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HONDA PCX 160 ABS 2023 SMART KEY LEARNING VIDEO FOR VOCATIONAL HIGH SCHOOL STUDENTS USING 4D MODEL

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Abstract

The learning process at SMK Muhammadiyah Prambanan still faces challenges in students' understanding of the motorcycle smart key system, as indicated by 39% of students failing to meet the minimum competency criterion. This condition highlights the need for innovative learning media to improve student engagement and understanding. This study aimed to develop a learning video on the Honda PCX 160 Smart Key System for the Basic Automotive Fundamentals subject for Grade X students at SMK Muhammadiyah Prambanan, and to determine the feasibility of the developed media. This study employed a Research and Development (R&D) approach using the 4D model proposed by Thiagarajan (1974), consisting of the Define, Design, Develop, and Disseminate stages. The research subjects included one material expert, one media expert, and 26 Grade X TBSM students at SMK Muhammadiyah Prambanan. Data were collected using validation questionnaires for the material expert and media expert, as well as a student response questionnaire. The data were analyzed descriptively and quantitatively using percentage-based feasibility criteria. The results showed that: (1) the study produced a learning video on the Honda PCX 160 Smart Key System that can be accessed through YouTube as a self-learning medium; and (2) the video achieved feasibility scores of 95.5% from the material expert, 100% from the media expert, and 95.5% based on student responses, all categorized as highly feasible. Therefore, the learning video is considered highly feasible for use as a learning medium in the Basic Automotive Fundamentals subject for Grade X students at SMK Muhammadiyah Prambanan.

Keywords:
Learning Video, Smart Key System, Honda PCX 160

Abstrak

Proses pembelajaran di SMK Muhammadiyah Prambanan masih menghadapi kendala dalam pemahaman materi smart key sepeda motor, dengan 39% peserta didik belum mencapai KKM. Kondisi ini menunjukkan perlunya inovasi pembelajaran untuk meningkatkan keterlibatan dan pemahaman peserta didik. Penelitian ini bertujuan mengembangkan video pembelajaran System Smart Key Honda PCX 160 pada mata pelajaran Dasar-Dasar Otomotif kelas X di SMK Muhammadiyah Prambanan serta mengetahui tingkat kelayakan media yang dikembangkan. Penelitian ini merupakan penelitian dan pengembangan (Research and Development) menggunakan model 4D yang dikemukakan oleh Thiagarajan (1974), meliputi tahap Define, Design, Develop, dan Disseminate. Subjek penelitian terdiri atas satu ahli materi, satu ahli media, dan 26 peserta didik kelas X TBSM SMK Muhammadiyah Prambanan. Pengumpulan data dilakukan menggunakan angket validasi ahli materi, ahli media, dan respons peserta didik. Data dianalisis secara deskriptif kuantitatif menggunakan persentase tingkat kelayakan media. Hasil penelitian menunjukkan bahwa: (1) penelitian ini menghasilkan video pembelajaran System Smart Key Honda PCX 160 yang dapat diakses melalui platform YouTube sebagai media pembelajaran mandiri; dan (2) video memperoleh persentase kelayakan sebesar 95,5% dari ahli materi, 100% dari ahli media, serta 95,5% dari respons peserta didik dengan kategori sangat layak. Dengan demikian, video pembelajaran dinyatakan sangat layak digunakan sebagai media pembelajaran pada mata pelajaran Dasar-Dasar Otomotif kelas X di SMK Muhammadiyah Prambanan.

Kata Kunci:
Video Pembelajaran, System Smart Key, Honda PCX 160

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1. INTRODUCTION

The development of motor vehicle technology in recent years has changed the motorcycle operating system from a mechanical system to a more advanced electronic system (Sanusi & Wardhani, 2023; Shaik & Peddakrishna, 2025). One of these innovations is the Smart Key System, which is a keyless locking system that utilizes communication between the remote and the Smart Control Unit (SCU) to improve the safety and ease of operation of the vehicle (Rakhmadi et al., 2025; Siahaan et al., 2022). This technology has been applied to various modern motorcycles, one of which is the 2023 Honda PCX 160 ABS, so that it is a competency that needs to be mastered by Vocational High School (SMK) students, especially in the competence of Motorcycle Engineering and Business expertise.

Along with the development of automotive technology, the learning process in Vocational High Schools is required to be able to keep up with these developments so that the competencies possessed by students are in accordance with the needs of the world of work. Therefore, the use of learning media that is in accordance with the characteristics of the material is one of the important factors in supporting the success of learning in the field of automotive expertise. Various studies show that the use of learning media, especially video-based media, is able to improve concept understanding, learning motivation, and learning outcomes of students in automotive skills competencies (Widjanarko et al., 2024).

However, based on the results of observations made by researchers at SMK Muhammadiyah Prambanan, the delivery of the Honda PCX 160 ABS 2023 Smart Key System material is still dominated by lecture methods, limited demonstrations, and the use of media in the form of books and PowerPoint. This condition causes some students to have difficulty in understanding the system configuration, the working principles of each component, and the Smart Key operating procedure because the material studied is dynamic and most of the work process cannot be observed directly. The following is the daily assessment Table 1 on the System Smart Key material:

Table 1. Daily Assessment Results of Basic Automotive Fundamentals Subject Class X Subjects

Minimum Criteria Value	Conclusion	Incomplete	Average Student Score
75	19 students (61%)	12 students (39%)	69,8

One of the alternative media that can be used to overcome these problems is learning videos. Learning videos are audiovisual media that are able to combine various elements, such as images, sounds, text, animations, and demonstrations in one unit so that the delivery of material becomes more interesting and easy to understand by students (Alvianto et al., 2022; Maulidi et al., 2022) . Presenting the material through visualization and audio simultaneously also helps to explain abstract concepts more concretely, so that it can increase students' understanding of the material being studied (Rahma et al., 2025; Rahmadayani & Darmansyah, 2023)

Beyond their application in classroom instruction, educational videos empower students with the flexibility to review content autonomously on digital platforms, tailoring their study experience to their individual pacing and requirements.These characteristics make video a flexible medium because it can be played repeatedly without being limited by time or place. The use of the YouTube platform further supports the independent learning process because it provides easy access to learning materials, so that students can repeat the material anytime and anywhere as long as the internet network is available (Musfiza et al., 2025).

Therefore, this study uses the 4D development model proposed by Thiagarajan, Semmel, and Semmel. This model was chosen because it has a structured development stage, including define, design, develop, and disseminate, so that it is suitable to produce learning media that is valid, practical, and suitable for use in learning activities (Thiagarajan et al., 1974). There remains limited development of learning videos specifically designed to explain the operation of an integrated electronic keyless system on a particular modern motorcycle, particularly the Smart Key System of the Honda PCX 160 ABS.

2. RESEARCH METHOD

The method section structure should: describe the materials used in the study, explain how the materials were prepared for the study, describe the research protocol, explain how measurements were made and what calculations were performed, and state which statistical tests were done to analyze the data.

This research uses the Research and Development (R&D) method with the 4D development model (Four-D Model) proposed by Thiagarajan, Semmel, and Semmel. This model was chosen because it provides a directed development stage in producing a learning product, starting from needs analysis to

product dissemination to users. These development stages include define, design, develop, and disseminate. The 4D model is widely used in learning media development research because it is able to produce products that have gone through a process of validation, testing, and refinement before being implemented in learning activities (Thiagarajan et al., 1974).

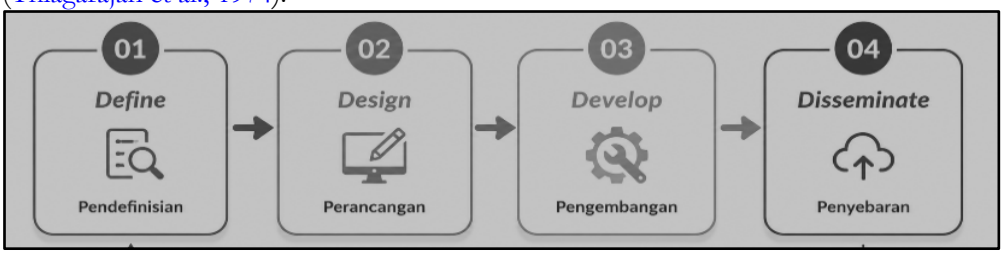


Figure 1. 4D Model Stage

The research was carried out at SMK Muhammadiyah Prambanan Yogyakarta involving 1 material expert, 1 media expert, and 26 students of class X of Motorcycle Engineering and Business as research subjects. The product developed is in the form of a Honda PCX 160 ABS 2023 System Smart Key learning video in the subject of Automotive Fundamentals.

The research instrument was used to obtain data on the feasibility of learning videos developed through assessments from material experts, media experts, and students. The instrument for subject matter experts aims to assess the suitability of the content of the material with the learning objectives, while the instrument for media experts is used to assess the quality of visual appearance, the effectiveness of presentation, and the ease of use of media. Meanwhile, the instruments given to students aim to determine the level of media acceptance, including the attractiveness, ease of understanding the material, and the usefulness of learning videos in supporting the learning process. These aspects of assessment are described in Tables 2, 3 and 4.

Table 2. Material Expert Instrument Grid

No	Aspects	Indicator	Item Number
1	Content quality and purpose	Accuracy of the content of the material	1,2,3
		Suitability of the material with the curriculum	4,5,6
		Clarity of sequence and depth of material	7,8,9
2	Presentation quality	Flow clarity	10,11,12
		Integration between text, images, and narrative	13,14,15
		Attractiveness and ease of understanding	16,17,18
3	Student orientation	Suitability of the material to the student's initial abilities	19,20
		Video capabilities help	21,22,23

Table 3. Media Expert Instrument Grid

NO	Aspects	Indicator	Item Number
1	Visual display	Image quality and resolution	1,2,3
		Use of color, text	4,5,6
		Appropriateness of videos, narration, & content	7,8,9
2	Learning design	Clarity of the flow and duration of the video	10,11
		Clarity of study instructions	12,13
3	Audio and narration	Clear sound quality	14,15,16
		Sync audio with video display	17,18
4	Media Familiarity	Ease of use of video	19
		Media appeal	20

Table 4. Student Instrument Grid

NO	Aspects	Indicator	Item Number
1	Video display quality	Interesting and not boring videos	1,2,3
		Clear picture and sound quality	4,5,6
		Clear subtitles	7,8,9
		Easy-to-understand material	10
2	Quality of material content	Video helps understand the working system of the Honda PCX 160 ABS Smart Key 2023	11
		Videos help recall material that has already been learned	12
3	Ease of use	Videos are easily accessible and self-used	13
		Videos can be repeated to deepen understanding	14,15

The research instrument used a questionnaire with a four-level Likert scale, namely Strongly Disagree (1), Disagree (2), Agree (3), and Strongly Agree (4). The use of a four-level scale aims to obtain a more assertive assessment because it does not provide a neutral answer choice, so respondents are encouraged to give an assessment according to their perceptions. The questionnaire was prepared to obtain an assessment from material experts, media experts, and students on the quality of the developed learning videos, including aspects of material content, presentation, media display, and ease of use (Mawardi, 2019).

Tabel 5. Alternative Answers and Scoring

Alternative Answers	Score
Strongly agree	4
Agree	3
Disagree	2
Disagree	1

The data analysis results were used to obtain the average score of the assessment of the developed product. The data obtained from the expert assessment questionnaires were subsequently analyzed quantitatively using the following percentage formula:

$$\text{Feasibility Percentage} = \frac{\text{score obtained}}{\text{maximum score}}$$

The research data was analyzed using quantitative descriptive analysis techniques by calculating the feasibilty percentage based on the score obtained compared to the maximum score. The results of the percentage calculation are then interpreted into the feasibility category to determine the feasibility level of the developed product. Quantitative descriptive analysis in development research is widely used to describe the level of validity, practicality, and feasibility of a product based on the results of the assessment of validators and users (Rahmatin et al., 2025; Siregar, 2023).

Table 5. Percentage Range and Qualitative Criteria

Feasibility Percentage	Conversion Results
75-100%	Highly Worth It
55-74.99%	Worthy
40-54.99%	Less Worthy
0-39.99%	Not Eligible

Content specialist appraisals are conducted to verify that the subject matter aligns with educational standards, maintains conceptual accuracy, and fulfills targeted pedagogical goals. Conversely, media specialist assessments focus on evaluating the visual interface, instructional delivery, user navigation, and the overall technical standard of the newly designed educational tool. In addition to the assessment from the validator, student responses are also used to determine the level of acceptance, ease of use, and benefits of learning videos in supporting the learning process (Santini et al., 2025)

3. RESULTS AND DISCUSSION

This research aims to develop a Smart Key System learning video as a learning medium for the subject of Automotive Basics class X TBSM at SMK Muhammadiyah Prambanan Yogyakarta. The results of product development and feasibility tests that have been carried out are explained as follows:

Define

Based on the results of observations and interviews with the teaching teachers at SMK Muhammadiyah Prambanan Yogyakarta, the learning process in the Smart Key System material is still dominated by the lecture method. This condition causes students to have difficulties in understanding the concept, configuration, and working principles of the Smart Key System which are technical so that they need media that is able to visualize the process in real life. In addition, the results of the learning objectives analysis show that students are expected to be able to understand system configuration, working principles, activate Emergency Mode, set up the Answer Back System and Anti Theft Alarm System, and register remotely. However, the average daily score of students of 69.8 is still below the Minimum Completeness Criteria (KKM) of 75, so it is necessary to develop video-based learning media that is more interactive, contextual, and easy to understand.

Design

At this stage, the initial design of the product was prepared in the form of a Smart Key System learning video. The stages carried out include the following:
Selection of Teaching Materials.

Table 6. Learning Objectives

No	Learning Objectives
1	Students can understand ***the Smart*** *key system configuration* on Honda PCX motorcycles.
2	Students can understand **the Overview and How** *the Smart key system* works on Honda PCX motorcycles.
3	Students can activate ***the Emergency mode*** *Smart Key on Honda PCX Motorcycles.*
4	Students can do ***the Setting Answer back system*** *Smart Key* on Honda PCX Motorcycles.
5	Students can do ***the Anti Theft Alarm System*** *Smart Key* Setting on Honda PCX Motorcycles.
6	Students can do ***Remote Registration and Smart Control Unit*** *Smart key* Registration on Honda PCX Motorcycles.

Initial Planning or Storyboard.

Table 7. Storyboard

No	Activities	Script	Time
1	Introduction	Assalamu'alaikum warahmatullahi wabarakatuh. I explained about the smart key system on Honda PCX motorcycles, starting from the definition of components, how the system works, to some small glitches that often occur.	1 Minute
2	Definition of Smart Key	Displays the use of remote smart keys on the Honda PCX. Narrative: "Smart key systems are modern security technologies that use remotes instead of conventional keys." Displays smart key features such as an answer back system and immobilizer. Describe the security functions, ease of use, and efficiency of the system.	2 Minutes
3	Wiring Diagram System Smart Key PCX.	Displays the wiring diagram of the Honda PCX in full. Explain the electrical symbols and the relationships between the smart key components. Use zoom and highlights to make it easy for students to understand.	2 Minutes
4	Explanation of How the Smart Key System Components Work	The working sequence of the Smart Key system can be summed up as follows: The remote is on → SCU receives the signal → the ignition knob can be used → the SCU communicates with the ECU → the starter switch is pressed → the ECU activates the ignition and the engine starts.	1 Minute
5	Definition of Answer Back System	The Answer Back System is one of the features on the Honda PCX 160 Smart Key system that functions to help users find the vehicle's position.	50 Seconds
6	Explanation of Setting Answer Back System - Setting the Volume - Changing the Tone	The Answer Back System work process starts from the remote being active, then the remote sends signals to the SCU, then the SCU activates the vehicle response system in the form of lights and indicator sounds.	2 Minutes
7	Explanation of Anti Theft Setting -Adjust the Sensitivity when the motorcycle is parked	When the system is active and the sensor detects the presence of forced vibration, it will trigger a buzzer or loud siren and turn on the warning light.	1 Minute
8	Definition of Emergency Mode	The emergency mode on the Honda PCX 160 is used when the Smart Key remote is malfunctioning, the remote battery is low, or the remote cannot transmit the signal normally.	1 Minute
9	Emergency Mode Setting Explained	On the Honda PCX 160, Emergency Mode works through the ID code verification process between the user and the SCU or Smart Control Unit. If the code entered is appropriate, then the SCU will grant permission so that the ignition knob can be used and the engine can be started.	2 Minutes
10	AI Animation Videos	Explain with AI to make students more interested. Starting from getting to know the meaning of components to how it works.	2 Minutes
11	Conclusion	Thus the explanation of the Smart Key system on the Honda PCX. Hopefully, this learning video can help you understand the meaning of components, how they work, and minor disturbances in the Smart	1 Minute

No	Activities	Script	Time
		Key system. I would like to thank the supervisors, friends, and all parties who have helped the process of making this video. Thank you and see you in the next video.	

Develop

The initial product is the result of a System Smart Key video. The videos that have been developed are then validated and tested to determine their feasibility. The initial products are as follows:



Figure 2. Opening Learning Video



Figure 3. Self-introduction of the material in the video



Figure 4. Introduction of Components and Placement of Components

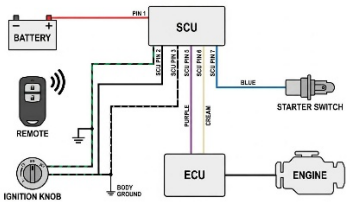


Figure 5. Wiring Diagram System Smart Key



Figure 6. How System Smart Key Works



Figure 7. Answer Back System and Anti Theft Alarm System



Figure 8. Emergency Mode



Figure 9. Closure is done by The Cast in The Video

The results of product development and feasibility tests that have been carried out are explained as follows:

Expert Assessment

The validation of the material expert was carried out by Agnitou Tatwada, S.Pd., as the teacher of the Automotive Basics class X TBSM subject at SMK Muhammadiyah Prambanan Yogyakarta. The validation results can be seen in the following Table 8.

Table 8. Material Expert Validation Results

Assessment Aspects	Expert Score	Category
Content quality and purpose	94,4%	Highly Worth It
Presentation quality	97,2%	Highly Worth It
Orientation with students	95%	Highly Worth It
Average total score	**95,5%**	**Highly Worth It**

From the table above, it shows that the Smart Key System learning video obtained an average feasibility percentage of 95.5% with a very feasible category. In terms of content quality and objectives, a percentage of 94.4% was obtained, the quality of presentation was 97.2%, and the orientation aspect with students was 95%. Thus, the learning video was declared "very feasible" to be used as a learning medium in the Automotive Basics class X TBSM subject.

Media Expert Ratings

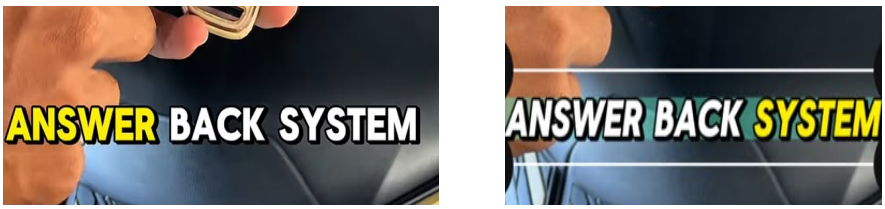
To evaluate the educational video's practical suitability, a media specialist assessment was conducted focusing on its visual communication, content delivery format, and overall technical specifications. This formal appraisal was executed by Dr. Ir. Arif Bintoro Johan, M.Pd., an academic faculty member within the Mechanical Engineering Vocational Education Study Program at Sarjanawiyata Tamansiswa University in Yogyakarta. The specialist's evaluation outcomes concerning the Smart Key System instructional video are detailed in the subsequent Table 9.

Table 9. Media Expert Validation Results

Assessment Aspects	Expert Score	Category
Visual Display	100%	Highly Worth It
Learning Design	100%	Highly Worth It
Audio and Narration	100%	Highly Worth It
Media Familiarity	100%	Highly Worth It
Average total score	**100%**	**Highly Worth It**

From the table above, it shows that the learning video obtained a feasibility percentage of 100% with the category "very feasible". In addition, the combination of text, images, narratives, and practice demonstrations is considered to have been able to support the effective delivery of the material. "The validator also provided some input related to improving the appearance and presentation of the video which was then used as a basis for revising the product before the trial stage." The following is a revision of the validation of media experts:

Before Revision **After Revision**



Caption: Correcting English writing with italics

Figure 10. Media Expert Product Revision

Development Trials

The trial was carried out on 26 students of class X of TBSM Vocational School Muhammadiyah Prambanan. The instrument used was in the form of a questionnaire consisting of 15 statements with an assessment scale of 1–4. The aspects assessed include the quality of the video display, the quality of the content of the material, and the ease of use. The results of the development trial can be seen in the following table:

Table 10. User Eligibility Results (Students)

Assessment Aspects	Research Score	Expected score	Average Total
Video Display Quality	905	936	96,6%
Quality of Content	293	312	93,9%
Ease of Use	292	312	93,5%
Quantity	**1490**	**1560**	**95,5%**

Based on the table above the learning video, a total score of 1,490 out of a maximum score of 1,560 was obtained, so that a percentage of 95.5% was obtained with the category of "very feasible". In the aspect of video display quality, a score of 905 out of a maximum score of 936 was obtained, the quality of the content obtained a score of 293 out of 312, while the ease of use aspect obtained a score of 292 out of 312. The results showed that students responded very positively to the developed learning videos.

The results showed that the video display quality aspect obtained the highest score (96.6%), while quality of content (93.9%) and ease of use (93.5%) obtained slightly lower scores. This difference may be attributed to the complexity of presenting technical content on the motorcycle smart key system, which requires clear explanations, appropriate sequencing, and easily accessible navigation. Although the scores remained within the highly feasible category, these aspects indicate areas that can still be improved. Future revisions will focus on simplifying technical explanations, improving the organization and sequencing of the learning materials, and optimizing navigation and accessibility features to provide a more user-friendly learning experience.

Disseminate

The learning videos that have been declared feasible based on the results of validation are then used in the distribution stage to students in class X of SMK Muhammadiyah Prambanan through the YouTube platform. It can be seen via the following link or scan:



Figure 11. Barcode for Disseminate

By scanning the QR Code using smartphones or computers, students can access videos practically as a source of independent learning and support for learning in the classroom.

The development of video-based learning media has been proven to provide positive results in the learning process. Some research found that the instructional video developed for motorcycle ignition system learning was highly feasible based on material and media expert validation and effectively supported students' learning in vocational education (Alvianto et al., 2022; Utomo & Ratnawati, 2018). These findings are supported by Firdaus et al., (2021), who found that a video-based learning medium for light vehicle electrical systems, particularly starter system maintenance, was feasible for use in vocational learning and could support students in understanding the learning material. In addition, research by Siahaan et al., (2022) explains that the application of Smart Key technology on motorcycles is able to improve vehicle safety so that it is one of the important technologies for students to learn as automotive technology develops.

Various studies show that video-based learning media is able to improve the quality of learning, especially in the vocational and automotive fields. Widjanarko et al., (2024) found that the use of question-based instructional videos in automotive engineering education significantly improved students' learning outcomes compared with conventional instruction, demonstrating the effectiveness of video-based learning in vocational education. Similar findings have also been reported in several studies. who concluded that the video-based learning media and digital media developed obtained the category of valid, practical, and suitable for use in supporting the learning process, especially in automotive materials that require visualization of work procedures (Hekele et al., 2022; Nandiyanto et al., 2026; Qi et al., 2026).

In addition to media quality, the use of digital platforms plays an important role in increasing learning flexibility and supporting independent learning. Aziz et al., (2024) explained that video-sharing platforms enable students to access and repeat learning materials according to their needs without being limited by space and time. This characteristic is relevant to automotive learning, particularly for technical materials that require repeated observation of components and procedures.

The high feasibility scores in this study can be attributed to the characteristics of the developed video. The material is presented systematically and contextually through explanations, visual demonstrations, and

direct examples of the Honda PCX 160 Smart Key System. This presentation allows students to connect theoretical concepts with actual automotive applications. In addition, the video can be paused and replayed, allowing students to learn at their own pace. These features may explain the high assessments from the material expert (95.5%), media expert (100%), and students (95.5%).

These findings are consistent with Aziz et al., (2024), while also extending their findings to a vocational automotive context in which visual demonstrations are important for understanding technical procedures. Thus, the developed video is considered highly feasible and has potential to support both classroom and independent learning. However, these results indicate media feasibility rather than direct evidence of improved learning outcomes.

4. CONCLUSION

The findings from this research and development project confirm the successful creation of an instructional video focused on the Honda PCX 160 ABS 2023 Smart Key System, which was structured utilizing the 4D (Define, Design, Develop, Disseminate) framework. This educational resource was systematically generated by navigating essential phases including requirement assessment, structural planning, material creation, expert evaluation, modification, and widespread distribution to guarantee that the final product perfectly aligns with the specific pedagogical requirements of vocational institutions.

The learning video has characteristics in the form of a systematic presentation of material that is equipped with learning objectives, an introduction to Honda PCX 160 ABS 2023 Smart Key components, an explanation of the working principles of the system, a demonstration of how to work, a discussion of simple disturbances, and a closing. The product is published through the YouTube platform and is equipped with a QR Code as a learning medium inside and outside the classroom.

The feasibility evaluation showed that the instructional video obtained a score of 95.5% from the material expert, 100% from the media expert, and 95.5% from student responses. All results were categorized as highly appropriate. These findings indicate that the developed video meets the assessed criteria for content, media presentation, and student acceptance and is suitable for use as a supplementary learning resource in Automotive Fundamentals instruction. However, these findings should not be interpreted as evidence of the effectiveness of the video in improving students' learning outcomes, as this study did not include effectiveness testing through pre-test and post-test comparisons or a control/comparison group.

This study is limited by its focus on product feasibility and student responses without testing learning effectiveness through pre-test and post-test or comparison groups, as well as by the limited number of experts and educational context. Future research is recommended to involve more experts and participants from diverse vocational schools and to use experimental or quasi-experimental designs to examine the video's effectiveness in improving learning outcomes, knowledge retention, and practical competencies when integrated with automotive hands-on activities.

REFERENCES

Alvianto, N., Handoyono, N. A., & Ratnawati, D. (2022). Pengembangan Video Tutorial pada Pembelajaran Sistem Starter di SMK Ma'arif 1 Nanggulan. *Dinamika Teknik Mesin*, *7*(2), 89–98. https://doi.org/https://doi.org/10.21831/dinamika.v7i2.52544

Aziz, F., Arsalaan, A. T., & Widaniah, N. (2024). Analisis Penggunaan Platform Berbagi Video dalam Mendorong Self-Directed Learning Siswa pada Pembelajaran Pengembangan Perangkat Lunak dan Game. *UPGRADE : Jurnal Pendidikan Teknologi Informasi*, *2*(1), 49–56. https://doi.org/10.30812/upgrade.v2i1.4274

Firdaus, H., Atikah, C., & Ruhiat, Y. (2021). Pengembangan Video Pembelajaran Kelistrikan Kendaraan Ringan Berbasis Animaker Terintegrasi Youtube. *Jurnal Pendidikan Teknik Mesin Undiksha*, *9*(2), 100–108. https://doi.org/10.23887/jptm.v9i2.33579

Hekele, F., Spilski, J., Bender, S., & Lachmann, T. (2022). Remote vocational learning opportunities—A comparative eye-tracking investigation of educational 2D videos versus 360° videos for car mechanics. *British Journal of Educational Technology*, *53*(2), 248–268. https://doi.org/10.1111/bjet.13162

Maulidi, A., Handoyono, N. A., & Samidjo, S. (2022). Pengembangan Media Pembelajaran Video Tutorial Menggunakan Hand Tools. *EDUKASIA: Jurnal Pendidikan Dan Pembelajaran*, *3*(2), 109–122. https://doi.org/10.62775/edukasia.v3i2.69

Mawardi, M. (2019). Rambu-rambu Penyusunan Skala Sikap Model Likert untuk Mengukur Sikap Siswa. *Scholaria: Jurnal Pendidikan Dan Kebudayaan*, *9*(3), 292–304.

https://doi.org/10.24246/j.js.2019.v9.i3.p292-304

Musfiza, L., Elizar, & Rohmani. (2025). YouTube Videos as Learning Media to Improve Science Learning Outcomes in Elementary Schools: A Systematic Literature Review. *Indonesian Journal of Educational Research and Review*, *8*(2), 569–582. https://doi.org/10.23887/ijerr.v8i2.89937

Nandiyanto, A. B. D., Susilawati, A., Farobie, O., Ximmateliyev, D., & Gayupova, S. K. (2026). Video-Based Learning in Heat Exchanger System: From Conceptual Understanding, Higher-Order Thinking, and Cognitive Analysis to Reducing Misconceptions among Vocational Students in Support of the SDGs. *Journal Of Technical Education And Training*, *18*(1), 105–117. https://doi.org/10.30880/jtet.2026.18.01.008

Qi, Z., Wang, J., Du, Y., & Zhang, X. (2026). The effect of blended learning approaches on vocational school students' practical skills performance and learning behaviors: virtual simulations or hands-on activities while accessing instructional videos. *Instructional Science*, *54*(1), 1–23. https://doi.org/10.1007/s11251-026-09793-4

Rahma, N., Ajie, H., & Fauziastuti, V. T. (2025). Pengembangan Video Pembelajaran Animasi Untuk Mingkatkan Pemahaman Materi Desain Grafis Di SMK Negeri 1 Jakarta Dengan Model Four-D. *Jurnal Pendidikan Dan Teknologi Indonesia*, *5*(9), 2698–2705. https://doi.org/10.52436/1.jpti.1042

Rahmadayani, S., & Darmansyah, D. (2023). Pengembangan Media Video Animasi Pembelajaran Seni Budaya Dalam Metode Demonstrasi Kelas VIII Di MTS. *Jurnal Pendidikan Indonesia*, *4*(2), 167–184. https://doi.org/10.36418/japendi.v4i02.1611

Rahmatin, J. A., Larasati, S. A. N., & Alawiyah, R. (2025). A Literature Review: The Implementation of the Borg & Gall Development Model in Science Learning. *Indonesian Journal of STEM Education*, *7*(1), 40–46.

Rakhmadi, A., Aji, D. K., Rosad, S., Azis, A., & Wahyusari, R. (2025). An IoT-Based Motorcycle Security System Using Arduino and Android for Theft Prevention. *Compiler*, *14*(1), 43–52. https://doi.org/10.28989/compiler.v14i1.2889

Santini, F. de O., Sampaio, C. H., Rasul, T., Ladeira, W. J., Kar, A. K., Perin, M. G., & Azhar, M. (2025). Understanding students' technology acceptance behaviour: A meta-analytic study. *Technology in Society*, *81*, 102798. https://doi.org/10.1016/j.techsoc.2024.102798

Sanusi, A., & Wardhani, D. F. (2023). Perkembangan Kendaraan Bermotor Dengan Teknologi Electronic Control Unit (ECU). *Journal Balitbang Dalampung*, *13*(1), 1–15.

Shaik, Z. B., & Peddakrishna, S. (2025). Design and implementation of electric vehicle with autonomous motion and steering control system using single board computer and sensors. *Results in Engineering*, *25*, 103995. https://doi.org/10.1016/j.rineng.2025.103995

Siahaan, I. H., Irawan, R. R. P., & Alimin, R. (2022). Aplikasi Android Smartkey 3 in 1 sebagai Sistem Monitoring dan Kendali serta Safety pada Sepeda Motor. *Jurnal Teknik Mesin*, *19*(1), 21–26. https://doi.org/10.9744/jtm.19.1.21-26

Siregar, T. (2023). Stages of Research and Development Model Research and Development (R&D). *DIROSAT: Journal of Education, Social Sciences & Humanities*, *1*(4), 142–158. https://doi.org/10.58355/dirosat.v1i4.48

Thiagarajan, S., Semmel, D. S., & Semmel, M. I. (1974). *Instructional development for training teachers of exceptional children: A sourcebook*. Leadership Training Institute/Spesial Education, University of Minnesota. https://doi.org/10.1016/0022-4405(76)90066-2

Utomo, A. Y., & Ratnawati, D. (2018). Pengembangan Video Tutorial dalam Pembelajaran Sistem Pengapian di SMK. *Taman Vokasi*, *6*(1), 68–76. https://doi.org/10.30738/jtvok.v6i1.2839

Widjanarko, D., Khumaedi, M., Kurniawan, A., & Santosa, T. (2024). Effectiveness of Question-Based Instructional Video (QBIV) for an Automotive Engineering Study Program. *International Journal of Emerging Technologies in Learning (IJET)*, *19*(03), 56–66. https://doi.org/10.3991/ijet.v19i03.47785