

## Preliminary Design of Kit Kinematics Learning Tools assisted by Phyphox Mobile Apps

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### Abstract

*Integration of learning tools with information technology can enrich the learning experience, including in learning physics. This research is the development of kinematics learning tools assisted by Phyphox to support the improvement of scientific thinking skills. The scope of kinematics material is horizontal straight motion, vertical straight motion, and circular motion. In this study, the initial design process and design evaluation were carried out. Evaluation of the initial design was carried out by five experts and data were collected using a questionnaire. Data analysis used Content Validity Ratio (CVR) and Content Validity Index (CVI). The analyzed aspects include six indicators, namely: the functional relationship between components, component completeness, work order, practicality, efficiency, and effectiveness. The results of this study indicate that the initial design of the kinematics learning device is in a good category (CVR = 5.60; CVI = 0.93). Thus, this learning tool can be further tested on relevant students. The impact of the use of this tool will not only increase science skills, with certain learning strategies it can also grow the skills of working together and critical thinking.*

**Keywords:** Preliminary Design, Physics Learning, Kinematics, Phyphox

### Rancangan Awal Piranti Belajar Kinematika berbantuan Mobile Apps Phyphox

#### Abstrak

Integrasi piranti belajar dengan teknologi informasi dapat memperkaya pengalaman belajar termasuk dalam pembelajaran fisika. Penelitian ini merupakan pengembangan piranti belajar kinematika berbantuan *Phyphox* untuk mendukung peningkatan keterampilan berfikir sains. Cakupan materi kinematika adalah gerak lurus horizontal, gerak lurus vertikal, dan gerak melingkar. Dalam penelitian ini dilakukan proses perancangan awal dan evaluasi rancangan. Evaluasi rancangan awal dilakukan oleh lima ahli dan pengumpulan data dikumpulkan dengan angket. Analisis data menggunakan Content Validity Ratio (CVR) dan Content Validity Index (CVI). Aspek yang dianalisis mencakup enam indikator, yaitu: hubungan fungsi antar komponen, kelengkapan komponen, urutan kerja, kepraktisan, efisiensi, dan efektivitas. Hasil penelitian ini menunjukkan bahwa rancangan awal piranti belajar kinematika dalam kategori baik (CVR= 5,60; CVI= 0,93). Dengan demikian, piranti belajar ini dapat diujicobakan selanjutnya pada siswa yang relevan. Dampak penggunaan dari piranti ini selain akan meningkatkan keterampilan sains, dengan strategi pembelajaran tertentu dapat menumbuhkan pula keterampilan bekerja sama, dan berfikir kritis.

**Kata Kunci:** rancangan awal, pembelajaran fisika, kinematika, *Phyphox*

**How to Cite:** Fatmawati, I., Sulisworo, D. (2021). Preliminary Design of Kit Kinematics Learning Tools assisted by Phyphox Mobile Apps. *Jurnal Pendidikan Fisika dan Keilmuan (JPFK)*, 7(1), 13-22. Doi: <http://doi.org/10.25273/jpfk.v7i1.9955>

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## INTRODUCTION

Learning media is one of the most important tools in the physics learning process (Hochberg, Kuhn, & Müller, 2018; Mariyo & Islami, 2019; Widodo & Islami, 2019). The increasingly massive development of technological developments should be utilized by educators to design effective, innovative, and efficient learning media so that learning objectives can be achieved (Firdaus, Setiawan, & Hamidah, 2017; Mustafa, Hermandra, & Zulhafizh, 2019; Yusrizal, Hajar, & Tanjung, 2019). Of the several technologies that can be utilized in learning, *smartphone* devices are the most potential to be used in secondary schools (Pierratos & Polatoglou, 2020).

Utilization of *smartphone* devices in learning activities is because this device has several excellent features, including being able to detect and generate data from sensors inside the *smartphone*, easy to use, provides many free applications, and enables a real-time data acquisition system which in its application has proven to be very helpful in the process. physics learning (Nuryantini, Sawitri, & Nuryadin, 2018; Temiz & Yavuz, 2015).

In practice, the use of *smartphone* devices when learning cannot stand alone but requires other supporting devices. One of the supporting applications that are often used and have proven to be reliable is the *phyphox app* (Staacks, Hütz, Heinke, & Stampfer, 2018). In addition, another device that needs to be considered is the experimental device, because the data generated by this *phyphox app* cannot be separated from the real experimental device used.

Several previous research results have also confirmed that the combination between devices greatly determines the quality of the kinematics experimental data obtained (Fayanto, Ishafit, & Sahlan, 2019; Kittiravechote & Sujariththam, 2020; Pierratos & Polatoglou, 2020). However, some of these studies have made experimental tools that are still limited to sub-experiments and have not been integrated into a single kinematics learning tool kit, so that when used in experimental activities in schools they are less efficient. Thus, it is necessary to develop a specially designed kinematics tool integrated with the *phyphox app*.

## RESEARCH METHODS

This research includes adapted development research (Dieter & Schmidt, 2009) which aims to produce an initial design of a *Phyphox*-assisted kinematics learning tool. The stages carried out include 3 phases, namely conceptual design, conceptual prototyping (design embodiment), product prototyping, and design evaluation (design details) as shown in Figure 1.

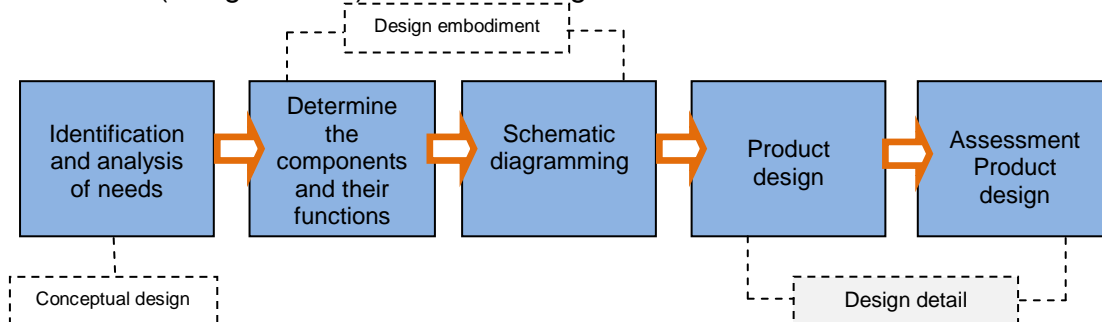


Figure 1. research flow chart

Product design assessment is carried out by adapting testing techniques from (Sugiono, 2019) namely by internal testing by five experts through filling out a questionnaire compiled using six indicators : function relationships between components, component completeness, work order, practicality, efficiency, and effectiveness. The number of questionnaire items is 6 items. The scale used is 0 to

1. The data analysis technique uses the *Content Validity Ratio (CVR)* and *Content Validity Index (CVI)*. The results of this calculation become the basis for categorization, where the product is considered feasible if the CVI is more than 0 (Lawshe, 1975).

**RESULTS AND DISCUSSION**

**1. Conceptual design**

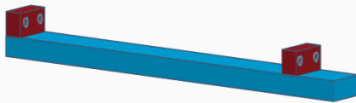




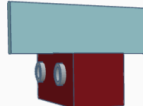
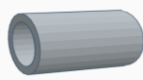
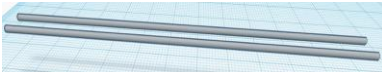
The results of the studies that have been carried out show that 21st-century learning requires a digital laboratory to support the physics learning process on kinematics material (Hinnant et al., 2012; Van De Heyde & Siebrits, 2020). As a solution to these problems, it is necessary to develop the design of kinematics experimental tools for horizontal straight motion, vertical straight motion, and circular motion (kinematics kit). In addition, in designing a kinematics kit, several indicators need to be considered, including simple design, easy to use, thorough, economical, safe to use, good quality, easy maintenance, and integrated with technology.


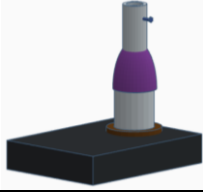


**2. Design embodiment**

a. Determination of components and their functions

The form of actualization carried out in the manufacture of the kinematics kit which is designed based on the indicators in phase I begins with determining the required components. These components can be seen in Table 2.

Table 2. Kinematics kit components

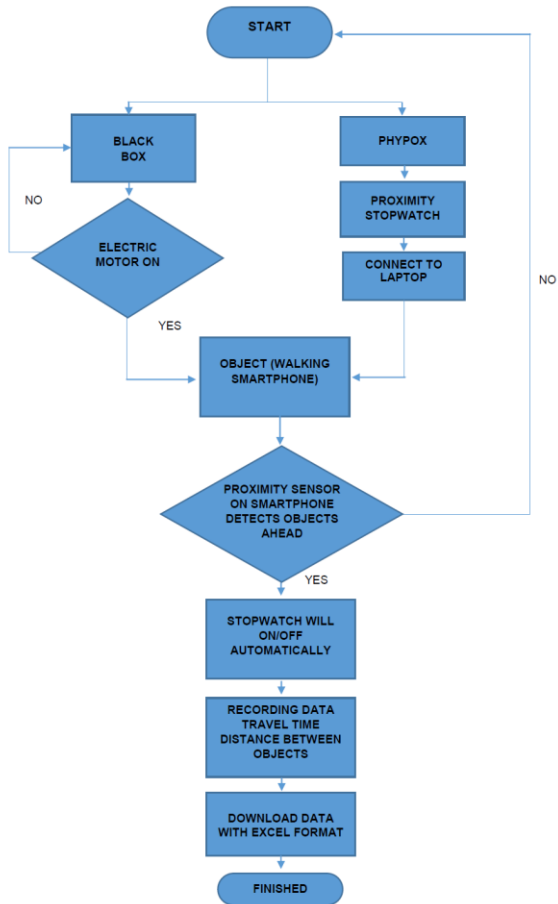
Component name	Function	Component pictures
Track	Supports the main components	
Phyphox	Time counter app with proximity and audio sensors and id <i>centripetal acceleration</i>	
Black Box	Container for controlling electronic components and electric motors	
Buzzer, relay, switch, jack Dc, cabel, Dc electric motor	Electronic components supporting tools	
Object	Proxymity sensor trigger on <i>smartphone</i>	
Smartphone holder	Smartphone support	
Bearing Linear	Cancellation of the motion of the smartphone holder that serves to reduce friction	
Iron 100 mm	Smartphone support trajectory	

Iron stative besi 5 mm	Magnetic <i>Holding Support</i>	
Stand Statif	Stative Support and Spherical Disc	
<i>Holding Magnet</i>	Drag and drop objects	
Circle plate	Circular path of object ( <i>smartphone</i> )	

b. Skematic diagramming

1) Horizontal straight motion schematic diagram

Table 3. Schematic diagram of horizontal straight motion

Flow chart	Activity
 <pre> graph TD     START([START]) --&gt; BLACK_BOX[BLACK BOX]     START --&gt; PHYPOX[PHYPOX]     PHYPOX --&gt; PROXIMITY_STOPWATCH[PROXIMITY STOPWATCH]     PROXIMITY_STOPWATCH --&gt; CONNECT_TO_LAPTOP[CONNECT TO LAPTOP]     BLACK_BOX --&gt; ELECTRIC_MOTOR_ON{ELECTRIC MOTOR ON}     ELECTRIC_MOTOR_ON -- YES --&gt; OBJECT[OBJECT (WALKING SMARTPHONE)]     ELECTRIC_MOTOR_ON -- NO --&gt; BLACK_BOX     CONNECT_TO_LAPTOP --&gt; OBJECT     OBJECT --&gt; PROXIMITY_SENSOR{PROXIMITY SENSOR ON SMARTPHONE DETECTS OBJECTS AHEAD}     PROXIMITY_SENSOR -- YES --&gt; STOPWATCH[STOPWATCH WILL ON/OFF AUTOMATICALLY]     STOPWATCH --&gt; RECORDING_DATA[RECORDING DATA TRAVEL TIME DISTANCE BETWEEN OBJECTS]     RECORDING_DATA --&gt; DOWNLOAD_DATA[DOWNLOAD DATA WITH EXCEL FORMAT]     DOWNLOAD_DATA --&gt; FINISHED([FINISHED])     PROXIMITY_SENSOR -- NO --&gt; START     </pre>	<p><b>Preparatory steps</b></p> <ol style="list-style-type: none"> <li>1) open phyfox app with smartphone,</li> <li>2) select stopwatch proximity,</li> <li>3) connect phyfox with Personal Computer (PC) via remote access,</li> <li>4) put the smartphone on the holder,</li> <li>5) set the distance between objects,</li> <li>6) connect the holder to the dc motor on the black box using a thread</li> </ol> <p><b>Data retrieval steps</b></p> <ol style="list-style-type: none"> <li>1) click play phyfox button via PC,</li> <li>2) move the switch on the black box to the GLB to turn on the dc motor which aims to pull the smartphone,</li> <li>3) the smartphone runs the stopwatch automatically and in realtime it will record the time.</li> <li>4) after the smartphone passes the 5th object, turn off the dc motor.</li> </ol> <p>Download data on <i>phyfox</i> via pc with <i>microsoft excel</i> format.</p>

2) Vertical straight motion schematic diagram

Table 4. Schematic diagram of vertical straight motion

Flow chart	Activity
	<p><b>Preparatory steps</b></p> <ol style="list-style-type: none"> <li>1) open phyfox app with smartphone,</li> <li>2) select stopwatch proximity,</li> <li>3) connect phyfox with Personal Computer (PC) via remote access,</li> <li>4) put the smartphone on the holder,</li> <li>5) set the distance between objects,</li> <li>6) position the track at an angle of 30o and hold the smartphone.</li> </ol> <p><b>Data retrieval steps</b></p> <ol style="list-style-type: none"> <li>1) click play phyfox button via PC,</li> <li>2) remove the smartphone with the aim of moving it under the influence of gravity.</li> <li>3) the smartphone runs the stopwatch automatically and in realtime it will record the time.</li> </ol> <p>Download data on phyfox via pc with microsoft excel format.</p>

3) Free fall motion schematic diagram

Table 5. Free fall motion schematic diagram

Flowchart	Activity
	<p><b>Preparatory steps</b></p> <ol style="list-style-type: none"> <li>1) connect the black box with the magnetic holder,</li> <li>2) open the phyfox application with a smartphone,</li> <li>3) select acoustic stopwatch,</li> <li>4) connect phyfox with Personal Computer (PC) via remote access</li> <li>5) place the smartphone next to the black box,</li> <li>6) tie 5 pieces of iron to the thread with a distance between the irons of 10 cm.</li> </ol> <p><b>Data retrieval steps</b></p> <ol style="list-style-type: none"> <li>1) click play phyfox button via PC,</li> <li>2) show the switch on the black box to GJB,</li> <li>3) stick one end of the iron on the magnet holder</li> <li>4) press the Start button on the black box (the buzzer will sound, the magnetism in the holder is lost, the iron falls)</li> <li>5) Automatic stopwatch running and realtime sera will record time data.</li> </ol> <p>Download data on phyfox via pc with microsoft excel format.</p>

4) Schematic diagram of uniform circular motion

Table 6. Schematic diagram of uniform circular motion

Flowchart	Activity
	<p><b>Preparation steps</b></p> <ol style="list-style-type: none"> <li>1) open phyphox app with smartphone,</li> <li>2) select Centripetal acceleration,</li> <li>3) connect phyphox with Personal Computer (PC) via remote access,</li> <li>4) Place the smartphone on a round disc.</li> </ol> <p><b>Data retrieval steps</b></p> <ol style="list-style-type: none"> <li>1) open the phyphox application with a smartphone,</li> <li>2) select centripetal acceleration,</li> <li>3) connect phyphox with a personal computer (PC) via remote access,</li> <li>4) place the smartphone on a round disc.</li> </ol> <p>Download data on phyphox via pc with microsoft excel format.</p>

3. Phase III Design Details

a. Kinematics kit design creation

In this phase, the activity carried out is making a kinematics kit design, the main activity is divided into 2, namely making a black box scheme design using the Proteus application and designing a detailed 3D kinematics kit display using Tinkercad. The results of the black box scheme design are shown in Figure 6.7 and the kinematics kit of horizontal straight motion, vertical straight motion, and circular motion can be seen in Table 7 as follows:

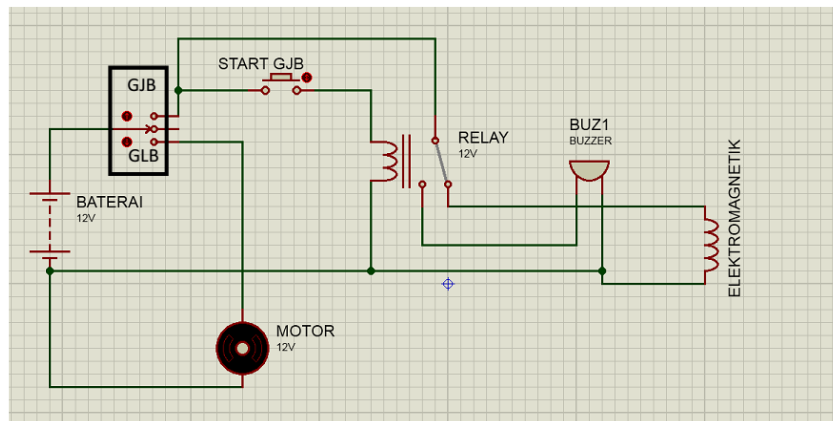


Figure 6. black box scheme



Figure 7. *black box display design*

Table 7. Conceptual drawings and finished products

Conceptual image	Finished product

### b. Product design assessment

The last stage of the development of the kinematics kit design is an evaluation of the assessment by 5 experts which aims to determine the quality of the design that has been made. At this stage, the evaluation of media design is carried out using a questionnaire instrument with 6 indicators adapted from (Sugiono, 2019). The data obtained were then analyzed quantitatively using *CVR* and *CVI*. The results of the *CVR* and *CVI* analysis shown in table 8 obtained a *CVI* score of 0.93 meaning that the media design developed was valid and had good quality.

Table 8. Analysis of *CVR* and *CVI*

Indicator	Validator					CVR	Description
	1	2	3	4	5		
Functional relationship between components	1	1	1	1	1	1,00	Valid
Completeness of components	1	1	1	1	1	1,00	Valid
Order of work	1	1	1	0	1	0,60	Valid
Practicality	1	1	1	1	1	1,00	Valid
Efficiency	1	1	1	1	1	1,00	Valid
Effectiveness	1	1	1	1	1	1,00	Valid
<b>TOTAL CVR</b>						5,60	Valid
<b>CVI</b>						0,93	Valid

The assessment results obtained indicate that the developed media has an attractive appearance, is simple, easy to use, and is time-efficient, so the media deserves a good assessment (Istiantara et al., 2019; Karo-Karo & Rohani, 2018; Pierratos & Polatoglou, 2020; Widiyanta & Pramono, 2019). This media is also used in collaboration with the phyphox apps which have been proven reliable and have data accuracy, and can be presented in real-time (Ishafit & Wahyuni, 2019; Pierratos & Polatoglou, 2020; Pusch, Ubben, Laumann, Heinicke, & Heusler, 2021; Suyanto & Herlina, 2020). The voltage source used in this medium is a DC 5v current that can be recharged, so it is environmentally friendly and will increase the safety factor when used.

Other results obtained from the evaluation stage are several suggestions were given by experts, including 1) Installation of the buzzer should be placed on the black box, 2) the voltage component of the voltage is lowered to 5 volts so that it can work with a battery voltage source, 3) installation of a length measuring instrument on the mainframe.

### CONCLUSION

This research resulted in the initial design of the kinematics kit and its working system. The evaluation results from the kinematics kit design expert are of very good quality. Based on these results, the design of the kinematics kit can be continued to the next stage, namely the trial process in schools.

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