathematics local culture in improving students' problem-solving abilities. Results of previous studies on the use of various Malay cultures in teaching and learning methods showed positive impressions on students' problem-solving abilities.

Therefore, further studies are needed to determine the effects of the REACT model based on the Riau–Malay cultural context on high school students' ability to solve mathematical problems and achieve motivation.

### 2.3. Ability to solve mathematical problems

The essence of novice problem solving is to carry out procedural operations systematically step by step. According to Abdurrahman (2012), problem-solving usually involves several combinations of concepts and skills in a new or a different situation. However, Santrock (2011) defined problem-solving as looking for the right way to attain a goal. By contrast, Ormrod (2009) defined problem-solving as using (transferring) prior knowledge and skills to answer unanswered questions or to solve difficult situations. Based on the above revelations, problem-solving is the ability possessed by students to find the right method of solving difficult situations to achieve a goal. Robbins and Timonhy (2009) noted that ability is the capacity of an individual to perform assignments uniformly. On the contrary, Santrock (2011) defined problem-solving as finding the best possible ways to achieve a goal. Based on the similar definitions, the ability of students to solve mathematical problems is by applying their own knowledge and skills to current situation to find answers to problems.

Polya noted four stages of problem-solving, namely, understanding the problem, devising a plan, carrying out the plan and looking back. In addition to the steps, indicators of mathematical problem-solving ability exist. Sumarmo (2006) stated that the indicators are as follows: identifying the adequacy of data to solve problems, creating and solving a mathematical model from a situation or daily problem, selecting and implementing strategies to solve mathematical problems or other matters, explaining or interpreting results according to the original problem, and checking the correctness of the answers and applying them meaningfully. Sumarmo (2006) also added that the indicators of problem-solving ability are as follows: identifying known elements, asking questions and determining the adequacy of elements, creating mathematical models, implementing problem-solving strategies, explaining/interpreting results, resolving mathematical models and real problems, and using mathematics meaningfully.

Bahri et al. (2018) noted that solving mathematical problems involves a high order of thinking skills. Hence, teachers need to focus on this matter. Teachers can help students by associating everything from the learning environment, including the cultural elements. This learning approach is recognised as ethnomathematics (Kiptiyah, 2016). Multicultural mathematical activities associate the elements of culture with typical mathematical topics. These activities may motivate students of diverse cultures and ethnicities to explore and at the same time respect their own cultural heritage while learning important mathematical content. Learning to solve mathematical problem through daily life activities may improve students' cognitive abilities and develop their affective skills. Both are equally important to instill appreciation towards local heritage and culture.

Marlissa (2016), Rosyid and Puadi (2016), Ritonga (2017) and Laelatunnah et al. (2018) found that the REACT teaching model could improve students' ability to solve mathematical problems. These studies proved that the REACT teaching and learning model causes higher ability amongst high school students in comparison with conventional methods. However, the present study is different from the former studies as it applies the REACT model based on Riau–Malay culture. Besides improving students' abilities, this model also creates awareness and understanding of the Riau–Malay culture and its connections with mathematics.

### 2.4. Achievement motivation

Motivation is a paramount inner element that all students should possess in the process of achieving their learning objectives. According to Sardiman (2007), a person's achievement in learning is strongly influenced by his self-motivation. In psychological education, achievement motivation is indeed very important. McClelland et al. (1953) stated that achievement motivation is a self-drive that encourages students to perform towards significant achievement. The drive to achieve something encourages students to be enthusiastic when fulfilling their learning tasks in the best possible way.

The positive notes on achievement motivation are supported by several other relevant views on its definition. Djaali (2013) defined motivation as 'encouragement to do a task properly based on excellence standards'. In addition, Willis (2013) stated that 'achievement motivation is encouragement from within towards better achievement'. Hence, achievement motivation is very important for students to perform and achieve their learning goals, specifically in learning mathematics. Having eagerness that fires a great strive for success is essential for students to achieve the best

learning outcomes. Santrock (2005) noted that achievement motivation is the desire and drive of an individual to do something with good results. Moreover, Parson et al. (2001) concluded that achievement motivation is a force for success, a desire to progress, self-confidence and self-efficacy.

Based on the above discussion, achievement motivation is defined as a self-drive that forces one to attain his or her personal aims, to improve himself or herself, and to perform in new and creative ways, thus attaining optimal performance and achievement. The eagerness to excel is intrinsic, and students who have high achievement motivation want to complete their assignments and improve their performance. Asnawi (2002) noted that achievement motivation is the drive to do something better or more efficient than before. Students who have achievement motivation clearly have distinct characteristics which distinguish them from those who have low motivation. According to Asnawi (2002), the manifestation of achievement motivation is observed in behaviours, such as having personal responsibility, obtaining feedback from one's actions, choosing moderate risks in one's actions and trying to do things in new and creative ways. McClelland (1987) listed other characteristics of people who are motivated to excel, namely, having performance drive, highly competitive, excellent go-getters, liking realistic challenges and wanting great feedback about success and failure. Based on these aspects of achievement motivation, the significant characteristics of someone with achievement motivation are as follows: having the desire to go forward and believing in one's own abilities, responsible and wanting feedbacks on one's actions, being able to choose the risks involved in one's actions, doing things in creative new ways, never stops trying to complete any given task, striving for a continuous achievement, very competitive and liking realistic challenges.

Ismaya et al. (2015) and Arigiyati et al. (2017) found that REACT strategies influence the motivation to learn amongst high school students. However, Safitri and Mahmudi (2017) found no significant impression of using the REACT model strategy based on contextual learning towards student motivation. Based on these contrasting studies, studying the use of the REACT model as an effort to enhance the motivation of high school students by involving cultural aspects is necessary. Thus, the present study is different from previous studies because it was carried out by involving the Riau–Malay culture in explaining topics in teaching and learning mathematics.

The present study applies the REACT model in the context of the Riau–Malay culture to improve students' ability to solve mathematical problem and to enhance students' achievement motivation. Starting with the *relating* stage, students are given problems which are very much connected with their daily lives. The Riau–Malay culture is linked in the form of narrative questions so that students are motivated to learn well and understand the concepts further. In the experiencing phase, students are then challenged to explore and find their own solutions. In the *applying* stage, students are eager to solve the given questions using their own personal abilities. These three steps are in accordance with indicators of achievement motivation, by which students are responsible to find their own creative solutions to solve questions successfully. The next stage is the *cooperating* stage, where students are grouped to collaborate on completing assignments, which provide opportunities for students to share information and their experiences to solve mathematical problems. At the same time, they are competing with other groups to master one another's subject matter. At the *transferring* stage, students easily transfer their knowledge to solve new mathematical questions. Thus, students can solve any mathematical problem using the abilities they acquired. The application of REACT will also foster student achievement motivation. The REACT model can positively influence the ability to solve mathematical problems and enhance achievement motivation.

### 3. Methodology

#### 3.1. Research design

This quasi-experimental research involves pre-test and post-test (Creswell, 2012). According to Christensen (2001), a quasi-experiment is a research design suitable for situations where the influence of irrelevant variables cannot be fully controlled. In this study, the characteristics of the treated participants and the control group were not similar, and the participants were not selected at random, but were obtained from available classes (Sugiyono, 2013). A pre-test is performed before the actual study to determine the initial conditions for the difference between the treatment participants and the control group. Table 1 shows the framework of this study.

**Table 1.** Pre-test–post-test control group design

Experiment Class	O <sub>1</sub>	X <sub>1</sub>	O <sub>2</sub>
Control Class	O <sub>1</sub>	X <sub>2</sub>	O <sub>2</sub>

Notes:

O<sub>1</sub>: *Pre-test* (students' ability to solve mathematical problems and their achievement motivation)

O<sub>2</sub>: *Post-test* (students' ability to solve mathematical problems and their achievement motivation)

X<sub>1</sub>: REACT model

X<sub>2</sub>: Conventional methods

Participants in the treatment and control groups were tested before and after the test. People in the treatment group used the REACT model to learn mathematics in the context of the Riau-Malay culture, while those in the control group were exposed to conventional methods. A post-test was performed one month after treatment. As suggested by Campbell and Stanley (1963), the appropriate time period for the post-test is one month, six months and one year after the forecast. The tools for pre-test and post-test are problem-solving ability tests and self-efficacy checklists. Prior to conducting the actual study, the class teachers were properly trained by the researchers for 1 month with eight meetings. This training was to ensure that teachers would clearly understand the implementation of REACT teaching model in the context of Riau–Malay culture.

### 3.2. Participants

The present study involved 287 high school students in Pekanbaru, Riau, Indonesia. A total of 143 students were classified in the treatment group, whereas 144 students in the control group. Students in both groups were selected using the convenience sampling method and intact group. Christensen (2001), Campbell and Stanley (1963) suggested that sample selection can be achieved based on convenience and intact groups. The rationale for choosing a convenience sampling method is because the education system in Indonesia places students in fixed classrooms.

### 3.3. Measurement

Students' ability to solve mathematical problem was measured through a series of written tests, with items adapted from Hamzah (2014). These items measure students' ability to write what they know and to write answers to questions. Students' ability was also measured in the aspects of their abilities as follows: to plan strategies by writing formulas, to design correct problem-solving procedures, to carry out calculations with correct procedures and to draw conclusions in words as required by the questions.

**Table 2.** Scoring rubric of students' mathematical problem-solving ability

The Aspects Measured	Description	Score
Understand the task	Do not write what is known and what is asked	0
	Write what is known and what is asked and vice versa	1
	Write what is known and what is asked correctly and precisely.	2
Plan solutions (problem-solving)	A problem-solving strategy has no design at all	0
	Design a problem-solving strategy by writing a formula, but it is not quite right	1
	Design a problem-solving strategy by writing a formula, the strategy is right but incomplete	3
Executing the plan	Design a problem-solving strategy by writing a formula, the strategy is correct and concise	3
	No answer at all	0
	Carry out the designed strategy by writing the answer but the answer is wrong.	1
	Carry out the designed strategy by writing down the answer, the answer is correct but incomplete	2
Rechecking/interpreting the results obtained	Carry out the designed strategy by writing down the answer, the answer is correct and concise	3
	No conclusion	0
	Write the conclusion of the answer, but not in words according to the question	1
	Write the conclusion of the answer, in words according to the question	2

Students' problem-solving ability was tested in the present study in the form of essay questions consisting of five questions, which were arranged based on the ability to solve mathematical problems. The test questions were analysed by three experts prior to the test. The test questions received 89% agreement by the three experts. Hence, the questionnaire was deemed valid. Table 2 shows the score criteria for the ability to solve mathematical problems. The questionnaire to determine achievement motivation consists of 26 items, which are equally divided into positive and negative statements. The objective is to distinguish between motivated and non-motivated students based on the different two sets of answers. The questionnaire uses a Likert-type scale comprising SS (strongly agree), S (agree), TS (disagree) and STS (strongly disagree). The following items are concerning: completing assignments responsibly, completing assignments successfully, completing assignments in new creative ways, selecting risks in every action and progressing ahead of others.

### 3.4. Data Analysis

In this study, the analysis of covariance (ANCOVA) test using SPSS software 25.0 was used to determine the difference between students' ability to solve math problems and achievement motivation. ANCOVA is used to test hypotheses (Field, 2011). Christensen (2000) pointed out that ANCOVA is the most suitable analysis method for non-experimental control group, pre-test-post-test design type quasi-experimental research. The current work is a quasi-experimental study, and the two groups of subjects are not randomly selected. Therefore, a homogeneity test was conducted to determine the diversity and proficiency of the intelligence spectrum before treatment. According to Field (2011), the Levene test aims to analyze the following hypothesis: In the same population study, the variance of the dependent variable is different from each independent variable.

## 4. Results and Discussion

### 4.1. Differences in the ability to solve problems between the treatment and the control groups

ANCOVA was performed to determine the difference in problem-solving ability between the treatment group and the control group. Before the test, the prerequisites for the ANCOVA test have been met. The pre-test results of the kurtosis and skewness tests of the treatment group and the control group were 0.70, -0.44 and 0.77, 0.27, respectively. In addition, the post-test results of the treatment group and the control group were -0.33, -0.04 and 0.77, 0.27, respectively. The results indicate that the problem-solving ability data of the treatment and control groups are normal (Pallant, 2005). In addition, Levene's test showed that the variances between the comparison variables were similar ( $F = 4.440$ ,  $\text{sig} = 0.098$ ). Therefore, the requirements for running ANCOVA tests are met.

**Table 3.** ANCOVA test for differences in the ability to solve problems between treatment and control groups

Source	Type III Sum of Squares	df	Mean Square	<i>F</i>	Sig.	Partial Eta Squared
Corrected model	85,639.758 <sup>a</sup>	2	42,819.879	794.162	0.001	0.848
Intercept	6,485.306	1	64,85.306	120.280	0.001	0.298
Pre-test	25,960.581	1	25,960.581	481.480	0.001	0.629
Group	55,593.602	1	55,593.602	1,031.071	0.001	0.784
Error	15,312.800	284	53.918			
Total	1,085,304.000	287				
Corrected total	100,952.557	286				

Table 3 shows the significant difference in the ability to solve problems between the treatment and the control groups after the intervention of react model based on the context of Riau–Malay culture. The pre-test is a covariate [ $F = 1031,071$ ,  $\text{sig} = 0.001$  ( $p < 0.05$ )]. The distinctive effects are moderate (0.784). The mean for the treatment group (mean = 72.55) reveals that students in the treatment group have higher problem-solving ability than students in the control group (mean = 44.68).

The results of this study show that the REACT learning model in the context of Riau–Malay culture positively affects students' ability to solve mathematical problems and their achievement motivation. This result is parallel with results of Fauziah (2010), Marlissa (2016), Rosyid and Puadi (2016), Ritonga (2017) and Laelatunnah et al. (2018). These previous studies proved that applying the REACT model can improve the ability to solve mathematical

problems amongst high school students. The same results are also determined by the current study, wherein students who experienced the REACT learning model have a better ability to solve mathematical problems and have higher motivations than those who underwent conventional learning.

The REACT learning model based on Riau–Malay culture theoretically begins the lesson by giving a real initial problem according to students’ experience and level of knowledge associated with Riau–Malay culture. The problems given are in accordance with the learning objectives. Students explore and understand the problem. They are involved in activities to find the concept of topics studied to solve the problems. Students then discuss in groups. They collaborate and share information to solve the problems. Each group presents the answers in front of the class, whereas members of other groups respond to the answer. The activities used in conventional teaching methods were not applied. In general, the learning process in the treatment group is in accordance with the set criteria.

The REACT learning model also shows that students have a moderate ability to solve mathematical problems. This result proves that the use of the REACT learning model based on Riau–Malay culture can be an added information for results of studies carried out by Fitria et al. (2018) and Aisyah et al. (2018). These studies found that problem-solving abilities amongst high school students for the rectangle and triangle topics were still low. The model not only improves students’ ability to solve problems but also enhances achievement motivation towards change. However, the current study is in contrast with the findings of Ismaya et al. (2015) and Arigiyati et al. (2017) who found that the use of the REACT model strategy is simply not enough to enhance students’ motivation. By contrast, REACT learning model based on Riau–Malay culture improves students’ motivation.

#### 4.2. Differences in achievement motivation between treatment and control groups

The ANCOVA test was performed to identify the different levels of achievement motivation between treatment responders and control groups. Before the ANCOVA test, the prerequisites for using the ANCOVA test have been met. The pre-test results of the kurtosis and skewness tests of the treatment group and the control group were 0.16, -0.73 and 0.22, -0.49, respectively. However, the post-test results of the treatment group and the control group were -0.35, -0.38 and 0.32, -0.37, respectively. Therefore, the achievement motivation data of the treatment group and the control group are normal (Pallant, 2005). In addition, the Levene test shows that the variances between the comparison variables are similar ( $F = 3.128$ ,  $sig = 0.078$ ), and meet the requirements of the ANCOVA test.

**Table 4.** ANCOVA test for differences in achievement motivation between treatment and control groups

Source	Type III Sum of Squares	df	Mean Square	<i>F</i>	Sig.	Partial Eta Squared
Corrected model	11,380.201 <sup>a</sup>	2	5,690.100	164.664	0.001	0.537
Intercept	13,949.145	1	13,949.145	403.671	0.001	0.587
Pre-test	1,296.022	1	1,296.022	37.505	0.001	0.117
Group	9,676.741	1	9,676.741	280.033	0.001	0.496
Error	9,813.834	284	34.556			
Total	1,688,191.000	287				
Corrected total	21,194.035	286				

Table 4 shows the significant difference in achievement motivation between the respondents in the treatment group and the control group after the REACT model intervention based on the Riau-Malay cultural background. The pre-test is a covariate [ $F = 280.033$ ,  $sig = 0.001$  ( $p < 0.05$ )]. The unique effect is considered high (0.496). The average value of the treatment group (mean = 82.05) shows that students in the treatment group have higher motivation for achievement than students in the control group (mean = 70.42).

Results of the present study also support Ismaya et al. (2015) and Arigiyati et al. (2017) who found that the REACT strategy influences high school students’ learning motivation. The use of the REACT learning model based on Riau–Malay culture also enhances students’ achievement motivation. The Malay cultural content which is used as contextual learning positively impacts students. Students are interested and enthusiastic in reading and understanding problems because they are having interesting and appropriate contents. Hence, they are eager to fully participate in their own learning. Students’ responses to the achievement motivation questionnaire also reveal a significant and



positive influence of the model. Further studies are recommended to continue using this model but in broader scopes in terms of topics, population or other mathematical competencies.

Hopefully, the results of the present study are worthy of consideration by the Riau Ministry of Regional Affairs and use them to accelerate the movement and implementation of the Riau 2020 vision. Specifically, the Malay culture should be integrated synergistically with educational, religious and cultural programmes. However, clear specifications and policies from the Riau ministry must be made immediately to embed Malay culture in the high school curriculum for all schools in Riau. Apart from that, preparing Malay culture teachers is necessary before they transfer Malay culture knowledge to students in all schools in Riau. In addition, future researchers are recommended to use the Riau–Malay culture as a teaching strategy or learning approach to encourage students to be motivated. Therefore, future research on the effectiveness of this integrated teaching method should include elements of the Riau–Malay culture. The next research on cultural-based REACT model should also investigate its influence on higher-level thinking skills, critical thinking and also mathematical reasoning. Future tests should also involve various aspects in mathematics to strengthen the notion of using the REACT Riau–Malay culture-based teaching model in teaching and learning mathematics.

## 5. Conclusion

This research successfully proved the impact of the REACT learning model based on Riau Malay culture on students' ability to solve mathematical problems and enhance achievement motivation. This special REACT teaching model is a teaching method that can improve the problem-solving ability and achievement motivation of middle school students. It is hoped that teachers can change their teaching methods or strategies by applying this teaching model. Future researchers will develop and innovate in their efforts to improve students' problem-solving ability and achievement motivation. In addition, this research is expected to serve as a standard for improving students' ability and achievement motivation. Therefore, new methods or teaching strategies that also involve cultural factors can be produced.

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