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Analysis of the Need for Electronic Module IPAS Development to Improve Independence, Creativity and Critical Thinking

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Abstract

According to the HDI, science education in Indonesia has a low number in producing students with independence, creativity, and critical thinking. In fulfilling and improving these criteria, the use of media learning based on Android, HTML, and offline-accessible applications has been enforced. The purpose of this research is to examine the need for developing learning media aiming to increase students' independence, creativity, and critical thinking. Descriptive narrative survey research is used as the method to employ the instrument indicators, including independence, creativity, and critical thinking. The instrument indicators consist of learning process, the need for electronic materials and supporting facilities and infrastructure. This study was conducted on 40 teachers, 3 male and 37 female, at SMK Pusat Keunggulan and 125 students, two females and 123 males, at SMKN 1 Trenggalek, two female and 123 male students. The survey on the students is also conducted to acknowledge and measure the indicators, including independence, creativity, and critical thinking. Data analysis is carried out through the validation of the instrument as the first step. After being revised, the implementation of the instrument was then conducted. Following the steps, the data were analyzed by applying Likert analysis. Based on the data obtained, 88% of the students and 100% of the teachers required innovative, intriguing, and accessible electronic-based materials to support and enhance both comprehensions of the lessons. Students who are categorized as less independent have 83.25% independency, 68.25%, and 83% critical thinking in average. As a result, learning media that are accessible offline, based on Android, HTML, and applications, are required.

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INTRODUCTION

The development of project-based electronic materials is one of the efforts to increase creativity, independence, and critical thinking. Project Based Learning (PjBL) is a learning model that emphasizes student activities to complete projects with specific themes assigned by teachers (Hwang, Hsiung, Chen, & Lai, 2017; Karnando, Rezki, & Tasrif, 2021; Kumalasari, Sudarmin, & Sulistyorini, 2019; Wahyuni & Rahayu, 2021). PjBL teaches students how to solve everyday problems and how to work in groups or teams (Wijayanti, Damayanthi, Sunarya, & Putrama, 2016). PjBL distinguishes itself by allowing students to solve the challenges set by the teacher with freedom. Students work independently to complete projects in groups or individually within a set time frame (Winaya, Darmawiguna, & Sindu, 2016). The focus of project-based learning in Vocational High Schools is strengthening competence, character, and work culture in accordance with the Pancasila student profile.

If the supporting factors are met, the project learning process will be effective and efficient. Teaching materials, in the forms of electronic materials, are one of the necessary supporting learning factors. Electronic materials are collections of digital or non-printed teaching media that have been systematically organized for distinct purposes (Mulyasari, 2021; Nikita, Lesmono, & Harijanto, 2018; Sari, 2021; Wijayanti et al., 2016). Images, audio, video, and animation can all be displayed using the electronics material. At SMK Pusat Keunggulan, electronic materials are tailored to students' geographical, economic, and socio-cultural circumstances to achieve the flow of learning objectives.

Using the independent curriculum, observations of the necessity of electronics material were made on teachers at SMK Pusat Keunggulan. From initial observations in 2022, adopting the independent curriculum, it was found that teachers need media that is suitable for students. Observations were also fashioned at SMKN 1 Trenggalek which revealed that the students are also in need of learning media that suits their needs. Moreover, limited facilities for project implementation, restricted learning through support books, and lack of learning media to increase affected the delayed improvement of the students' independency, creativity, and critical thinking.

METHODS

The research method used in this study is survey research. The samples used in this study were teachers and students. Teachers range in age from 25-45 years, while students in age range from 15-17 years. The data were analyzed using Likert scale and Guttman scale. This study was conducted on 40 teachers at SMK Pusat Keunggulan, three male and 37 female, and 125 student at SMKN 1 Trenggalek, two female and 123 male.

The following data collection techniques were used: (1) distributing questionnaires to IPAS teachers at SMK Pusat Keunggulan in East Java using the Google Form application with 17 items and 3 indicators, and (2) distributing questionnaires to grade X students at SMK Negeri 1 Trenggalek using Google Form with 13 items and 3 indicators. Data analysis is based on information provided by respondents with Likert analysis.

The following data collection techniques is the distribution of questionnaires using Google Form which consist of 42 items. This technique is enforced to measure the students' creativity in fulfilling learning outcomes. The data then become the benchmark to determine their fluent thinking, flexible thinking, authentic thinking and elaborating. The questionnaire to assess the students' independencies consists of 40 items with indicators, including initiative, responsibility, autonomy, and self-control to learn independently.

Questions aimed to assess the students' critical thinking in fulfilling learning achievements were based on their ability to induce and consider induction, consider whether the source is credible, ask and answer questions, and examine the results of observations, and define terms and considerations. Based on the information acquired from the respondents, the data was then analyzed with Likert scale measurements.

RESULTS AND DISCUSSION

Observations of the electronic module needs of IPAS material for science teachers at SMK Pusat Keunggulan in the East Java region aimed to determine the state of social science learning needs as well as the existing facilities and infrastructure in schools. Table 1 shows the findings of an analysis of observations made on science teachers at SMK Pusat Keunggulan.

Table 1. Results of Teacher Observations at the SMK Pusat Keunggulan in East Java

Category	Description
Learning process	Most of the learning carried out by teachers has carried out project-based learning, but the facilities for project completion are inadequate. Based on the observations, 28 teachers stated that the facilities needed for conducting project learning were inadequate.
The need for electronic materials	40 respondents (100%) need electronic materials to support and facilitate project-based implementation. According to their answers, the electronic materials needed should be communicative and can be monitored by the teachers. Instructions for use, learning objectives, learning activities according to syntax are necessary to support the use of electronic materials, and should cover all science materials. In addition, during the usage, evaluation is needed for further adjustment and improvement.
Supporting facilities and infrastructure	Most teachers have personal computers/laptops and smartphones that can be used for the learning process and can access electronic materials. Personal computers and laptops used for learning in schools are not sufficient so that students' smartphones are needed.

The findings of student observations at SMK Negeri 1 Trenggalek were intended to determine students' interest in learning science and technology. Table 2 shows the findings from observations at SMK Negeri 1 Trenggalek.

Table 2. Results of Observations on Students at SMK Negeri 1 Trenggalek

Category	Description
Learning process	Students still have difficulty in achieving science learning due to lack of completeness of materials, teaching aids, availability of workshops, supporting facilities for project completion and other supporting media such as materials and electronic materials.
The need for electronic materials	Students need handbooks or textbooks that are used to study science learning outcomes, so students look for literature either from the internet or in the library to understand the material. According to the observations, 88% of the students need innovative, intriguing, and accessible electronic based materials to enhance their understanding of the lessons given.
Supporting facilities and infrastructure	Most of the facilities owned by students already have Android-based smartphones.

The results of distributing questionnaires, which assessed students' creativity in fulfilling learning outcomes, includes fluent thinking skills, flexible thinking, original thinking and elaborating in less categories as shown in Figure 1.

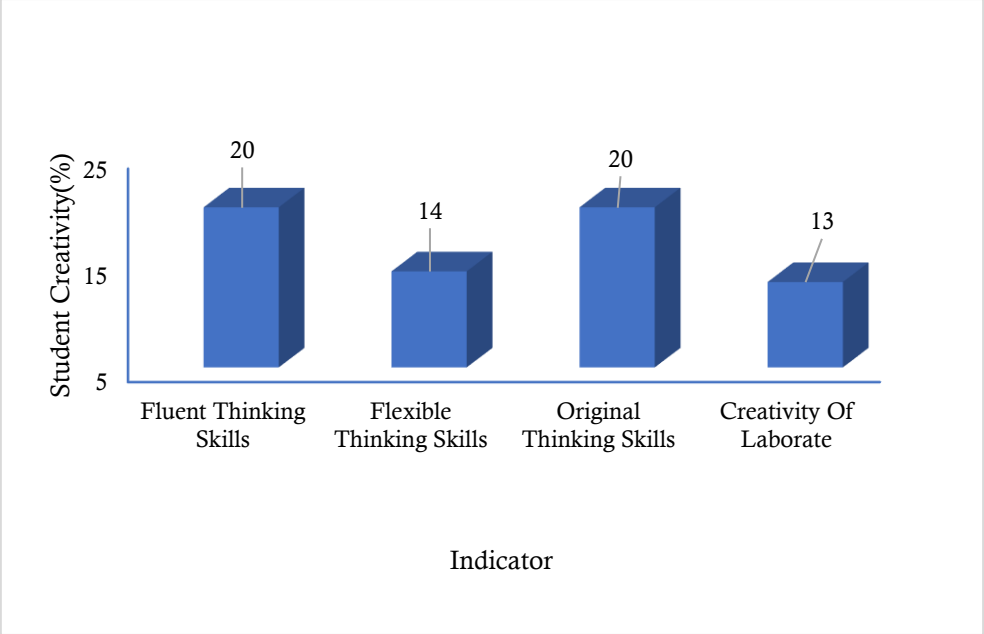

Figure 1. Student Creativity Questionnaire Data (Handoko, 2017)

According to Figure 1, the results of the student creativity questionnaire analysis show that 80 percent of students still have poor fluent thinking skills. The examination of the data, using Likert Scale Measurements, conveyed that low mastery of this aspect demonstrated a deficiency in asking questions. Moreover, it indicates their lacking in answering questions from pedagogy, learning process, ideating problems, expressing ideas, quickly analyzing, and evaluating errors in problem solving (Handoko, 2017).

The possible causes behind the lower capability of fluent thinking, which is less than 80%, are (1) the teacher does not provide lighter questions related to the students' daily life and limit their freedom in conveying ideas, (2) the students have less capability in understanding, communicating, explaining, and concepting their ideas due to low literacy skills, and (3) students have lower ability to communicate and convey their ideas due to having poor literacy and comprehending concept, (3) as the students are set on the teacher's question, they then had slower progress in developing their mindset; (4) Due to the higher intensity of learning through counts and numbers, the students faced difficulties in solving problems quickly and accurately.

The next aspect is the students' creativity and flexible thinking skills which remains low at 86%. With lower capabilities of this aspect, the students became less capable in interpreting data, including pictures, tables, and graphs, applying principles, equations, and even laws from physics in problem solving which led to limited shifting in their spontaneous thought process and different surroundings (Handoko 2017; Rosid, 2019).

The chances behind the lower capability of flexible thinking, which is less than 86%, are (1) teachers do not provide various objects, (2) students have lower capabilities in interpreting images, stories, and problems, (3) students possess low literacy skills related to the habits of problem solving, and (4) students are not given the opportunity to think spontaneously based on the teacher's questions. In the lower category, the creativity aspect for original thinking skills is 80%.

By lacking in this area, the students then became less capable in generating exceptional ideas as they continuously use the old mindset which is to always stick with the common thoughts shared with others which caused the students to find difficulties in provoking new solutions and stick to analyzing situations rather than synthesizing it (Handoko, 2017; Rosid, 2019). The possibility of original thinking skills remains low, owing to the following factors: (1) the teacher does not motivate students to think about things that have never been thought of by others, (2) students have incomplete supporting facilities to discover and validate novel things, and (3) students are having low literacy and skills and comprehension of factual knowledge.

The last aspect was students' creativity to elaborate, which is less than 87%. As the students are showing low ability of this aspect, they became less intrigued in digging the depth of problem solving and following the detailed steps of it. Moreover, they are less interested in conducting detailed experiments on generating solutions, lacking the sense of beauty, and are not into exploring and elaborating existing ideas (Handoko, 2017; Rosid, 2019).

Based on the factors examined, there are some reasons behind the lacking: (1) students lack factual knowledge literacy, (2) students are less able to elaborate on existing ideas, and (3) teachers lack

of motivation for detailed problem solving. According to the data analysis, the creativity aspect of students at SMKN 1 Trenggalek is still low, therefore appropriate media to increase student creativity must be developed.

The research on material development for increasing creativity on static fluid material can improve students' learning creativity with a gain value of 0.46 or in the medium category (Novianto, Masykuri, & Sukarmin, 2018). Developing an integrated PjBL e-material with STEM in vocational students with N-gain results of 0.36 or the medium category can increase creativity. As a result, it is possible to conclude that using learning media can boost students' creativity (Cahyani, Mayasari, & Sasono, 2020).

The results of distributing questionnaires for students' independence in fulfilling learning outcomes are then applied to determine learning initiative, responsibility, autonomy, and self-control for learning independence in the less category shown in Figure 2.

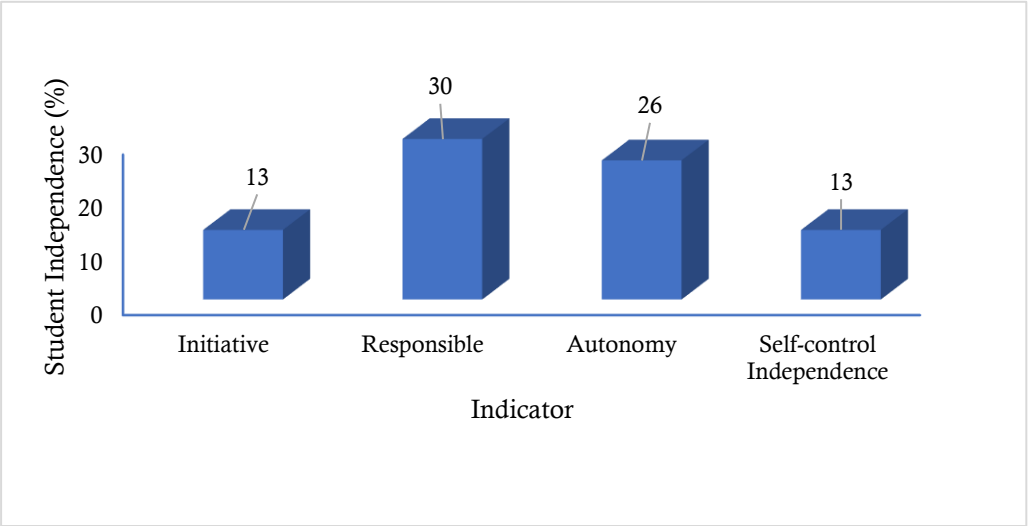

Figure 2. Student Independence Level Questionnaire Data (Astuti, 2016)

In the less category, the initiative's independence is 87 percent. The low level of this aspect indicates that students are less capable of directing themselves and initiating problem-solving (Astuti, 2016). The chances of low independence in the initiative were caused by: (1) students are less capable of arranging their schedules for learning activities, (2) students and teachers are not having discussions related to the concept of clarity, (3) teachers do not direct students to summarize what they have read, (4) students are lacking the initiative to summarize what they have read, (5) students are facing concerns in asking questions related to learning difficulties, and (6) students lack of communication with the teacher to ask questions related to learning difficulties.

The next aspect of learning independence was responsibility, which is 69% of the less category. This aspect's low level demonstrates the lack of responsibility as a student in dealing with learning difficulties (Yanti & Surya, 2017). The chances of independence in being responsible was low because (1) teachers do not motivate the students enough regarding the importance of being self-reliant, (2) students are not ready to finish the assignments given as they lack knowledge, (3) students do not understand the significance of absorbing knowledge from their surroundings, and (4) the teacher does not provide a guide to comprehension based on the student's learning style.

The aspect of autonomy was 72%, categorized as the lower position which pect's low level indicates that students are less able to see difficulties as challenges, apply learning strategies, and evaluate learning processes and outcomes (Gusnita & Delyana, 2021). The case of autonomy in the aspect of the lower one, namely: (1) students are not capable enough to face difficulties, (2) students are less confident about the results of what they are working on, (3) students lack the knowledge to solve problems, (4) teachers do not provide motivation for the importance of literacy, and (5) students are less motivated because learning set on the existing facilities and infrastructure.

The aspect of self-control was 87%, categorized in the less category. This aspect's low level indicates a lack of seriousness in learning and exploring knowledge, which is also a shortfall in how the students connect problem-solving with knowledge (Nahdliyati, Parmin, & Taufiq, 2016). The possibility of independence in the aspect of self-control is low because: (1) students do not study other references as they are limited to the material provided by the teacher, (2) students lack of the desire to make a summary before the lesson is over, and (3) the teacher has not fully linked learning to

environmental conditions; (4) students are less capable of linking problem-solving with their knowledge; (5) students are less capable to relate lessons learned to life; (6) students have lower capabilities to apply concepts in problem-solving, and (7) teachers are less creative in providing examples of problems and solutions.

The findings of Sari's research on the development of e-materials meet the criteria of being feasible, practical, and effective. The feasibility of developing e-materials is 71, which is in the 'very good' category, and the product's practicality is also in the 'very good' category. Based on the data, the established e-material can promote independence and practical application. The other e-material development research falls into the appropriate category, with increased independence based on the gain score test. According to the results of the paired samples test, the use of e-materials also affects learning independence (Mulyasari, 2021). As a result, it is possible to conclude that developing learning materials can increase student independence.

Figure 3 depicts the results of distributing questionnaires to assess students' critical thinking in fulfilling learning achievements for the child's ability to induce and consider induction, decide whether the source is credible, ask and answer questions, observe and analyze the results of observations, and define terms and craft definition in the less category.

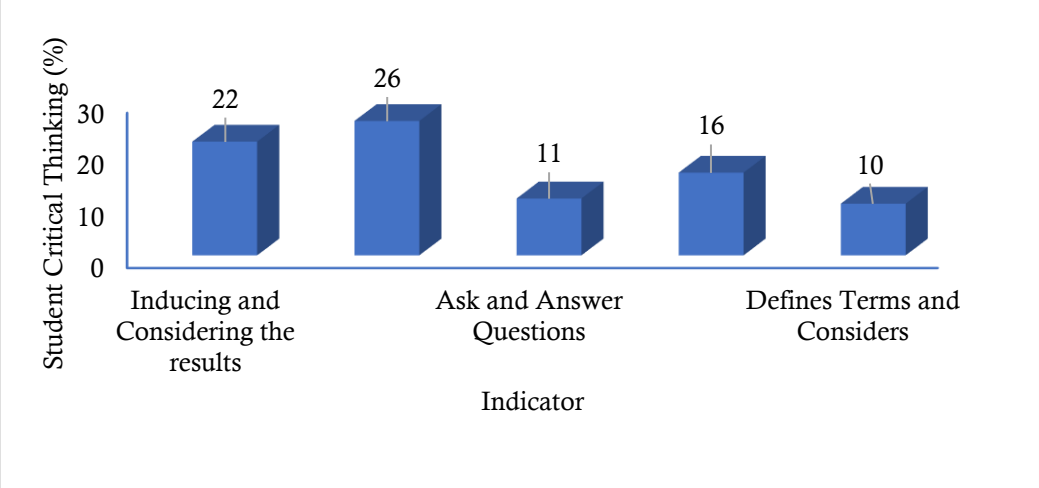

Figure 3. Student Critical Thinking Questionnaire Data (Nuryanti, Zubaidah, & Diantoro, 2018)

Aspects of critical thinking on inducing and considering the results of induction are less than 78 percent. This aspect's low level demonstrates students' inability to identify and explain conclusions (Nuryanti, Zubaidah, & Diantoro, 2018). The low skill of induction and consideration can be caused by some factors which are: (1) students are less able to put forward hypotheses due to a lack of knowledge, (2) teachers do not equip projects that are in accordance with student character and student expertise, (3) students are less able to relate and conclude the activities carried out, and (4) teachers do not provide examples of innovative projects related to environmental conditions.

In the 74% less category, another aspect of critical thinking considers whether the source is credible. This aspect's low level indicates students' inability to explain the truth and its relevance (Nuryanti et al., 2018). The chance of considering the validity of the source is low, as follows: (1) students have limited literature related to the subject given by the teacher, (2) the teacher does not provide various literature the students can use, and (3) students are less able to write down the results of their observations and experiments to promote analysis.

Within the critical thinking aspects, which is 89 percent of the time, the students have a low capacity in asking and answering questions in the less category. This aspect's low level indicates a lack of ability in formulating questions (Nuryanti et al., 2018). Furthermore, the ability of students to answer questions is unrelated to one another (Rahmawati, Hidayat, & Rahayu, 2016). The possibility of being able to ask and answer questions is low due to the following factors: (1) students struggle in expressing something, (2) students lack extensive knowledge related to the material, (3) student's low level of literacy related to the material, (4) teachers do not provide knowledge and guidance on how to improve their communication skill, and (5) teachers do not provide literature information as a basis for asking questions.

Afterward, the critical thinking aspect is used to observe and consider the results of observations which is in the 84% less category. This aspect's low level demonstrates students' inability to empirically prove events in the environment (Rahmawati, et al. 2016). The possibility of being able to observe and

consider observations is low due to the following factors: (1) students are not given the opportunity to do practicum / initiate independent projects, (2) students are less sensitive to their surroundings, and (3) teachers do not provide motivation and descriptions related to symptoms. (4) Students continue to struggle with transmitting the results of observations, both orally and written.

The critical thinking aspect is used to measure students in defining terms and considering a definition, which is less than 90% in the category. The low level of this aspect shows a lack of understanding of the concept correctly, specifically, and clearly (Rahmawati et al., 2016). The probability of defining a term and considering a definition is very low, namely; (1) students are less able to review the results of the projects carried out, (2) to understand the material and concepts, (3) to express the symptoms that exist in the environment related to the material, (4) the teacher does not provide innovations related to environmental-based projects.

Research on material development by (Hasanah, Sarwanto, & Masykuri, 2018) was conducted to improve a skillset of process and students' critical thinking skills on temperature and heat material. The results show that the material was feasible to be used and the material was suitable to improve process skills and critical thinking skills effectively. The aspect of process skills after treatment resulted in a moderate category of observation, high category experiment planning, and high category evaluations. Meanwhile, critical thinking for indicators synthesizes the medium category, analyzes the high category, recognizes the medium category problem, solves the medium category problem, concludes the medium category, and evaluates the high category. Similar research was also conducted by (Latifah, Ashari, & Kurniawan, 2020; Rokhim, Suparmi, & Prayitno, 2016)) resulting in effective material used to improve students' critical thinking skills. The development of effective material aiming for the improvement of students' critical thinking gets a medium category with an average score of 0.6, while the average student learning outcome is 80.34 with 100% classical learning completeness (Sujiono & Widiyatmoko, 2014). In conclusion, the development of learning materials can improve students' critical thinking skills.

CONCLUSION

The data were acquired through survey method with teachers and students as the samples, teachers within the age range of 25-45 years, and students within 15-17 years. The data were analyzed using Likert scale and Guttman scale. This study was conducted on teachers at SMK Pusat Keunggulan with a total of 40 teacher respondents, three male and 37 female, and students at SMKN 1 Trenggalek with a total of 125 student respondents, two females and 123 males.

Data were analyzed with Likert Scale Measurement and get a data that is according to the findings, 88 percent of students and 100% of teachers required electronic-based materials as innovations, interesting, and accessible in aiding comprehension of the lesson. Students in the less independent category have an average aspect of 83.25% independence, creativity in the less independent category is 68.25, and critical thinking is 83% with Guttman analysis.

Based on the findings, the students face some difficulties in learning sciences: low independence with a lack of creativity and critical thinking. One of the main reasons is that electronic-based learning media, including mobile-based learning methods, have not been used by teachers. It is necessary to create engaging media in learning activities to encourage students to become active, independent, and creative while developing students critical thinking skills. The findings indicate that students require electronic-based learning media accessible online and offline. Furthermore, it is expected this research will aid students in increasing their independence, critical thinking, and creativity.

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