PERIÓDICO TCHÊ QUÍMICA
ARTIGO ORIGINAL

DESENVOLVENDO MEIOS DE APRENDIZAGEM DE GRÁFICOS DE FÍSICA NO CONCEITO DE CINEMÁTICA E SUA AVALIAÇÃO USANDO TUG-K (TEST OF UNDERSTANDING GRAPHS IN KINEMATICS)

DEVELOPING PHYSICS GRAPH LEARNING MEDIA IN THE CONCEPT OF KINEMATICS AND ITS ASSESSMENT USING TUG-K (TEST OF UNDERSTANDING GRAPHS IN KINEMATICS)

PENGEMBANGAN MEDIA PEMBELAJARAN GRAFIK FISIKA PADA KONSEP KINEMATIKA DAN PENILAIANNYA MENGGUNAKAN TUG-K (TEST OF UNDERSTANDING GRAPHS IN KINEMATICS)

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RESUMO

Introdução: Avaliação para determinar a capacidade de dominar gráficos MRU e MRUV, nomeadamente o Teste de Compreensão de Gráficos em Cinemática (TUG-K). Por meio do TUG-K, que é ajustado às competências básicas, os professores podem formular indicadores de desempenho de competências. **Objetivos**: Este estudo teve como objetivo desenvolver meios de aprendizagem de grafos físicos (GraFIS) no conceito de cinemática, descrever a eficácia da aprendizagem após o uso de mídia GraFIS e descrever as percepções dos alunos sobre a aprendizagem usando mídia GraFIS e avaliação usando TUG-K. **Métodos**: Esta pesquisa foi uma pesquisa de PandD. Os aplicativos desenvolvidos utilizam a tecnologia HTML5 que pode ser distribuída em um aplicativo web. O software desenvolvido foi aplicado a 143 respondentes do grau X MIPA da SMA Negeri 3 Purworejo. A coleta de dados foi conduzida com o fornecimento de planilhas de validação a especialistas em materiais, especialistas em mídia e respostas a questionários de alunos, para fornecer informações sobre os produtos desenvolvidos. **Resultados e discussões**: Os resultados da pesquisa foram na forma de aplicação do graFIS como um meio adequado para uso. Os resultados da implementação das atividades de ensino e aprendizagem por meio dos planos de aula elaborados mostraram que a eficácia da aprendizagem com o aplicativo GraFIS ainda se encontrava na categoria baixa com um ganho de pontuação normalizado de 0,03, o que significava que ainda precisava de revisão e aprimoramento. Os resultados da análise das diferenças nas pontuações do pré e pós-teste usando Shapiro-Wilk obtiveram dados que não foram normalmente distribuídos, com Sig. 0,015 <0,05. Portanto, o teste continuou usando o Wilcoxon Signed Rank Test. Foram obtidos os valores de Asymp. Sig. (Bicaudal) <0,05, o que interpretou que houve diferença significativa entre os resultados do pré e pós-teste. **Conclusões**: Conclui-se que melhorias e revisões ainda são necessárias. Com base nas percepções dos alunos, o aplicativo GraFIS atendeu aos padrões de usabilidade e qualidade móvel.

Keywords: *TUG-K*, HTML5, media, *web, móvel.*

ABSTRACT

Background: Assessment to determine the ability to master GLB and GLBB charts, namely the Test of Understanding Graphs in Kinematics (TUG-K). Through TUG-K which is adjusted to basic competencies, teachers can formulate indicators of competency achievement. **Aim** : This study aimed to develop Physics Graph learning media (GraFIS) on the kinematics concept describe the effectiveness of learning after using GraFIS media and describe students' perceptions of learning using GraFIS media and assessing using TUG-K. **Methods:** This research is an R and D research. The developed applications used HTML5 technology that can be published on the web app. and mobile app. The application was applied to 143 respondents in grade X MIPA of SMA Negeri 3 Purworejo. Data collection was conducted by giving validation sheets to material experts, media experts, students' questionnaire responses, to provide input on the products developed. **Result and Discussion**: The results of the research were in the form of graFIS application as a suitable medium for use. The results of implementation in teaching and learning activities through lesson plans that had been prepared showed that the effectiveness of learning using the GraFIS application was still in the low category with a normalized score gain of 0.03, which meant that it still needed revision and improvement. The analysis results of differences in pretest and posttest scores using Shapiro-Wilk obtained data that were not normally distributed, with Sig. 0.015 <0.05. Therefore, testing continued using the Wilcoxon Signed Rank Test. It was obtained the values of Asymp. Sig. (2-tailed) <0.05, which interpreted that there was a significant difference between the results of the pretest and posttest. **Conclusions:** The conclusion is improvements and revisions are still needed. Based on students' perceptions, the GraFIS application met usability and mobile quality standards.

Keywords: *TUG-K*, HTML5, media, *web, mobile*

ABSTRAK

Latar Belakang : Penilaian untuk mengetahui kemampuan penguasaan grafik GLB dan GLBB yaitu Test of Understanding Graphs in Kinematics (TUG-K). Melalui TUG-K yang disesuaikan dengan kompetensi dasar, guru dapat merumuskan indikator pencapaian kompetensi. **Tujuan** : Penelitian ini bertujuan untuk mengembangkan media pembelajaran Grafik Fisika (graFIS) pada konsep kinematika, mendeskripsikan efektivitas pembelajaran setelah menggunakan media graFIS dan mendeskripsikan persepsi peserta didik terhadap pembelajaran yang menggunakan media graFIS pada konsep pemenuhan standar usability dan mobile quality serta penilaiannya menggunakan Test of Understanding Graphs in Kinematics (TUG-K). **Metode** : Penelitian ini merupakan penelitian R and D dengan desain meliputi: analisis kebutuhan, perencanaan dan pengembangan produk, pengembangan produk, evaluasi produk, produk akhir dan diseminasi presentasi. Aplikasi yang dikembangkan berteknologi HTML5 yang mampu dipublikasikan di web app. dan mobile app. Aplikasi diterapkan pada responden berjumlah 143 peserta didik kelas X MIPA SMA Negeri 3 Purworejo. Pengumpulan data dilakukan dengan pemberian lembar validasi kepada ahli materi, ahli media, angket respon peserta didik, untuk memberi masukan pada produk yang dikembangkan. **Hasil dan Pembahasan** : Hasil penelitian berupa aplikasi graFIS sebagai media yang layak digunakan. Hasil implementasi dalam kegiatan belajar mengajar melalui RPP yang telah disusun, menunjukkan bahwa efektivitas pembelajaran menggunakan aplikasi graFIS masih berada pada kategori rendah dengan gain skor ternormalisasi sebesar 0,03 sehingga masih memerlukan revisi dan perbaikan. Hasil analisis perbedaan skor pretest dan posttest menggunakan Shapiro-Wilk didapat data tidak terdistribusi normal, dengan nilai Sig. 0,015 < 0,05 oleh karena itu pengujian dilanjutkan menggunakan Wilcoxon Signed Rank Test yang diperoleh nilai Asymp. Sig. (2-tailed) < 0,05 , yang menginterpretasikan bahwa terdapat perbedaan bermakna antara hasil pretest dan posttest. **Simpulan** : Kesimpulannya, masih perlu perbaikan dan revisi. Berdasarkan hasil persepsi peserta didik, aplikasi graFIS memenuhi standar usability dan mobile quality

Keywords: *TUG-K*, HTML5, media, *web, mobile*

1. INTRODUCTION

The rational development of the 2013 curriculum emphasizes the strengthening of material through enrichment and elaboration given to students. The material needs to remain relevant to the basic competencies listed in Permendikbud (Minister of Education Regulation) number 24 of 2016. The mastery of basic competencies of students is fulfilled by the teacher through the preparation of the Indicators of Competency Achievement so that the expansion of the material requires the creativity of the teacher to be by following indicators of competency achievement. Then, the indicators are used as a basis in designing assessments that will be billed to students.

PhysPort can be used as a reference to improve the creativity of physics teachers in classroom teaching. The published content is based on research such as teaching methods, assessment, and the results of physics education research. The results of physics education research are believed to have made great progress in developing various tools to enhance students' physics learning. The purpose of PhysPort itself is to synthesize and translate the results of physics education research. Then, it can be used in a class. One menu that can be used by the teacher in Physport is an assessment guide that contains more than 50 research-based assessment instruments that can be used to find out what learners must learn. One of which is an assessment to determine the ability to master the GLB and GLBB charts, namely TUG-K. Through TUG-K adjusted to basic competencies, teachers can formulate indicators of competency achievement.

One of the basic competencies that must be mastered by students of X grader is kinematic. Kinematics concepts in physics have been modeled graphically (Tebabal and Kahssay, 2011). The students are difficult to present data and graphs on the experimental motion results to investigate the characteristics of straight motion with constant speed (fixed) and straight motion with constant acceleration (fixed) following physical meaning. Alimisis and Boulougaris (2014) have identified serious difficulties that students encounter in drawing and interpreting graphs.

The TUG-K assessment guidance contains questions that can measure the level of graphic mastery to achieve these basic competencies. Limited time to study at school becomes an obstacle to mastering the basic competencies required. The limitedness can be found in a solution by using information technology. The use of information technology in the learning process has become a necessity and a demand in this global era (Muhson, 2010). Advances in technology and information as strength can be a solution to overcome the limited time to study at school through technological devices. Therefore, they can independently learn whenever and wherever they are.

The development of technology is currently very rapid with the presence of multimedia-based mobile technology. It is in harmony with the mindset of the 2013 curriculum, which needs to be developed from single-tool learning into multimedia-based learning. The development of multiplatform learning software is needed to adjust to the currently developed technological devices. The use of mobile applications as a learning media can help students learn independently using their smartphones. The software is also expected to run well using web-based devices through a browser on a computer, with the result that it will accommodate more technological devices owned by students and schools. Learning can be held in a computer laboratory to overcome the device gaps that students have. Collaboration and discussion in learning will be easier to do when students use computer devices.

This GraFIS application was developed to be used as a learning medium in the kinematics graph learning framework. Application development is expected to increase understanding of graphs related to kinematics material because graphs in kinematics play an important role in students' understanding of the basic concepts of physics related to motion. Graphs are abstract representations, so a student’s logical thinking level might be an indicator for understanding kinematics graph (Bektasli, 2012). The Understanding Graph Test in Kinematics (TUG-K) that has been developed by Beichner will be used to measure the ability to install it.

The previous research has been carried out by Ayop and Ismail (2019), March and Singh (2016), Antwi, Savelsbergh and Eijkelhof (2018); Klein *et al*. (2019) and Zavala *et al*. (2019), which similarly adopted the TUGK from Beichner to assess students' understanding of kinematics charts. Research by Lichtenberger *et al*. (2017) related Concept Tests Kinematical, validated and addressed by FCI which the TUG-K was also indicated as resources. Eshachs (2010) researched re-examining the power of video motion analysis to promote the reading and creating of kinematic graphs. Eshachs (2014) showed intuitive rules in interpreting students' difficulties in reading and creating kinematic graphs. Then, Ayop and Ismail (2019) took on the material kinematics in the same field, but they focused on the assessment and conceptual difficulties and teaching strategies.

Based on the stated problems, one of the efforts that can be used as an alternative problem solving is through the development of PHYSICS graphics (graFIS) software based on Test of Understanding Graphs in Kinematics (TUG-K), which is designed for mastering basic competencies number 4.4 of X grade in the 2013 Curriculum. GraFIS software is not only a web-based media but can also be run on an Android smartphone.

The purpose of this research was to develop Physics Graph learning media (GraFIS) on the kinematics concept describe the effectiveness of learning after using GraFIS media and describe students' perceptions of learning using GraFIS media and assessing using TUG-K on kinematics material the concept of GLB and GLBB for high school level. In the development process, it would be carried out through the Research and Development (RnD) method of the Borg n Gall model. Therefore, in this study, the title is "Development of Physics Graph Learning Media on Kinematics Concepts Based on Tug-K."

2. MATERIALS AND METHODS:

The main objective of this research is to develop physics graphs (GraFIS) learning media on the kinematics concept by using HTML5-technology software that can be published on various platforms. Content in the software focuses on learning kinematics of graphic material, which the development refers to the assessment of TUG-K. Then, the type of research is Research and Development (RnD). Generally, the systematic of this research is to design, develop and to evaluate, process, and produce products.

The development procedure in HTML5-technology software development research published to various platforms in high school students was carried out in various stages. The development procedure showed in Figure 1 and explanation for every stage described below (Ahmed and Pearson, 2013).

2.1 Requirements Analysis

At this stage, the developer conducted a needs analysis to collect data. It was analyzing basic competency-based on *Permendikbud* No. 24, 2016. The fact shows that many students at high school, or even university level, have less ability to understand and interpret graphs in physics (Planinic, 2012). Students in schools are rarely asked to analyze graphic information and describe it, even though this skill is important at the next level of education (Chaudhury, 2015). Graphs can contain a lot of information and make it possible to predict an event to be resolved (Larkin, 1981). Analysis of material data contained in the revised 2013 curriculum of grade X on the first semester of SMA Negeri 3 Purworejo with essential material to be developed, as well as an assessment of the problems occurred.

2.2 Product Development Planning

At this stage, the developer determined by the research's team about the purpose and the character of the product, looked for sources of content from the product design to be made, arranged the stages of making products/product concepts in the form of storyboards, flowcharts, and developed initial products.

2.3 Product Development

In developing the early product, researchers had some consultations and cooperated with experts, namely material experts and media experts.

In this research and development, the trial design was that before large group trials were carried out, the product was consulted with material experts, media experts and tested on small groups. After getting advice, it was necessary to revise. This research step was expected to find weaknesses, deficiencies, errors, and suggestions for improvement. Therefore, the resulting product was valid and suitable for use.

2.4 Product Evaluation

The evaluation product stage produced a representative measurement tool in obtaining data through the validation carried out by experts. Small-scale field trials on initial products were conducted to obtain responses and product revisions by experts and students.

2.5 Final Products

The developer produced the final product based on the input and results of the initial product revision. After going through expert reviews and trials, the product was refined based on expert and student input to produce a proper and effective product (Ahmed and Pearson, 2013) The product was also implemented in X grade of MIPA to get responses from students about aspects of usability and mobile quality. This responses used instrument qualitative and quantitative)

2.6 Dissemination and Presentation

This stage aimed to disseminate products in the form of physics material applications that can be downloaded for free through the Playstore on a smartphone/gadget or accessed using a specific domain. Product dissemination was carried out through MGMP (Subject Teachers' Deliberation) and social media such as Facebook, Instagram, Twitter, WhatsApp, and others.

The subject of the trial was the target product users, namely students of SMA N 3 Purworejo. Small scale trials were tested on 32 XII grader students of MIPA-1 in SMA N 3 Purworejo, and large scale trials were tested on 143 X grader students of MIPA in SMA N 3 Purworejo.

The data obtained from this research were quantitative data that were converted into qualitative. The data were used to provide an overview of the quality of physics learning media developed, including Metaphor; Interactivity; Learning Content (Parsons and Ryu, 2006), and Learnability; Operability; Understandability (ISO, 2003).

The instrument used to collect data in this study was a questionnaire. There are three questionnaire. The first questionnaire was used as a data collection tool from material expert. The first questionnaire consists of 14 item for material expert. The second questionnaire consists of 19 item for media experts. The blue print of material experts and media experts showed on Table 1. The third questionnaire for students related to criticism, suggestions, and input that was beneficial for the quality of the product. The third questionnaire was adopted from Ahmed and Parsons (2012), which had been applied to measure the usefulness of learning applications named "Think Learn".

Table 1 The blue print of material experts and media experts

No	Statements	Evaluation aspects
S1	This mobile learning experience was enjoyable	Learning content
S2	This mobile application was easy to use	Learnability
S3	Navigation through this application was easy	Operability
S4	This application guides me to formulate a hypothesis	Understandability
S5	The given suggestions in the application were relevant	Methapor
S6	This application helps me understand the relationship between different variables	Interactivity
S7	The given suggestions help me to understand the topic	Methapor
S8	This application helps me to improve my reasoning skills	Interactivity
S9	It is an effective learning application	Learning Content

The collected data were used to analyze the quality of the product development that was produced. Qualitative data about the effectiveness, efficiency, and attractiveness of the product were used to revise the product. The data analysis technique used in this study was the percentage analysis descriptive technique (Widodo, 2014). This percentage analysis technique was used to analyze and evaluate development subjects to assess product quality and acceptability. Descriptive analysis is the accumulation of basic data in the form of descriptions only, meaning that it does not explain relationships, test hypotheses to make predictions, or draw conclusions (Muhson, 2006). It was used the one group pretest-posttest method to measure learning success, illustrated in the following Table 2.

Table 2. Research design

Pretest	Implementation	Posttest
S_{pre}	X	S_{post}

S_{pre} was the result of the pretest. X was the treatment given that was kinematics learning with graphic media, which the development was based on TUG-K. S_{post} was the result of the posttest. The pretest and posttest scores were used to analyze the effects of learning based on the normalized score gain. Analysis of questionnaire data from the application of the media used a *one-sample t-test*.

3. RESULTS AND DISCUSSION

3.1 Results of the Requirement Analysis Phase

Basic competency analysis on *Permendikbud* No. 24, 2016 for high school physics subjects in the first semester of grade X, KD (Basic Competence) 4 discusses graphics. Journal analysis found that many students had less ability to interpret graphs. Analysis at Physport.org on the assessment menu obtained Test of Understanding Graphs in Kinematics (TUG-K) can be used to test the ability to master the GLB and GLBB graphs. Analysis of material understanding of the concepts of GLB and GLBB and mathematical calculations needed to be developed through graphical analysis to obtain the quantity in question. Analysis of the problem found that many students in secondary school, or even university level, could not understand and interpret physics graphs (Planinic, 2012). Students in schools were rarely asked to analyze graphical information and describe it, although this skill was important at the next level of education (Chaudhury, 2015).

3.2 Results of the Product Planning and Development Phase

Analysis of the design development objectives was to produce applications that had the following capabilities. Those were (1) It can be installed on any Android-based smartphone, and; (2) It can be used as a physics learning media on the subject matter of kinematics GLB and GLBB graphics. In the design stage, the developer designed a learning media product design by referring to the analysis phase and creating story-boards and flowcharts. Producing the beginning design used Jquery Mobile software of 1.4.5 version formed with the name 'graFIS' (Physics Graphs). Images of the software developed showed in Figure 4 and 5.

3.3 Product Development Stage Results

In the testing phase of media expert lecturers and material expert lecturers and trials for students, applications that had been designed at an early stage were given to material experts and media experts. They were published to student respondents to be given an assessment or validation related to aspects of the quality and feasibility of the media.

3.4 Final Product Stage Results

The average results of the pretest and posttest scores of graFIS were presented in Table 3. Results of Analysis of Normality. Test Differences in Pretest and Posttest Scores with the Kolmogorov-Smirnov were presented in Table 4, and statistical test results of pretest and posttest score were presented in Table 5.

Table 3. *Results of analysis of normality*

Z		***-2478b***
Asymp.	Sig. (2-tailed)	.013

Table 4. *Test differences in pretest and posttest scores with the Kolmogorov-Smirnov*

	Kolmogorov-Smirnov	***Shapiro walk***
	sig.	sig.
diff	0.005	0.0*15*

Table 5. *Statistical test results of pretest and posttest score*

Pretest	***Posttest***	***Normalized Gain Score***
3.74	4.35	0.03

In gaining student questionnaire responses, the questionnaire was given to students after applying the GraFIS application in learning. The number of students as respondents was 4 classes with a total of 143 respondents. There were 9 statements in the questionnaire, as presented in Table 1.

The usability aspect consisting of three questionnaire statements (S2, S3, and S4) had been found in the GraFIS application, namely linearity, operability, and understandability (ISO, 2003). Student responses from statements S2, S3, and S4 revealed that the application of GraFIS was not difficult to use. The navigation was easy, and students agreed that the application guides it to make hypotheses. One sample t-test against a neutral value of 3 was used to analyze it (t_{95} = 16.319, $p < 0.05$ for P2; t_{95} = 12.444, $p < 0.05$ for P3; t_{95} = 15.256, $p < 0.05$ for P4) . According to students, GraFIS applications included interactive learning media, which were able to link various variables and help their reasoning skills. The results of interactivity aspects were confirmed (t_{95} = 12,914, $p < 0.05$ for P6; t_{95} = 19,213, $p < 0.05$ for P8). The learning content aspect through statements S1 and S9 revealed that the GraFIS application was effective in learning and provided a pleasant experience (t_{95} = 17.115, $p < 0.05$ for S1; t_{95} = 21.425, $p < 0.05$ for S9). The metaphor aspect meant that students got learning experiences through the whole learning process (t_{95} = 15.047, $p < 0.05$ for S5; t_{95} = 15.150, $p < 0.05$ for S7). Then, the qualitative responses of students were in the form of a discussion group by giving three questions in the discussion to evaluate the application after the students had got their learning experience. The questions given were related to usability and mobile quality.

This model defines usability as a combination of effectiveness, efficiency, satisfaction, learnability, and security, along with a recommended set of related measures (Nayebi *et al*., 2012). The product distribution was expanded through publications on the Google PlayStore with the keyword "grafist". Dissemination was also carried out by providing a Google PlayStore application link on the WhatsApp of MGMP (Subject Teachers' Group) Physics Meeting at the Provincial level and the District Physics MGMP.

In this research, the development of learning media in the form of an Android-based graFIS application was used to create graphics on GLB material for high school grade X students. The product substance developed was based on the indicators in the TUG-K. The initial product development had been validated by media experts, material experts, and small groups of students. The average overall assessment of the learning media developed at the initial production stage was 80.75%, with a very good category. Thus, this media was appropriate to be used for learning media.

Implementation of learning had been carried out using RPP (Lesson Plan) learning media using the GraFIS application. The learning steps used the Jigsaw learning model so that all indicators can be studied effectively. This model provided opportunities for students to take responsibility for the mastery of the material provided. Students also seemed to cooperate in discussing issues in their respective expert groups. When students returned to their groups, they independently and politely presented the results of the discussion. Other students looked wise to pay attention to it. At the closing activity stage, students were guided by the teacher about making reports using the application. They seemed impressed that the GraFIS application was able to help make reports easily. Digital literacy indirectly grew in students' personalities. This was proofed by the existence of some of them, desiring to have the ability to create applications. Students felt proud when the teacher said that they were the first users of the GraFIS application. Applause echoed in the class as a form of appreciation for their teacher.

The results of applying GraFIS application, which had been tested through pretest and posttest based on Table 2, normalized score gain from learning that implements graFIS was 0.03. Thus, the effectiveness of learning after using GraFIS media on the kinematics concept was still in the low category. This indicated that revisions and improvements were still needed so that the learning effectiveness could increase. The results of the analysis of the differences in the pretest and posttest scores (see Table 3) used Shapiro-Wilk obtained that data were not normally distributed, with Sig. 0.015 <0.05. Therefore, testing continued using the Wilcoxon Signed Rank Test obtained by Asymp values. Sig. (2-tailed) <0.05, which interpreted that there was a significant difference between the results of the pretest and posttest.

Based on the results of the pretest and posttest scores for each TUG-K item shown in Figure 2, it was known that questions no. 2 and 13 with the same type of questions. The results of student acquisition scores tend to be stable, only slightly increased. This was supported by activity-3 and activity-4 in the application to analyze the graph by following the indicators of the problem. Big mistakes were seen in no. 1, 7, 9, 23, and 24. The numbers of students answering correctly were only under 12 of 143 students. This proved that students could not fully understand the 7th and 8th activities in the GraFIS application. A significant increase in scores was on questions no. 6, 11, 12, 19, 21, and 22. Based on these data, it can be concluded that the students quite understood the activities-1, activity-2, activity-9, and activity-10 of the GraFIS application.

4. CONCLUSIONS:

Based on the results of the pretest and posttest scores of each respondent from the TUG-K questions had been shown in Figure 1. Respondents of Class X-MIPA-1 and X-MIPA-3 obtained different pretest and posttest scores that had similar patterns, but class X-MIPA-1 had lower posttest scores than the pretest scores. The pattern looks different for class X-MIPA-2. Although the pretest and posttest results were lower than the other classes, the pattern formed showed the posttest tendency to be higher than the pretest results. For class X MIPA-4 the pattern was seen to have experienced a significant increase in the posttest results and occupied the highest score even though most respondents received a score of 0.

The implementation of GraFIS application in learning encouraged students to actively solve the problems given in their respective activity menus. Students well followed each step of the activity given until a graph showing the rendering results based on the data entered. Students enthusiastically analyzed the displayed graphs. The analysis began by answering the questions given in each activity. Then, it was developed independently by students. As a preliminary report, they carefully copied graphic images into graph paper that had been prepared in advance. The results of the analysis were also written as proof that they understood the graph.

Based on the results and analysis of the TUG-K that had been applied to 143 students, it could provide information for the teachers to try to improve students' understanding of the topic of the graph in kinematics through better planning in making lesson plans. In this study, we present test results with a low score. Therefore, one of the classroom teaching recommendations was to focus specifically on teaching about graphs of the position toward time, the speed toward time, and the acceleration toward time from a phenomenon of moving objects. Besides, more focus was also needed for teaching about calculating the acceleration of the velocity graph toward time.

This research has produced learning media in the form of GraFIS applications. Its characteristics met usability and mobile quality standards. After using the graFIS application media on the kinematics concept, the results of learning effectiveness were still in the low category. Therefore, improvements and revisions are still needed. However, the results of the pretest and posttest based on statistical analysis showed significant differences.

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6. OPEN ACCESS

***Figure 1** Development flow*

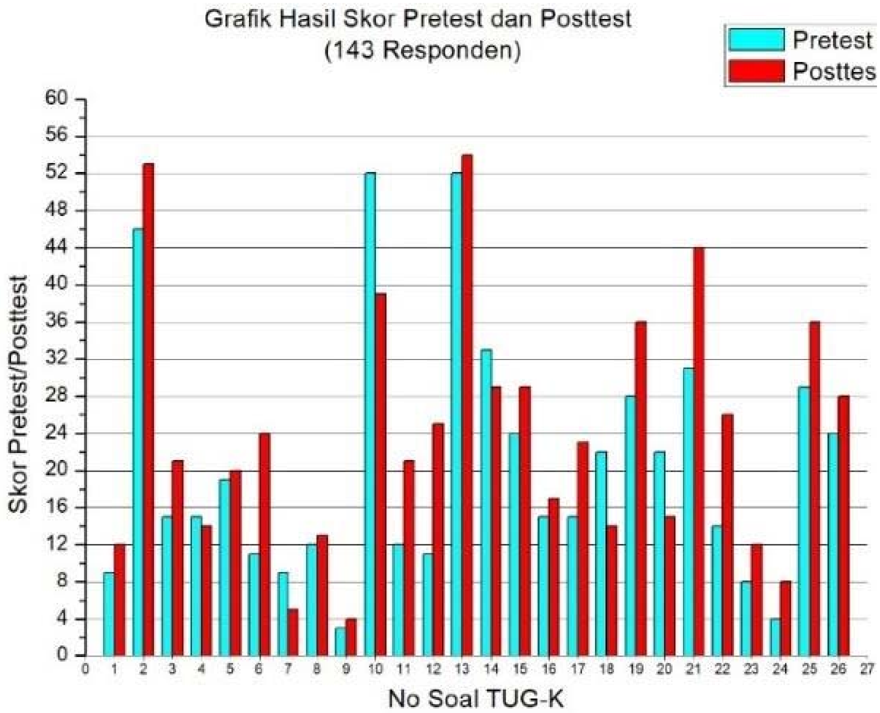

***Figure 2.** Pretest score and graph results posttest for each item*

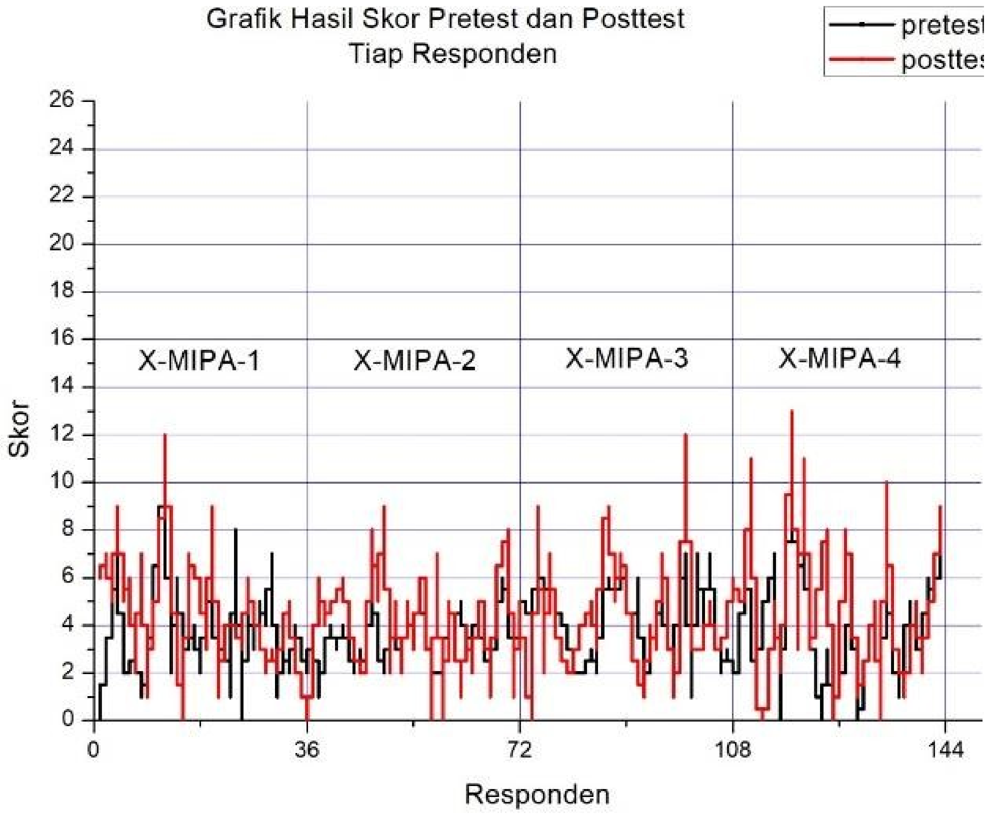

Figure 3. *Graph of pretest and posttest score for each respondent*

Figure 4. *Images the software developed (Initial view)*

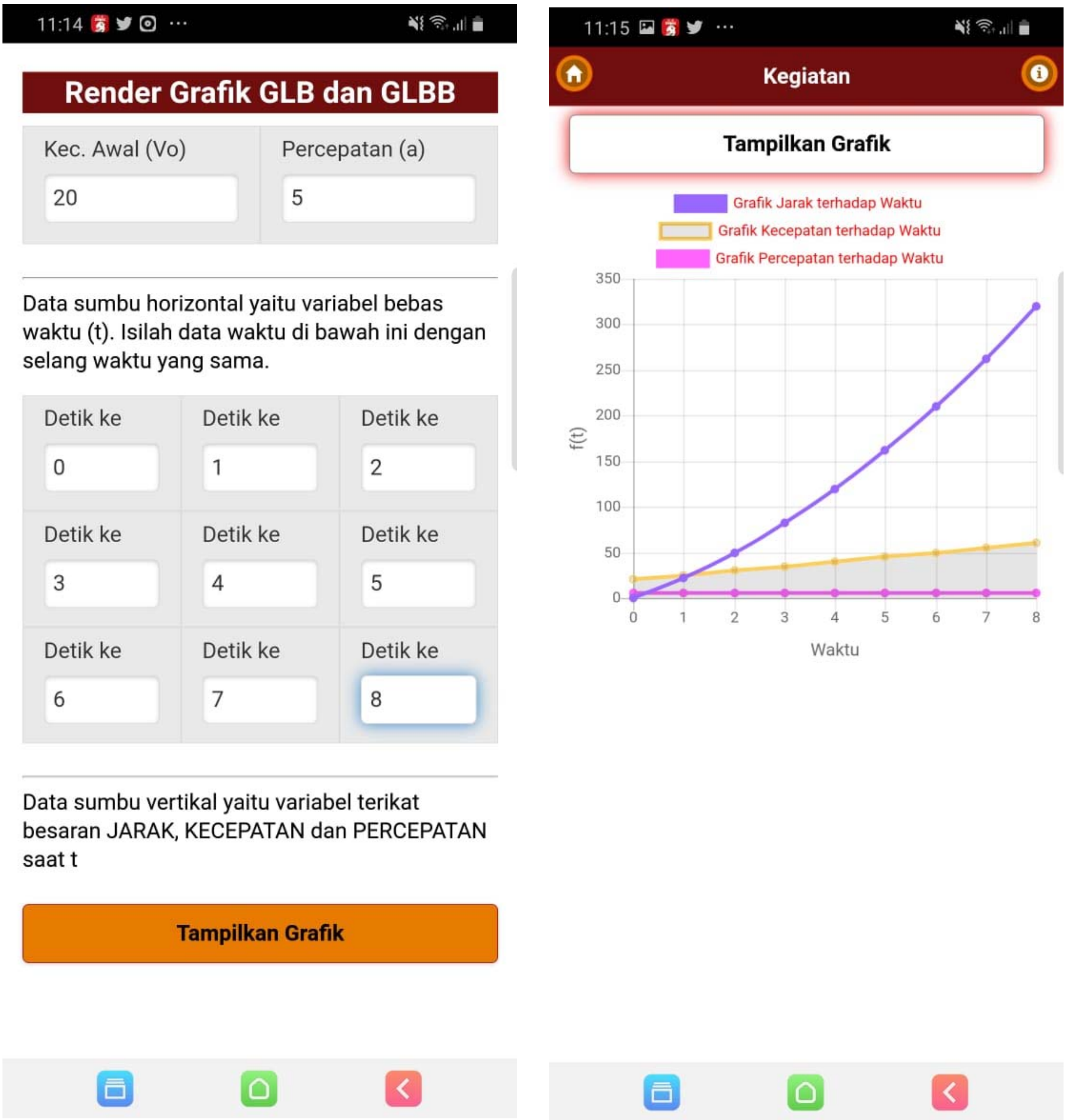

Figure 5. *Images the software developed (graphic view)*