

Developing Circular Motion Physics Module Integrated with Gumbaan Local Wisdom in Cooperative Learning Setting to Improving Learning Achievement

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Abstract

This research is carried out to examine the developed circular motion physics module in a cooperative learning setting for students of Grade X Science Senior High School in Banjarmasin. This study's general objectives are to produce a circular motion physics module integrated with gumbaan local wisdom in cooperative learning settings and describe its feasibility. Moreover, this study's specific objectives aimed to describe the validity, practicality, and effectiveness of the module. This study utilizes the ADDIE (Analyze, Design, Develop, Implement, Evaluate) development design model. The instruments used consisted of module validation sheets, students' questionnaire responses, and learning outcome test. The results of the study indicated that: (1) the validity of the module, based on the content and display, obtained a score of 3.20, which fell in the "good" category, (2) the practicality of the module, based on students' questionnaire responses, obtained a percentage of 64.92% which is categorized as "good", and (3) the effectiveness of the module, based on students' test scores, obtained a score of 0.44 which belonged in the "moderate" category. It is then concluded that the circular motion physics module, which integrated gumbaan local wisdom contents in cooperative learning settings, is proven feasible for learning and teaching and can be used as an alternative reference in improving the quality of learning, especially to improve the learning outcomes of learners. This module can be used as a reference that teachers can use in learning at senior high school.

Keywords: Circular motion; Gumbaan; Local wisdom; Physics module

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INTRODUCTION

Education depends on what students get in the learning process in order to achieve learning goals. A qualified education is highly demanded to promote the next generation's life skills development (Sudarsana, 2016). When education is delivered within a conducive atmosphere, it is without a

doubt that students would focus their minds and attention on the lessons taught. Their focus on what they are learning is expected to improve their learning outcomes (Damayanti, Dewi, & Akhlis, 2013; Oktaviana, Hartini, & Misbah, 2017; Almuharomah, Mayasari, & Kurniadi, 2019;).

Physics teachers are required to construct learning materials as attractive

as possible to increase students' engagement as a way to motivate them to be more enthusiastic in learning and teaching activities. An alternative can be done by associating physics materials with local wisdom, as physics materials that are affiliated with local wisdom make the learning more meaningful, and students are more familiar with the culture of their place of residence (Rahmayanti, Wati, & Mastuang, 2016; Oktaviana et al., 2017; Hartini, Firdausi, Misbah, & Sulaeman, 2018).

People of South Kalimantan continue to use traditional tools nowadays. One of the concurrent traditional tools used is gumba. Gumba is a traditional tool utilized to separate hulled rice and the rice remnants, such as pieces of rice stalks. The principle of gumba is that when the stalk is rotated, then the propeller will rotate, which then produces wind. The wind will then separate the hulled rice with the rice bran. The mass of the hulled rice is greater than the rice bran so that the wind generated on the rotating propellers will blow away the rice bran horizontally. Meanwhile, the hulled rice will fall to the container that has been provided.

The interview results with one of the physics teachers at Senior High School 8 Banjarmasin revealed that the textbooks used had not been linked with local wisdom. This underlies the motive of the researcher to develop a physics module that is integrated with gumba local wisdom, as it can facilitate learners with a more purposeful context while also introducing gumba, a traditional tool originated from South Kalimantan, as well as reinforcing students' comprehension since physics materials do not only revolve on calculations and equations but also the applications of the concepts in traditional tools in their residential area (Rahmayanti et al., 2016).

In Senior High School 8 Banjarmasin, students' learning outcomes in Grade X Science 1 on physics subjects were still relatively low based on the scores collected from the results of mid-semester exams. Out of 36 students, none of them exceeded the minimum passing score. This also urged the researcher in developing a module that contains gumba local wisdom, as several studies proved that the integration of the materials taught with local wisdom could aid students in understanding the implementation of the materials taught as they were able to associate it in everyday life (Oktaviana et al., 2017; Wati et al., 2017).

The solution to overcome the problems faced by the learners is to develop modules. The modules developed should contain physics materials and contents related to local wisdom, such as the traditional gumba tools. This is aimed to enrich students' knowledge of their own culture. Circular motion is one of the physics topics taught for Grade X students in the odd semester. One of the applications of circular motion can be seen in gumba. Moreover thus, the physics material chosen in this research is circular motion.

The learning model that is suitable for the topic of circular motion topic is the cooperative learning model. Cooperative learning is designed to help students solve academic problems in groups (Nurdyansyah & Fahyuni, 2016). The process of seeking for the solution to solve these problems as groups will also be guided using the developed module.

This developed module's novelty lies in the materials integrated with the traditional gumba tools and the pictures contained in the module's contents, which also represented the parts of gumba. Physics material associated with local wisdom in the students' area of residence promotes

students' learning outcomes (Rahmayanti et al., 2016; Oktaviana et al., 2017). This research aims to develop a physics module on the topic of circular motion integrated with local wisdom *gummaan* in a cooperative learning setting. Additionally, this research also describes the physics module's feasibility from the aspects of its validity, practicality, and effectiveness.

METHOD

This research utilizes the method of Research and Development (R&D), with the ADDIE (Analyze, Design, Develop, Implement, Evaluate) development model (Tegeh, Jampel, & Pudjawan, 2014). The ADDIE design model consists of: analyze, design, develop, implement, and evaluate.

Analyze, at this stage, the following steps are carried out: (a) analyzing existing products and the needs of the customers in the field, which are done by identifying the disadvantages in textbooks used, namely limited stock of books and that the books are not linked with the local wisdom; (b) analyzing students' characteristics, in which each student in the class of the research conducted has various levels of physics skills, but are still suitable with cooperative learning model; and (c) analyzing the characteristics of the teaching materials, where the uniform circular motion topic has a wide range of daily life applications, one of them can be found in the use of the traditional tool, *gummaan*, and the materials are also enriched with mathematical calculations, which strengthened the researcher's argument that the suitable learning model for studying this topic is cooperative.

Design, at this stage, the researcher acted out: (a) designing learning activities by elaborating the essential competencies into achievement competency indicators, determining the number of meetings needed for the

lessons; and (b) designing the instruments for the product evaluation.

Develop, in this stage, the product being developed is in the form of a module. The activities carried out at this stage are to make and fix the missing parts or add content to the module so that it produces a module that has novelty value. In addition to modules, this study also developed student worksheets, learning outcomes tests, and student response questionnaires. Developing a module is done by remodelling and/or adding content from several books, teaching materials, and modules from various sources. This module also links the circular motion material to local wisdom. The modules developed in this study consist of covers, title pages, preface, table of contents, module composition, competency standards, concept maps, explanations of traditional grafting tools, keywords, learning materials, physics info, physics figures, sample questions, summary, practice questions, student worksheets, glossary, bibliography, and answer keys to practice questions. Three validators subsequently validated the module, student worksheets, learning outcome tests, and response questionnaires that were developed.

Implement, at this stage, the developed module is applied for students of Grade X Science 1 Senior High School 8 Banjarmasin to determine the feasibility of the module in the learning and teaching process. It was in November 2019. In this stage, we will find out how practical and effective what has been developed.

Evaluate, in this stage, and the evaluation is conducted on the design and improvements that can be further carried out as suggested to perfect the developed module. The last stage is to conduct an evaluation which includes formative evaluation and summative evaluation. Formative evaluation is carried out at the design and

development stage, which is used to refine the developed module. Meanwhile, summative evaluation is conducted to determine the developed module's feasibility based on module validity, module practicality, and module effectiveness. Further improvements will be made if necessary. Then the researcher compiled a research report including module manuscripts, student worksheets, learning outcome tests, and student response questionnaires that had been developed.

The instruments utilized in this R&D are (1) module validation sheets assessed by three validators to discover the validity of the module developed; (2) students' questionnaire responses to examine the practicality of the module which they will be doing; and (3) learning outcomes test to determine the effectivity of the module which later will be worked on by the students.

As obtained from the validators' assessments, the generated data to examine the validity of the module are then calculated to find the average value. The module validity instrument contains mixed local wisdom in terms of content and appearance validity. The content validity instrument was reviewed from a content quality, organization, language, and evaluation. Meanwhile, the instrument of display validity was viewed from consistency, format, attractiveness, font shape and size, and language. In addition to making a module validity instrument, this study also made an instrument for the validity of student worksheets, learning outcomes tests, and student response questionnaires. Instrument validity of student worksheets in terms of student worksheet format, language, and content of student worksheets. The instrument of validity test of learning outcomes relates to aspects of general construction and aspects of item validity. Meanwhile, the instrument for the response questionnaire's validity was reviewed

from the instrument format, instrument content, and construction. The module validity data, student worksheets, learning outcome tests, and response questionnaires were obtained from the assessment results by three validators, namely two academic validators and one practitioner validator. The evaluation categories for the module's validity, student worksheets, learning outcomes tests, and response questionnaires with assessment categories 1 to 4, where 1 = not good, 2 = poor, 3 = good, 4 = very good. If the test result on the developed module is categorized as valid, the data obtained can then be tested for its reliability aspect using the *Alpha Cronbach* formula. The categories of the reliability of the module are also adjusted with the reliability assessment criteria for modules by Widoyoko (2016).

As observed from students' responses, the data collected for the practicality of the module were analyzed in the form of percentages on a Likert scale. The categories of the module's practicality were accustomed with Riduwan's practicality assessment criteria for modules (Margaretha & Suwito, 2019). The student response questionnaire was carried out by students using a response questionnaire by ticking the module's practicality categories were accustomed to 0 = disagree, 1 = less agreeable, 2 = neutral, 3 = agree, 4 = strongly agree. The rating scale uses a Likert scale.

Instrument effectiveness of the module in terms of test results of student learning in the form of description questions. This problem consists of 7 questions, of which 2 questions about quantities in circular motion, 3 questions about regular circular motion, and 2 problems about wheel relations. The effectiveness of the module is then perceived from the calculated *N-gain* score. It is based on Normalized Gain's equation (*N-Gain*) and later adjusted to

the *N-gain* assessment criteria (Hake, 1998).

RESULT AND DISCUSSION

The finished product of this research is a circular motion physics module integrated with *gumbaan* local wisdom. The novelty of the developed module lies in the materials which are associated with traditional *gumbaan* tools. The figures inserted within the materials of the module also took form in *gumbaan* parts. One of the figures represented the concept of periods and frequency. To explain this concept, the module utilized an image of a rotating shaft, where the rotating shaft on *gumbaan*, which repeatedly rotated in a specific time, and thus would cause physics units in a circular motion, namely period and frequency.

This physics module also contains a descriptive article regarding the tradition tool itself, *gumbaan*. The article is intended to introduce this tool to students who do not know and have never seen it before. The following products developed can be seen in Figure 1 and Figure 2.

Berdasarkan materi gerak lurus yang Anda pelajari sebelumnya, posisi suatu benda setiap saat berubah terhadap suatu acuan. Bagaimana dengan gerak berputarnya bola dalam sebuah ruang? seperti Gambar 1.2.



Gambar 1.2 Pusat sebuah bola dunia yang berputar tetap terhadap suatu acuan, namun posisi partikel-partikel di pinggir bola berubah setiap saat.

(Sumber: Kanginan, 2013)

Tampak pusat bola dunia tetap pada tempatnya, sehingga posisi bola jelas tetap terhadap ruang sebagai acuan. Tetapi, posisi partikel-partikel di pinggir bola setiap saat berubah terhadap pusat bola atau garis yang melalui pusat bola (disebut sumbu rotasi). Gerak yang dialami partikel-partikel di pinggir bola disebut **gerak melingkar**.

Perpindahan (linear) dan kecepatan (linear) pada gerak lurus termasuk besaran vektor. Sedangkan, pada gerak melingkar pun Anda akan mengenal besaran yang mirip dengan itu, yaitu perpindahan sudut dan kecepatan sudut, keduanya juga termasuk besaran vektor. Selain itu, dalam

gerak melingkar juga dipelajari mengenai periode dan frekuensi.

1.1 PERIODE



Gambar 1.3 Tangkai pemutar (Sumber: Dokumen pribadi)

Perhatikan Gambar 1.3, pada saat Anda memutar tangkai pemutar, tiap titik pada tangkai akan melakukan gerak melingkar. Misalkan, suatu titik pada tangkai pemutar memerlukan selang waktu 5 s untuk menempuh 1 kali putaran, dapat dikatakan bahwa periode tangkai tersebut adalah 5 s. Sehingga, periode (diberi lambang T) didefinisikan sebagai selang waktu yang diperlukan oleh suatu titik materi pada benda yang berputar terhadap suatu poros tertentu untuk menempuh satu kali putaran (satu kali melingkar). Sehingga, dapat ditulis persamaan periode sebagai berikut.

$$T = \frac{t}{n} \quad (1.1)$$

T = periode (s)
 t = selang waktu (s)
 n = banyaknya putaran

Figure 2 A Picture of The Rotating Shaft on *Gumbaan* Illustrates The Concept of The Period

ALAT TRADISIONAL GUMBAAN



Gambar 1. Gumboot (Sumber: Husaini, 2014)

Gumboot merupakan alat tradisional khas Kalimantan Selatan yang digunakan oleh para petani untuk memisahkan antara padi bersih dengan padi hampa dan sisa-sisa kotoran padi seperti potongan batang padi. Alat ini terbuat dari kayu berbentuk seperti gitar dimana berbentuk lingkaran dibagian depan, dan berbentuk persegi panjang pada bagian belakangnya.

Prinsip kerja dari *gumboot* ini adalah dengan memasukkan padi yang masih kotor ke dalam *takungan* sesuai dengan kapasitas dari *takungan* tersebut. Kemudian, putar tangkai yang ada pada *gumboot* tersebut dengan arah yang berlawanan dengan arah jarum jam sehingga baling-baling akan berputar. Lalu geser klip pengatur untuk mengatur alur keluarnya padi dari *takungan* sesuai keinginan. Pada saat digeser, padi akan jatuh dan baling-baling yang berputar tersebut akan menimbulkan angin yang akan

memisahkan antara padi bersih dan padi hampa. Padi bersih memiliki massa yang lebih besar dibandingkan padi hampa. Sehingga, padi yang massanya lebih besar akan jatuh menuju jalur penampung 1 yang merupakan tempat keluarnya padi bersih, sedangkan padi yang massanya lebih ringan bergerak horizontal menuju jalur penampung 3 yang merupakan tempat keluarnya padi hampa. Sedangkan jalur penampung 2 merupakan jalur batu hampa, yang masih bisa dibersihkan kembali karena masih mengandung sedikit padi bersih.



(Sumber: Dokumen pribadi)

Figure 2 An Article Describing The Traditional Tool, *Gumboot*, within The Module

The circular motion physics module integrated with *gumboot* local wisdom developed also incorporates the use of a cooperative learning model. The module involves several learning objectives that must be mastered by students, in which their learning motivation is associated with the traditional *gumboot* tools to encourage their interests in learning the topic of uniform circular motion. The module also contains information regarding the complete materials for the learners. The student worksheet, which is included in the module, requires students to study in groups guided by the teacher. The practise questions in this module, however, must be done individually. An answer key page can be found on the last page, enabling students to evaluate their mastery of the lessons taught.

Module Validation Results

This module's validity is based on several evaluation aspects, such as content validity and display validity. The results of the validity calculation can be seen in Table 1.

Table 1 Module Validation Results

Evaluation Aspect	Average	Category
Content	3,16	Good
Display	3,26	Good
Validity	3,21	Good
Reliability	0,80	Very Good

Based on the results displayed in Table 1, it is obtained that the circular motion physics module is categorized as “good”. Thus, this module is deemed suitable for use as it has managed to fulfil a good module's criteria. On the other hand, the validity of this module's content and display scored a “very good” degree of reliability, which means that the assessments conducted by the three validators towards the physics module indicated a very high level of reliability. This is following the statement expressed by Daryanto (Fitri, Sumarmin, & Advinda, 2015; Wati, Hartini, Misbah, & Resy, 2017), in which a module is considered as valid when the content of the module matches the learning objectives to be achieved.

Overall, this physics module is suitable for use as it meets the criteria both in the aspects of content and display. In terms of content, the module effectively reaches the learning objectives stated while also increasing students' motivation in learning (Asyhar in Wati et al., 2017). Meanwhile, in terms of display, the module is designed with a focus on the quality elements of the module (Sutrisno, 2008).

Module Practicality Results

The circular motion physics module's practicality integrated with *gumbaan* local wisdom is measured based on students' questionnaire responses. Table 2 below represents the data of the questionnaires' results.

Table 2 Module Practicality Results

Evaluation Aspect	Percentage	Category
Convenience	61,61	Good
Benefit	61,76	Good
Learning Time	72,68	Good

Efficiency		
Module Practicality	64,92	Good

Regarding the data displayed in Table 2, it can be inferred that convenience obtained a nominal percentage of 61.61% that belonged in the "good" category. This indicates that the developed circular motion physics module integrated with *gumbaan* local wisdom is represented systematically and gradually (Herdianto, Putra, & Anggoro, 2018). The size and font types of letters chosen are easy to read, and the language used is comprehensible (Sutrisno, 2008). As a whole, the materials can also be understood easily by the students (Prastowo, 2015). The physics module developed also has LKPD for each meeting, which helps the learners explore the materials being studied and ease them in learning independently (Prastowo, 2015).

The benefit aspects stated in Table 2 scored a percentage of 61.76%, meaning that it is categorized under “good” category. It can be inferred that the developed physics module presented exciting pictures which are following the learning materials taught (Sutrisno, 2008), as the pictures within the modules are taken from one part of the traditional tool, *gumbaan*, as adapted to the learning materials being taught. Besides, a concept map is also added to help students understand the crucial points of the materials to be studied. Moreover, the materials contained in the developed physics module is adjusted with the learning objectives (Prastowo, 2015). The available key answers also ease students who use the physics modules as they can assess their learning results (Prastowo, 2015).

The aspect of learning time efficiency in Table 2 achieved a nominal percentage of 72.68%, which is categorized as “good”, as it was proven that the developed physics module enables the learning process to complete the activities on time, and students were

able to finish the practice questions at the end of the lesson (Daryanto, in Rahmayanti et al., 2016; Sa'diyah, Suarsani, & Ibrohim, 2016). This illustrates that the practicality of the developed circular motion physics module integrated with *gumbaan* local wisdom, as observed from the aspects of convenience, benefits, and learning time efficiency, can be considered practical for learning and teaching.

Module Effectivity Results

The circular motion physics module's effectiveness integrated with *gumbaan* local wisdom is measured from students' academic scores. The following Table 3 presents the result of the *N-gain* calculation of the students' learning outcome scores.

Table 3 Module Effectivity Results

Pretest Average Score	Post-test Average Score	<i>N-gain</i>	Category
8.29	48.54	0.44	Medium

The physics module's effectiveness is determined by examining students' academic scores in terms of *N-gain* acquisition (Oktaviana, 2017). The pretest and post-test results are utilized to determine the *N-gain* value (Selvia, Arifuddin, & Mahardika, 2017).

This result was only the medium's category because students did not apply cooperation in groups; during group discussions, only one or two people were dominated. Thus, resulting in other students being passive and not understanding the material being studied. This is in line with Nurdyansyah & Fahyuni (2016) that one of the shortcomings of implementing the cooperative learning model in the teaching and learning process tends to be dominated by only one or two students.

Another factor is that students do not write down answers in detail. The learning outcomes test practice questions consisted of one C2 cognitive question, which is related to science processing skills, two C3 cognitive questions

regarding the applications of equations to solve the problems given, and four C4 cognitive questions, which is associated with science processing skills, namely one question regarding centripetal acceleration formula, another related to analyzing units in a circular motion, and the last question is related to the application of circular motion on the traditional *gumbaan* tool. There were only five students who managed to reach the minimum passing score on the post-test, whilst those who did not reach the minimum score were 23 students. Out of the seven questions distributed, questions number 3, 4, and 5 obtained the lowest average score.

On question number 3, students were asked to identify and define the experimental variables. However, some students only wrote the identification of the related variables without adding the variables' definitions. The students admitted that they had difficulty explaining how the tools are used, the tools used, and the units used to measure the units of the variables in the experiment. Meanwhile, on question number 4, students were instructed to analyze the data and conclude the experiment results. However, several students only wrote the conclusions without analyzing the data beforehand. This is due to the lack of experimental practicums in the school, while the learning activities in this research only consisted of one practicum activity. The research conducted by Novia, Hudri, & Dwiridal (2017) and Zulaiha, Hartono, & Ibrahim (2015) showed that the lack of practicum activities at schools tend to cause the low ability of students in defining variables and analyzing data.

Additionally, students were ordered to formulate the centripetal acceleration equation from the figure. Nevertheless, a few of the students did not formulate the equation before writing it down. It was figured out that this was caused by the fact that students were accustomed to

memorizing the final formula and immediately applying the formula to solve the problem. Hidayat, Hakim, & Lia (2019) revealed that physics learning emphasizes understanding concepts rather than memorizing. When one becomes accustomed to memorizing without comprehending the concepts of the material being taught, then the learning outcomes will be low, and formulating equations tend to be low. Another factor that affects this test results is that there are students who did not cooperate within the group works; for instance, one or two people dominated the discussion. As a result, the rest of the group members could not understand the materials discussed (Nurdyansyah & Fahyuni, 2016).

Nonetheless, the students' cognitive skills had improved compared to the previous lessons when they were not taught using the developed modules. This improvement is observed based on the increased average scores of the pretest and post-test. The students were also given individual exercise questions, which could help measure each of their learning outcomes. Besides, the modules also contained example questions. Anisah, Wati, & Maharika (2016) stated that a module is more effective when it is capable of giving an academic result aligned with the learning outcomes.

Another factor was that the learning material delivered had integrated *gumbaan* local wisdom, which eased the learners in comprehending the concept's application. This is supported by the convenience aspect obtained on the questionnaire responses reached a percentage of 61.61%, which fell in the "good" category. In line with the research results discovered by Wati et al. (2017) and Oktaviana et al. (2017), they claimed that students tend to master and comprehend the materials better after using the developed module, which proved that the use of physics module could enhance learning outcomes.

Moreover, physics modules that are integrated with local wisdom ease students in understanding the materials (Wati et al., 2017; Hartini, Isnanda, Wati, Misbah, An'Nur, & Mahtari, 2018; Misbah, Hirani, Annur, Sulaeman, & Ibrahim, 2020; Wati, Putri, Misbah, Hartini, & Mahtari, 2020) while also making the learning process more meaningful as they can apply their knowledge in everyday life situations. In addition, physics modules that contain local wisdom can raise students' motivation, as the familiar materials are connected with the local wisdom students commonly encounter (Fitriah, 2019). Arfinawati, Sudarmin, & Sumarni (2016) added that the enhanced learning outcome is also impacted by classroom activities that integrate local wisdom, as students' participation in the learning process becomes more enthusiastic. The existence of local wisdom incorporated within the learning materials also raises the relevance of physics with one's surroundings, as it can easily be felt, directly be sensed, and conveniently found that it promotes purposeful learning and teaching for learners. This relevance becomes substantial as students are capable of employing their comprehension in real life (Rahmayanti et al., 2016).

The developed physics module is explicitly designed to be adapted with the cooperative learning model. This is one of the factors which results in a more effective learning and teaching with the use of a physics module. Modules which are produced based on cooperative learning model boost students' learning (Hasanah, Suyidno, & Wati, 2014; Rahmayanti et al., 2016; Fajri, Yoesoef, & Nur, 2017; Rahim, Adri, & Suparno, 2019). This depicts that the developed physics module is considered effective for the learning process.

The development research that researchers have carried out does not escape the shortcomings and obstacles as

the limitations of the research. So that it can cause less than the maximum results with the desired expectations. This development research's weaknesses include: (1) There are 8 out of 36 students who did not attend at least one of the four meetings in this study. Thus, making the data from their work unusable for analysis purposes; (2) The ability of students to define variables operationally and analyze data and the ability of students to formulate an equation still tends to be low.

CONCLUSION

It is concluded that a circular motion physics module integrated with *gummaan* local wisdom in a cooperative learning setting is feasible. Thus, drawn from the above results, the developed physics module can be used by teachers in teaching physics, notably in the topic of circular motion. Future research is expected to explore the implication of the developed circular motion physics module integrated with the traditional *gummaan* tool to examine students' abilities and skills, especially in cooperative learning.

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