

Research Article

Innovation of an Integrated Ticker Timer Learning Media to Support Inquiry-based Physical Learning in Kinematics Competence for Senior High School

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Abstract.

Physics learning for kinematics sub-competence in high schools is expected to use a scientific approach by means of inquiry-based learning models. In order to implement the scientific approach for learning kinematics, we need an integrated good-quality ticker timer in such a way that students are able to observe straight-line motion phenomena. In this study, we have developed an integrated ticker timer with the following characteristics: valid, efficient, easy, safe, high durability, and visually eye-catching. As a result, our integrated ticker timer have the same frequency with better temperance and 2.30% margin of errors compared to commercial ticker timer. In addition, our developed ticker timer only requires a relatively small electrical power. Furthermore, the integrated ticker timer as an innovative learning medium can improve better performance in physics teaching and learning process, with these characteristics: (1) fast to obtain measurement data, precise and accurate; (2) easy to use, safe, and high durability; (3) able to help and motivate teachers and students to learn kinematics.

Keywords: ticker timer, learning media, inquiry-based, kinematics competence

1. INTRODUCTION

Integrated circuit (abbreviated as IC) is a basic component comprises of resistors, transistors and others in one single chip. The IC was first discovered by Jack Kilby and Robert Noyce who worked at Texas Instruments and Fairchild Semiconductor Corporation, The main objective of the IC discovery was to improve the performance of the discrete circuits of the previous transistors. The combination of several transistors on a semiconductor chip called chip is expected to be (a) more stable, compact and reliable because it only requires very few and uncomplicated interconnection connections, (b) able to perform more complex and complicated functions, (c) smaller and lighter. The IC is still being developed to improve its performance [5]. Therefore, the development

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of simpler and easier instruments is obviously important, as well as the development of integrated ticker timer for physics teaching and learning needs.

Now days, physics learning media available in the school or university laboratories, in general, are still separately in installation in which are not yet compact, specific and proportionate so that they have poor performance. The impact of learning media with poor performance forces teachers to be relatively unpleasant and reluctant to use the media during their teaching time. Teachers did not facilitate students to find knowledge through their own experiences and therefore they did not carry out inquiry-based learning [1] [1][4][10]. In other words, using media that has integrated supporters is expected to have better performance.

Theoretically, inquiry-based learning is one of the learning models developed for the purpose of teaching students how to think and to discover knowledge from their own experiences. Student-centered inquiry-based learning shows significantly better learning achievement compared to teacher-centered classes [1][8][6]. The results showed that inquiry learning could improve scientific mastery, productivity in creative thinking, and drill students skills in analyzing information and solving problems [3][11][12][16][18]. Previous research has shown that the application of innovative models, such as inquiry-based learning in physics learning, has proven to be effective in developing students' mastery concepts and problem-solving strategies [5][19][20]. The main role of the teachers when carrying out inquiry-based learning is to facilitate students to be able to engage in the process of inquiry and the thought process is always attentive and reflective to find their own knowledge [25][30][31].

The facilities needed by students to be able to find the knowledge of particularly kinematics competencies are easy to use instruments. Hence, we developed an integrated ticker timer as good learning medium. Students can learn kinematics through measurement by watching videos on *Youtube* and accessing quality free videos [7][13][24]. The learning media for wireless force sensors and accelerometers are very well used for demonstrations in preliminary physics programs [7]. Good media quality is valid (relevance and consistency), i.e. relevance (content validity) is a media validity criterion based on need (need) and sophisticated (state-of-the-art). Consistency (construct validity) is a media validity criterion which states that logically designed media according to the expert includes the shape, size and specification [2][6].

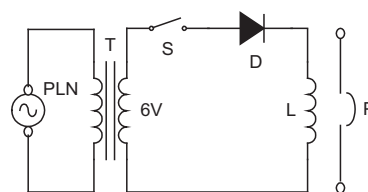
2. METHOD

The steps in developing learning media and technology effectively and systematically are known as procedural models that are given the acronym ASSURE. The ASSURE is Analyze Learners (A), State objectives (S), Select methods, media and materials (S), Utilize media and materials (U), Require learner participation (R), Evaluate and revise (E), [2]. The Specifications of integrated ticker timer also determined by laboratory activities as follows: Measurement of input and output power of the ticker timer and measurement of frequency and reliability of the integrated ticker timer. Further research determined the Validity, Practicality and Effectiveness of the Integrated Ticker Timer.

3. RESULTS AND DISCUSSION

Specifications of the Integrated Ticker Timer is the Input Power (P_i) with 10 repetitions were obtained as $P_i = (10.52 \text{ W} \pm 1.01\%)$. The Output Power (P_o) with 10 repetitions were obtained as $P_o = (7,34 \text{ W} \pm ,55\%)$, The frequency (F) with 5 repetitions we are obtained as $F = (49.02 \text{ Hz} \pm 1.52\%)$ and the reliability (K) with 7 repetitions for 10 cm of tape length are obtained as $K = (17,71 \pm 2.30\%)$. Laboratory measurement results show the validity of the Integrated Ticker Timer, because it shows the accuracy and precision of the device.

Further research results are obtained, Practical of Integrated Ticker Timer with 139 respondents showed 90.8 results in the practical category without improvement or height which meant that it was very easy to operate to achieve the expected learning goals, the Effectiveness of the Integrated Ticker Timer with 105 samples shows N-Gain 0.6 results in the medium category [8][9] which means it can be used to achieve the expected learning objectives. The Effect Size Ticker Timer Integrated with 105 samples shows a value of 0.7 in the medium category which means it has a positive enough impact to achieve the expected learning goals.



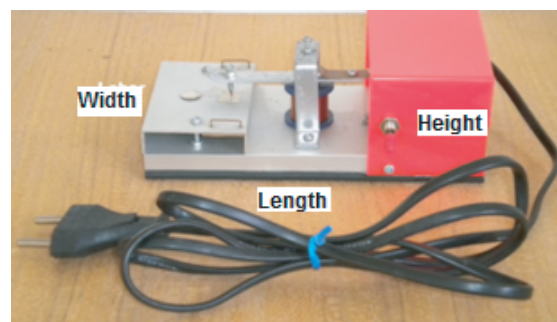
PLN : Ticker Timer power source from PLN 220V;
 T : Transformator Step down with output 6 V, 1A;
 S : Switch on/off;

D : Diode 3 A
 L : Inductor
 P : Knock plate/vibrator

Figure 1: Integrated Ticker Timer Schema [26].

3.1. The Working Principle and Shape of the Integrated Ticker Timer

The voltage of 220V by the Transformer(T) is reduced to 6V, the electric current flows in the diode circuit and the coil is determined by the position of the On/Off (S) switch. AC electricity with a voltage of 6V is directed by a half-wave rectifier by a diode (D) without a leveller in such a way that there is still a ripple strong enough to produce a changing magnetic field in the coil (L). The changing magnetic field pulls and releases the knocker plate (P) to produce a knock. The knock is fed to carbon and paper to record a trace of motion. The Shape and Size of the Integrated Ticker Timer.



Note:

Length : 19 cm
 Width : 7.5 cm
 Height : 5.5 cm

Figure 2: Shape and Size of the Integrated Ticker Time [27] [28].

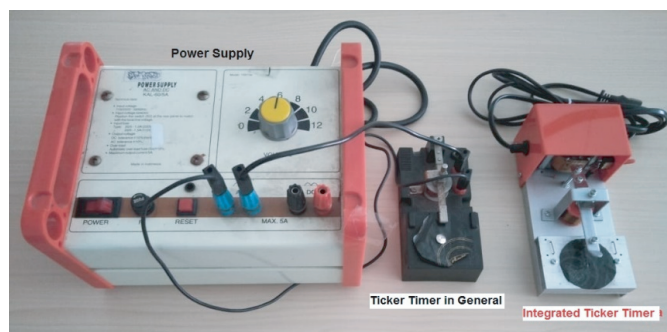


Figure 3: The Comparison of the Integrated Ticker Timer Size with the Ticker Timer in general.

4. DISCUSSION

The specifications integrated ticker timer requires input power $P_i = 10.52$ W and output power $P_o = 7.34$ W which is much smaller than the power provided by the 10 A \times 6 Volt

power supply = 60 W for the common ticker timer. The integrated ticker timer requires a low power source to activate the device. Therefore, the operation of the integrated ticker timer is much simpler and easier than the use of commercial ticker timers in general, economically saving operation and procurement costs. Teachers and students will be happy to operate this integrated ticker timer because they just need to plug the jack into the socket and press the on/off button without being burdened to assemble with other devices, which often causes difficulties. Using the Integrated Ticker Timer can get data quickly, help and motivate teachers and students to use it. The integrated ticker timer has a frequency $F = 49.02$ Hz which is the same as the commercial ticker timer used in the laboratory but has better clarity/reliability because its tolerance is only 2.30% less than 5% tolerance of electronic devices in general. Simply put, this device can be used with high accuracy so that it can obtain precise and accurate data.

The integrated ticker timer has a much smaller dimension ($19 \times 7.5 \times 5.5$) cm³ which is much smaller than the ticker timer volume and power supply in general so that it can save storage. During the study, there was no damage and heat found on the device, this device was equipped with a voltage safety cap so that it did not endanger the user, so this device was durable and safe to use. Based on the measurement results in the Laboratory the Integrated Ticker Timer specifications show the media is valid for use in measurements.

The Results practicality measurement of the Integrated Ticker Timer which was developed 90.8 in the practical category without improvement or height, means that it is very easy to operate can help students to get data in finding concepts.

The results of the measurement of the effectiveness of the integrated Ticker Timer developed produce N-Gain 0.6 in the medium category, meaning that it can be used to achieve the expected learning objectives. The result of Measurement Effect-Size (D) shows the value of 0.7 in the medium category, which means it has a positive enough effect to achieve the expected learning objectives.

5. CONCLUSION

The integrated ticker timer has been successfully developed with valid, practical and effective. The results of the integrated ticker timer show that it has the same count as the commercial timer ticker commonly used in the laboratory but has better clarity/readability with an error of 2.30%. Thi integrated ticker timer innovation development can improve good performance in physics learning to obtain these following characteristics: (1) Fast to obtain measurement data, precise and accurate; (2) easy to use,

safe, and high durability; (3) able to help and motivate teachers and students to learn kinematics.

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