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# Mobile-Based Application to Integrate Vocational Learning and Career Learning in Mechatronics Engineering Vocational High School

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***ABSTRAK***

*Paradigma pembelajaran baru dibutuhkan Sekolah Menengah Kejuruan (SMK) untuk mengadaptasi pembelajaran vokasi dengan kebutuhan dunia kerja di era revolusi industri 4.0. Perubahan struktur pola kerja akibat hilangnya lapangan pekerjaan yang ada dan munculnya lapangan kerja baru menuntut perlunya penguatan sekolah kejuruan sebagai pendidikan untuk pekerjaan dan juga sebagai pendidikan untuk pengembangan karir. Khususnya di SMK teknik mekatronika yang erat kaitannya dengan teknologi industri 4.0. Penelitian ini bertujuan untuk menghasilkan aplikasi berbasis mobile untuk mendukung integrasi kegiatan pembelajaran kejuruan dan pembelajaran karir di SMK teknik mekatronika. Pengembangan produk menggunakan metode research and development dengan tahapan pengembangan mengadaptasi model Holistic 4D yaitu tahapan Define, Design, dan Develop. Pengumpulan data dilakukan dengan menggunakan lembar observasi dan angket yang telah divalidasi oleh ahli. Metode analisis data yang digunakan adalah analisis data kuantitatif. Hasil telaah ahli dan uji coba operasional menunjukkan bahwa aplikasi media pembelajaran yang dikembangkan berada pada kategori sangat layak dengan skor penilaian rata-rata 3,55. Hasil ini menunjukkan bahwa aplikasi berbasis mobile yang dikembangkan layak dan dapat digunakan untuk pengembangan karir siswa SMK dengan kompetensi teknik mekatronika. Aplikasi berbasis mobile yang dikembangkan dapat digunakan untuk memfasilitasi proyek yang berpusat pada peserta didik, seperti pembelajaran mandiri, pembelajaran kolaboratif, dan manajemen proyek.*

**ABSTRACT**

A new learning paradigm is needed by Vocational High Schools (SMK) to adapt vocational learning to the needs of the world of work in the era of industrial revolution 4.0. Changes in the structure of employment patterns due to the loss of existing jobs and the emergence of new job opportunities required the need to strengthen vocational schools as education for occupation and also as education for career development. Especially in mechatronics engineering vocational high school, which was closely related to industrial technology 4.0. This study aims to produce a mobile-based application to support the integration of vocational learning and career learning activities in mechatronic engineering vocational high schools. Product development used the research and development methods with the development stages was adapting the Holistic 4D model, namely the Define, Design, and Develop stages. Data was collected using observation sheets and questionnaires that had been validated by experts. The data analysis method used is quantitative data analysis. The results of expert reviews and operational trials showed that the learning media application developed was in the very feasible category with an average assessment score of 3.55. This result showed that the mobile-based application developed was feasible and can be used for the career development of vocational students with mechatronic engineering competence. Mobile-based application developed can be used to facilitate learner-centred projects, such as self-directed learning, collaborative learning, and project management.



## 1. INTRODUCTION

Vocational high school (SMK) is a form of vocational education at the secondary level that prepares students to work in specific fields (Liu et al., 2020; Sudira, 2017). One of the challenges in implementing education in SMK was the absorption of SMK graduates in the job market (Beicht & Walden, 2019; Coetzer et al., 2020; Daryono et al., 2020). Competition for SMK graduates in the job market was getting tighter (Beicht & Walden, 2019; Triyono et al., 2020). The areas of expertise in SMK had a number of graduates that were not commensurate with the needs of the world of work (Olazaran et al., 2019; Triyono et al., 2020). As a result,

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many SMK graduates cannot work according to their expertise and cause unemployment (Daryono et al., 2020; Kusuma et al., 2021). The occurrence of discrepancies in the supply and demand of labor also results in the accumulation of graduates of certain skill competencies but instead lacks other skill competencies (Hadam et al., 2017; Olazaran et al., 2019).

Entering the era of the industrial revolution 4.0, the absorption of vocational graduates in the world of work faced increasingly difficult challenges (Popkova et al., 2019; Schwab, 2016; Xu, 2020). The emergence of modern technologies was starting to replace jobs that were originally finished by human labor (Cetrulo & Nuvolari, 2019; Kesai et al., 2018; Vermeulen et al., 2018). The emergence of existing technology was predicted to cause 3-14% of professions to disappear by 2030 so that millions of workers in the world have to change jobs (Bughin et al., 2017). Job losses do not only occur in jobs with lower skill levels. The loss of job opportunities in the industrial revolution 4.0 era was accompanied by the emergence of various new jobs in greater numbers (Bughin et al., 2017; Vermeulen et al., 2018). By 2030, the implementation of automation in Indonesia was expected to replace 23 million jobs, while creating 27 million to 46 million new jobs in the same period. Which the 10 million jobs of which were new types of jobs that did not currently exist (Algomaiah & Li, 2021; Das et al., 2019; Husain & Kolesar, 2018). This change in employment has resulted in a shift in the structure of the employment pattern (Li et al., 2021; Yoon et al., 2019). This indicates a reduction in the need for SMK graduates who are designated as operators. So SMK needed a new learning paradigm to adapt vocational learning to the needs of the world of work in the era of industrial revolution 4.0.

Based on observations made on the competence of mechatronic engineering skills at SMKN 7 Semarang, SMKN 3 Wonosari, and SMK SMTI Yogyakarta, the vocational learning that is currently taking place at the mechatronic engineering competencies tends to be unstructured and not yet integrated with career learning. Career learning has not been structured in directing students to identify occupations that are suitable for themselves and occupations related to the learning being carried out (Alkhudary & Gardiner, 2021; Hummel et al., 2018; Poulsen, 2020). So that students tend not to have confidence in career decisions and have the readiness and adaptability to develop a career. Learning activities in SMK had an important role so that students had the readiness to develop careers in the era of the industrial revolution 4.0. Learning for students' career development would be ideal if it was able to bridge students with available careers in the world of work (Bakke, 2021; Healy et al., 2020; Oliveira & Araújo, 2021; Steeb et al., 2021). Including linking the characteristics of students who were generation Z and proficient with information technology (Husain & Kolesar, 2018; Li et al., 2021; Stillman & Stillman, 2019; Yoon et al., 2019), with the characteristics of the world of work in the industrial revolution era 4.0 which applied a digital-based automation system that was controlled, computed, transparently scalable, and widely accessible (Algomaiah & Li, 2021; Majumdar et al., 2020; Prabakaran et al., 2021; Sudira, 2020). The application of e-learning and mobile learning in career learning has also been used to create more enjoyable career guidance and career information services, and increase students' motivation to seek career information according to their interests and talents (Baber, 2021; Obeng & Coleman, 2020; Veronica et al., 2020).

Based on observations, students in mechatronics engineering vocational high school are currently generation Z who are proficient with digital devices in learning. However, the application of e-learning and mobile learning to learn in SMK mechatronic engineering competence has not yet been maximized to integrate vocational learning and career learning. So that work-related learning carried out during vocational learning has less impact on increasing students' career development abilities, and vice versa career learning carried out does not have an impact on increasing self-awareness of students' learning to actively participate in vocational learning that is beneficial for their career development (Bassot, 2019; Dodd & Hooley, 2018; Draaisma et al., 2018; Hummel et al., 2018). Therefore, learning in vocational mechatronic engineering skills requires a new learning model that can integrate vocational learning and career learning activities (Ainslie & Huffman, 2019; Lundahl & Ydhag, 2020; Poulsen, 2020). In addition to being able to integrate vocational learning and career learning activities, the new learning model needed by vocational schools with mechatronic engineering skills needs to bridge the characteristics of students who are Generation Z and the characteristics of the world of work in the industrial revolution era 4.0, including the use of digital technology and the habit of human-machine interaction in learning (Chen et al., 2021; Husain & Kolesar, 2018; Majumdar et al., 2020; Yoon et al., 2019). So that learning can be realized that is more effective-efficient, integrated, and can be applied to develop the careers of vocational students with competence in mechatronic engineering skills.

Based on this background, this study develops a mobile-based application to support the integration of vocational learning and career learning activities in mechatronic engineering vocational high schools. This learning platform focuses on strengthening vocational learning in the form of work-related learning, learning to work, and learning for career development. This mobile-based application was developed to meet the needs of future work, so the learning paradigm adopted in the development of this learning model includes cybergogy, heutagogy and peeragogy. Career development efforts for mechatronics engineering vocational high school students needed to be maximized by integrating vocational learning activities and career guidance processes. Therefore, this research and development aimed to produce learning media in the form of mobile-based applications to support the integration of vocational learning and career learning activities in mechatronic engineering vocational high schools. The development of a mobile application platform was chosen because smartphones have become a commonly used device. both for work-related activities and to support learning activities. The mobile application-based career development process also has positive impacts such as high accessibility, convenience, and programs that can be adapted to different behavioral contexts (Elyakim et al., 2019; Ho et al., 2020; Lin et al., 2021). The mobile-based learning media platform developed in this study focused on its use in the context of mechatronic engineering vocational learning so that the products developed are adapted to learning needs which include the process of planning, implementing, and evaluating learning.

## 2. METHOD

This study uses research and development methods with development steps adapting the Holistic 4D model (Reigeluth & An, 2021). The Holistic 4D model includes four stages of development, namely the define, design, develop and deploy (Daryono et al., 2021; Luthfi et al., 2021). This research only adapted 3 stages of the Holistic 4D model, namely the define, design, and develop stages with three levels of holistic design and an iterative cycle, namely analysis, design, and evaluation (Reigeluth & An, 2021). The stages of developing mobile application media adapting the Holistic 4D model showed in Figure 1.

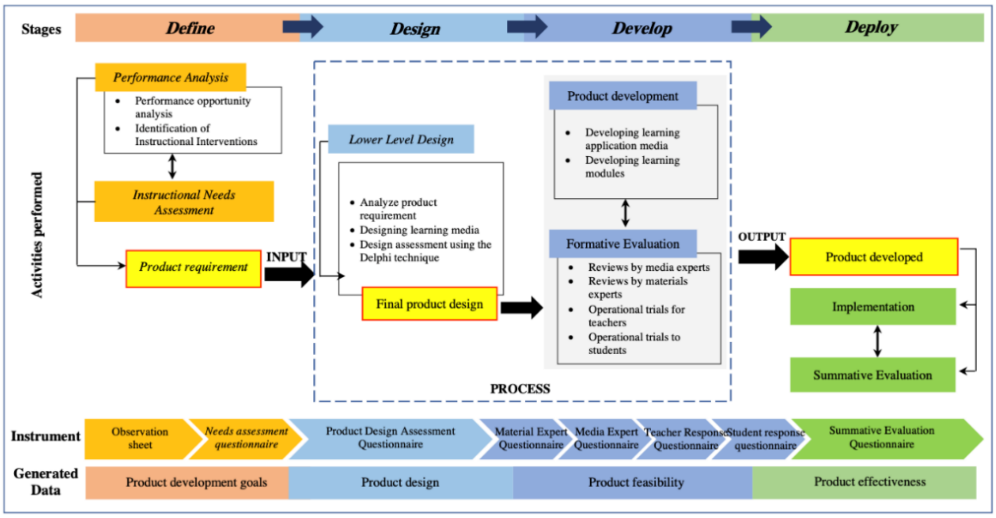


**Figure 1**. Stages of Developing Mobile-Based Application Media Adapting a Holistic 4D Model

Collecting data in this study using observation sheets and questionnaires that validated with expert judgment method. Performance analysis was carried out through observation activities at SMK N 3 Wonosari, SMK SMTI Yogyakarta, and SMK N 7 Semarang. Instructional needs assessment activities were carried out through the provision of questionnaires to 32 mechatronic engineering competency teachers from 10 vocational schools with accreditation A, B, C and not yet accredited in Yogyakarta and Central Java, namely SMK SMTI Yogyakarta, SMKN 3 Wonosari, SMK Ki Ageng Pemanahan, SMKN 1 Bawang, SMKN 2 Sukoharjo, SMKN 2 Wonogiri, SMKS Wisudha Karya Kudus, SMK PL Leonardo Klaten, SMKN Nurul Barqi, and SMKN 7 Semarang. The instrument used is the Instructional Needs Assessment Questionnaire with aspects assessed including learning planning, learning process, learning assessment, and vocational and career learning integration.

This research and development activity produced quantitative data and qualitative data. Qualitative data were obtained from observation (performance analysis), product design assessment using the Delphi technique, and questionnaire results in the form of comments or suggestions from experts and users. Quantitative data were obtained from questionnaires in the form of instructional needs assessment questionnaires, material expert questionnaires, media expert's questionnaires, teachers response questionnaires, and students response questionnaires with scoring guidelines for assessment criteria guided by the provisions as shown in Table 1.

Data analysis in this study used a descriptive method. Determination of learning needs was based on the results of calculating the scores obtained for each aspect of the statement items. Statement items with an average score of <3.5 were included in the learning needs category. The feasibility level of the product developed was obtained through descriptive analysis of quantitative data obtained from the assessment of material experts, media experts, students, and teachers. Determination of eligibility is based on the results of calculating scores for each aspect, then categorized according to the provisions in Table 2.

**Tabel 1**. Scoring Criteria

| No | Categories of Answer | Score |
|---|---|---|
| 1 | SS | 4 |
| 2 | S | 3 |
| 3 | TS | 2 |
| 4 | STS | 1 |

**Tabel 2**. Feasibility Category Criteria

| No | Average Score | Categories |
|---|---|---|
| 1 | >3.25 - 4.00 | Very feasible |
| 2 | >2.50 - 3.25 | Feasible |
| 3 | >1.75 - 2.50 | Less Feasible |
| 4 | 1.00 - 1.75 | Not Feasible |

## 3. RESULT AND DISCUSSION

**Result**

The product developed in this research and development was a mobile-based application to integrate vocational learning and career learning activities in mechatronic engineering vocational high schools. The application developed was in the form of an Android-based mobile application for students and a supporting application in the form of a web-based application for teachers and counselors. The product development stages include the Define, Design, and Develop stages which were described as follows. The Define stage consists of performance analysis and instructional needs assessment activities. The results of the performance analysis activity show that there were problems that required instructional intervention in mechatronics engineering learning. In the aspect of academic and social life situations, the problems that arose were that students and teachers have different generations, so that the different learning styles of students have not been accommodated, and the collaboration skills of students in learning activities are still limited. In the teaching and learning activities aspect, students had not been able to determine learning according to their needs. On the learning facilities aspect, e-learning was less practical in use because it was held with many platforms. In the career guidance services aspect, the problems that occurred included the unstructured career learning for students, students did not have confidence in career decisions, there were no career assessment activities for students, career guidance had not directed students to identify occupations that suit themselves, and the delivery of career information was still limited through the BKK (Student Career Center).

Performance analysis activities indicated the need for instructional interventions in mechatronics engineering vocational learning then followed by instructional needs assessment activities to assess the implementation of current learning and new learning needs that need to be met to improve the quality of learning from the point of view of vocational teachers. Based on the instructional needs assessment results, the scope of requirements in product development was in the scope of learning planning, learning processes, and learning assessments. The scope of learning planning included students being involved in learning planning, establishing a learning network for students based on information technology, as well as integrating vocational learning planning with career information. The scope of the learning process included student-centered learning, students as learning resources, integrating vocational learning with career information, and integrating vocational learning with career guidance services. The scope of the learning assessment includes the use of information technology to compute learning assessments, provide accurate feedback, communicate learning outcomes transparently and facilitate career assessment activities. The scope of product development was then evaluated by reviewing several theories related to vocational learning and career learning to determine product requirements. The product requirements that had been determined then become the basis (input elements) for the design stage.

The Design stage began with an analysis of product requirements obtained at the Define stage. Based on the analysis results, the product design included five main features, namely subjects feature (consisting of learning plan features, learning activities, and learning assessments), career information, career assessments, mechatronics learning forums, and career guidance services. The product design was assessed by experts consisting of two lecturers, two school principals, two teachers, three career experts, two software experts, and two alumni. Some things that were noted for design improvements based on expert input and advice include the content submitted needs to show the specificity of the mechatronics engineering competence, the application needs to be adjusted to the syllabus and useful learning tools, it was necessary to re-detail the flowchart or flow of application features for teachers and it was advisable to prioritize user experience for students so that the application is easy to use and does not add to the learning burden. The product design that had been evaluated based on the assessment and advice of experts and practitioners then becomes a reference in developing the product.

The learning media application developed was a mobile-based application to integrate vocational learning activities and career learning in mechatronic engineering vocational schools. The application developed was in the form of an android-based mobile application for students and a web-based support application for teachers and counselors so that students can connect with teachers and counselors during learning activities. Mobile devices that could use the application for students were devices with the Android operating system version 6.0 (Marshmallow) and above. Users of mobile-based applications developed were students, teachers, counselors, and admins. In the implementation of learning, the users of learning media applications were students, teachers, and counselors, while the admin acts as the manager of the application, including managing classes, subjects, and regulating access for teachers and students according to their respective classes. Each application user used a specific account to be able to access the application. The visualization of mobile-based application development is shown in Figure 2. The developed mobile-based application included five main features, namely learning plan features, learning activities features (consisting of learning planning, learning activity, and learning assessment), career information, career assessments, learning forums, and career guidance services. The appearance of the Android-based mobile application for students was as follows. The display of the mobile-based application for students is shown in Figure 3.

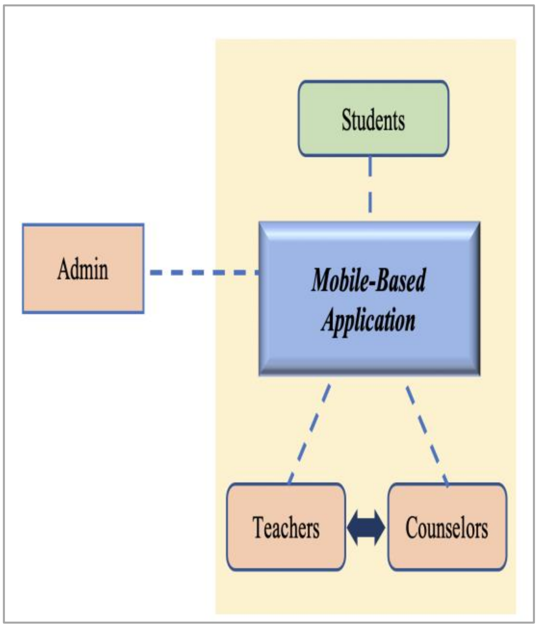


**Figure 2**. Users of Mobile-Based Applications Developed

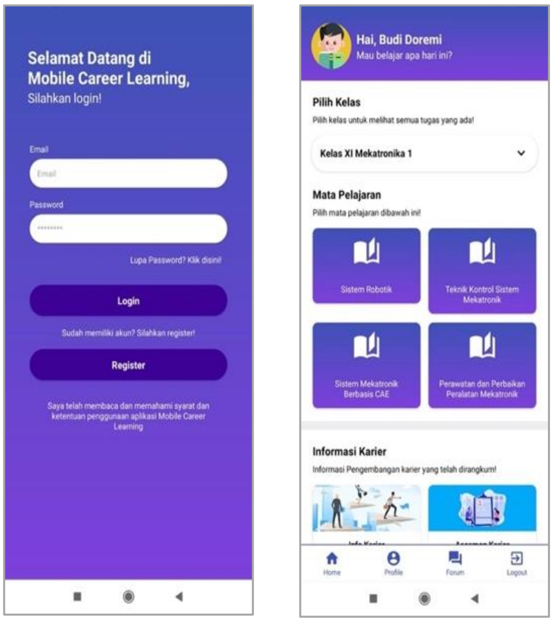


**Figure 3**. Mobile-Based Application for Students

Web-based applications for teachers/counselors and admins are accessed through the same address, but with different accounts. The difference between the application for admin and the application for teachers/counselors was the class menu and subjects menu in the admin application. The appearance of web-based applications for teachers/counselors and web-based applications for admins was is shown in Figure 4 and Figure 5.

The mobile-based application developed enters the formative evaluation stage consisting of expert review and operational trials. Expert reviews were carried out to ensure that the results of product development accordance with the requirements needed and are suitable for use in learning. The operational trial was used to ensure that the product developed can work well and to find out the operational problems. Feedback from a sample of students and teachers was used to make further product revisions and improvements. The feasibility of the product according to the material expert's review showed an average score of product relevance aspect was 3.71, an average score of usefulness aspect was 3.85, and the average overall material assessment score was 3.8. The feasibility of the product according to media expert reviews showed an average score of the usefulness aspect was 3.67, the usability aspect was 3.67, the attainability aspect was 3, the aesthetic aspect was 4, the emotional impact aspect was 3.33, and the average overall assessment score was 3.62. Assessment by material experts and media experts showed that the mobile-based application developed falls into the very feasible category. Feasibility assessment according to expert review showed in Figure 6.

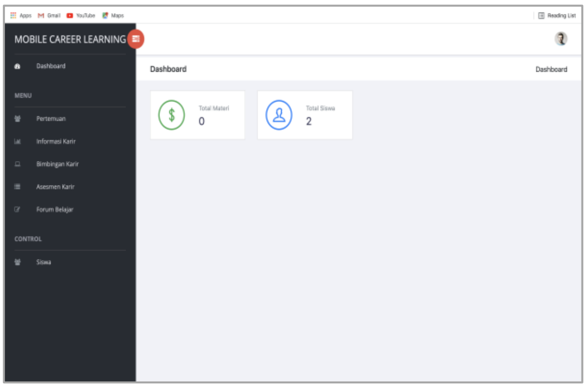


**Figure 4**. Web-Based Application for Teachers and Counsellors

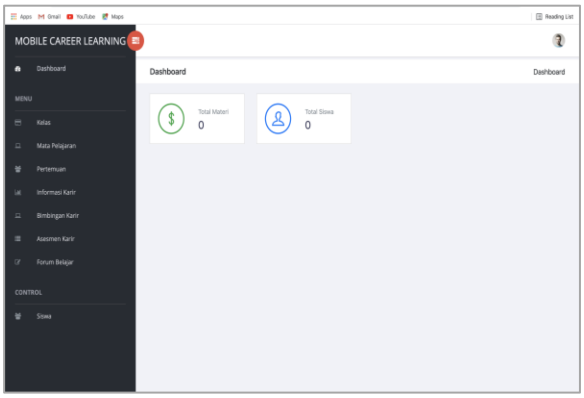


**Figure 5**. Web-Based Application for Admin


**Figure 6**. Feasibility Assessment According to Expert Review

Product feasibility assessment according to student responses showed an average score of the product relevance aspect was 3.27, the usefulness aspect was 3.25, the design aspect was 3.17, the usage aspect was 3.13, and the average assessment score of 3.22, including in the feasible category. Student responses indicate that mobile-based applications developed could be used in learning, but it needs usefulness, design, and product use improvements. Product feasibility assessment according to teacher response showed an average score of the product relevance aspect was 3.56, the usefulness aspect was 3.63, the design aspect was 3.5, and the usage aspect was 3.59. The average score was 3.59 and was included in the very feasible category. Teacher responses indicated that the mobile-based application developed was feasible and could be used in learning. Feasibility assessment according to operational trial showed in Figure 7.


**Figure 7**. Feasibility Assessment According to Operational Trial

The results of the formative evaluation in the form of expert reviews and operational trials of a mobile-based application to integrate vocational learning and career learning showed that the product developed is in the very feasible category with an average score of 3.55. This indicated that the Mobile-based application developed was feasible and could be used in mechatronic engineering vocational learning. Formative evaluation result showed in Table 3.

**Tabel 3.** Formative Evaluation Result

| No | Respondent | Average score | Category |
|---|---|---|---|
| 1 | Material expert | 3.80 | Very feasible |
| 2 | Media expert | 3.62 | Very feasible |
| 3 | Students | 3.22 | Feasible |
| 4 | Teachers | 3.58 | Very feasible |
| | **Average** | **3.55** | **Very feasible** |

**Discussion**

The mobile-based application supports online counseling services needed to identify students' learning potentials and problems (Fahyuni et al., 2021; Y. Liu et al., 2021; Moffitt-Carney & Duncan, 2021; Sadiq et al., 2021) and supports improving learning outcomes through the use of mobile-based e-learning (Mariono et al., 2021; Prasetyo & Nurhidayah, 2021). Products in the form of mobile applications were learning media for students, while applications for teachers were made web-based to facilitate use in learning. The mobile-based application developed consists of five main features, namely subjects (covering learning planning, learning activities, and learning assessments), career information, career assessments, mechatronics learning forums, and career guidance services. These features include the principles of learning content for career development which consist of self-learning, diversity, social justice, counseling theory and practice, use of technology, career assessment, labor market information, social and economic trends, and assessment. The use of attractive features made career guidance and career information services more enjoyable and increased the motivation of students to seek career information according to their interests and talents (Draaisma et al., 2018; Kettunen et al., 2020; Okolie et al., 2020; Veronica et al., 2020).

The subject features include learning information, choice of learning activity plans, choice of learning assessment plans, learning materials, career information related to learning materials, and assessments accompanied by feedback to reflect on learning outcomes. These features lead to a constructivist view with a more student-centered learning approach where students actively participate in directing their learning (Sudira, 2017; Williams, 2017). Through career information and career assessment features, learning was directed to help students have the ability to plan and prepare a career, responsibility, and self-assertion about the future, interest in exploring future possibilities and environments, and confidence in the ability to solve real career problems. Career information features that integrated with the subject feature, helped students learn about themselves, the things they prioritize, and about the development of the world of work, resulting in an increase in self-awareness of students' learning to actively follow vocational learning that is useful for their career development.

The learning forum feature realizes learning that focuses on collaborative learning/ peer learning. Students interact with other students through the formation of learning networks to achieve learning objectives. Each student can be a resource in a peer-to-peer connected study group. Students can share learning resources such as information and data and empower themselves to actively and proactively seek to learn to solve complex problems. Online collaborative learning encourages students to learn to solve problems and build new knowledge that can be distributed quickly (Chiang & Lee, 2016; Sudira, 2020). The application of collaborative learning in vocational learning was effective in increasing students' understanding if the learning process was properly monitored and facilitated (Liu et al., 2021; Polkowski et al., 2020).

Career guidance services play an important role in empowering students to take a more active role in the career decision-making process and to engage in activities that can enhance their employability. This statement agrees linearly with the results of research, regarding career guidance services in taking a more active role in the learning process so as to improve students' employability (Draaisma et al., 2018; Keshf & Khanum, 2021; Okolie et al., 2020). This is also in line with the results of research, on how the function of guidance services in improving the career guidance process (Kettunen et al., 2020; Okolie et al., 2020; Valverde et al., 2020). In this study, it is explained that the career guidance service feature serves to realize a career guidance process that involves dialogue between counselors and students. Career guidance that involves dialogue about real experiences and focuses on the future makes a major contribution to the development of students' career competencies. Without this dialogue, career guidance methods and instruments hardly contribute to the acquisition of students' career competencies.

The use of mobile-based applications developed in learning has the potential to facilitate the career choice intervention process, especially in job exploration and matching self-information with work (Lent, 2018; Lent & Brown, 2020). However, finding sources and obtaining data are key elements of a career information system. Therefore, vocational schools have an ethical responsibility for the continuous storage and updating of this information so that the integration of vocational learning and career learning in mechatronic engineering vocational competencies is accompanied by the availability of accurate and easy-to-understand career information. Dissemination of the mobile-based applications developed was included in the deploy stage which was the output part of the Holistic 4D model development stage. Product dissemination could be done by implementing the product for full-scale and regular use in schools. Through the full implementation of the product, the idea of a mobile career learning model using mobile-based application developed could be disseminated to all stakeholders, especially school management, teachers, and students. Learners of mechatronics engineering vocational high school should actively utilize the facilities provided in the application, increase self-awareness of learning and develop careers independently outside of learning, as well as provide feedback on the implementation of the mobile-based application developed as an evaluation material for the application of the mobile-based application in support the integration of vocational learning and career learning activities.

Teachers need to provide ongoing support to students in their career development process. Teachers should expand their knowledge and skills in innovating mobile career learning models using mobile-based application developed with other learning models (eg project-based learning). So that more effective vocational learning can be realized to improve the vocational competence and career development of students. Schools need to focus on building systems and relationships between stakeholders to ensure the achievement of the goals of implementing the mobile-based application to support the integration of vocational learning and career learning activities. Schools also need to actively support the application of mobile-based applications to integrate vocational learning and career learning, including by providing technical support (including in the form of facilities and/or funding), enforcing regulations related to use, encouraging the standardization of application in each class and providing technical training for users if required

## 4. CONCLUSION

In the application of mobile-based applications to integrate career learning, schools need to focus on building systems and actively provide implementation support, to ensure the realization of learning that is more effective-efficient, integrated, and can improve the career development of mechatronic engineering students. Through the full implementation of the product, the idea of a mobile career learning model using mobile-based application developed can be disseminated to all stakeholders, especially school management, teachers, and students. So that further product development can be adapted to situations, conditions, and specific learning needs. The mobile-based application developed becomes a learning media for teachers that can be improved by adding guidelines to facilitate student-centered projects or activities, such as self-directed learning, collaborative learning, and project management.

## 5. REFERENCES


Ainslie, P. J., & Huffman, S. L. (2019). Human resource development and expanding stem career learning opportunities: exploration, internships, and externships. *Advances in Developing Human Resources*, *21*(1), 35–48. https://doi.org/10.1177/1523422318814487.

Algomaiah, M., & Li, Z. (2021). Exploring work zone late merge strategies with and without enabling connected vehicles technologies. *Transportation Research Interdisciplinary Perspectives*, *9*, 1–17. https://doi.org/10.1016/j.trip.2021.100316.

Alkhudary, R., & Gardiner, P. (2021). Stages in project managers' careers: Learning and growth opportunities. *International Journal of Project Management*, *39*(5), 536–545. https://doi.org/10.1016/j.ijproman.2021.03.006.

Baber, H. (2021). Modelling the acceptance of e-learning during the pandemic of COVID-19-A study of South Korea. *The International Journal of Management Education*, *19*(2), 1–15. https://doi.org/10.1016/j.ijme.2021.100503.

Bakke, I. B. (2021). Career and cultural context: Collective individualism, egalitarianism and work-centrality in the career thinking of Norwegian teenagers. *British Journal of Guidance & Counselling*, *21*(1), 1–16. https://doi.org/10.1080/03069885.2021.1872767.

Bassot, B. (2019). Action without action planning: The potential of the Career Thinking Session in enabling transformational career learning and development. *British Journal of Guidance & Counselling*, *47*(5), 545–555. https://doi.org/10.1080/03069885.2017.1293937.

Beicht, U., & Walden, G. (2019). Transition to company-based vocational training in Germany by young people from a migrant background – the influence of region of origin and generation status. *International*

*Journal for Research in Vocational Education and Training*, *6*(1), 20–45. https://doi.org/10.13152/IJRVET.6.1.2.
Bughin, J., Manyika, J., & Woetzel, J. (2017). Jobs lost, jobs gained: Workforce transitions in a time of automation. *McKinsey Global Institute*, *December*, 1–160. https://doi.org/10.1002/lary.20616.
Cetrulo, A., & Nuvolari, A. (2019). Industry 4.0: Revolution or hype? Reassessing recent technological trends and their impact on labour. *Journal of Industrial and Business Economics*, *46*(3), 391–402. https://doi.org/10.1007/s40812-019-00132-y.
Chen, D., Srivastava, A., & Ahn, S. (2021). Harnessing connected and automated vehicle technologies to control lane changes at freeway merge bottlenecks in mixed traffic. *Transportation Research Part C: Emerging Technologies*, *123*, 1–25. https://doi.org/10.1016/j.trc.2020.102950.
Chiang, C. L., & Lee, H. (2016). The Effect of project-based learning on learning motivation and problem-solving ability of vocational high school students. *International Journal of Information and Education Technology*, *6*(9), 709–712. https://doi.org/10.7763/IJIET.2016.V6.779.
Coetzer, A., Susomrith, P., & Ampofo, E. T. (2020). Opportunities to participate in formal and informal vocational learning activities and work-related outcomes in small professional services businesses. *Journal of Vocational Education & Training*, *72*(1), 88–114. https://doi.org/10.1080/13636820.2019.1584637.
Daryono, R. W., Rochmadi, S., & Hidayat, N. (2021). Development and validation of video-based learning media to increase competency achievement in civil engineering education. *Journal of Physics: Conference Series*, *1833*(1–10), 012022. https://doi.org/10.1088/1742-6596/1833/1/012022.
Daryono, R. W., Yolando, A. P., Jaedun, A., & Hidayat, N. (2020). Competency of vocational schools required by construction industry in consultants' supervisor. *Journal of Physics: Conference Series*, *1456*, 012057. https://doi.org/10.1088/1742-6596/1456/1/012057.
Das, K., Wibowo, P., Chui, M., Agarwal, V., & Lath, V. (2019). Automation and the future of work in Indonesia. *McKinsey & Company*, *September*, 21–28. https://www.mckinsey.com/featured-insights/asia-pacific/automation-and-the-future-of-work-in-indonesia.
Dodd, V., & Hooley, T. (2018). The development of the Teachers' Attitudes toward Career Learning Index (TACLI). *Teacher Development*, *22*(1), 139–150. https://doi.org/10.1080/13664530.2017.1385518.
Draaisma, A., Meijers, F., & Kuijpers, M. (2018). The development of strong career learning environments: The project 'Career Orientation and Guidance' in Dutch vocational education. *Journal of Vocational Education & Training*, *70*(1), 27–46. https://doi.org/10.1080/13636820.2017.1392995.
Elyakim, N., Reychav, I., Offir, B., & McHaney, R. (2019). Perceptions of transactional distance in blended learning using location-based mobile devices. *Journal of Educational Computing Research*, *57*(1), 131–169. https://doi.org/10.1177/0735633117746169.
Fahyuni, E. F., Taurusta, C., Hariastuti, R. T., Bandono, A., & Muhid, A. (2021). Mobile counselling online an alternative counselling guidance system for millennial era student. *Journal of Education Technology*, *5*(3), 425–433. https://doi.org/10.23887/jet.v5i3.36191.
Hadam, S., Rahayu, N., & Ariyadi, A. N. (2017). *Strategi Implementasi Revitalisai SMK*. Kemendikbud.
Healy, M., Hammer, S., & McIlveen, P. (2020). Mapping graduate employability and career development in higher education research: A citation network analysis. *Studies in Higher Education*, *20*(1), 1–13. https://doi.org/10.1080/03075079.2020.1804851.
Ho, H. H., Mohd Rasdi, R., Ibrahim, R., & Md Khambari, M. N. (2020). Developing and evaluating the effectiveness of mobile phone-based career intervention for career competencies of Malaysian public managers: Protocol for a mixed method study. *Internet Interventions*, *22*(September), 100349. https://doi.org/10.1016/j.invent.2020.100349.
Hummel, H. G. K., Boyle, E. A., Einarsdóttir, S., Pétursdóttir, A., & Graur, A. (2018). Game-based career learning support for youth: Effects of playing the Youth@Work game on career adaptability. *Interactive Learning Environments*, *26*(6), 745–759. https://doi.org/10.1080/10494820.2017.1402062.
Husain, M., & Kolesar, S. (2018). Can technology change the existing culture? Case study on Bangladesh's public sector. *Development in Practice*, *28*(1), 152–164. https://doi.org/10.1080/09614524.2018.1404555.
Kesai, P., Soegiarso, R., Hardjomuljadi, S., Setiawan, M. I., Abdullah, D., & Napitupulu, D. (2018). Indonesia position in the globalization of construction industry. *Journal of Physics: Conference Series*, *1114*, 012133. https://doi.org/10.1088/1742-6596/1114/1/012133.
Keshf, Z., & Khanum, S. (2021). Career Guidance and counseling needs in a developing country's context: a qualitative study. *SAGE Open*, *11*(3), 215824402110401. https://doi.org/10.1177/21582440211040119.
Kettunen, J., Lee, J., & Vuorinen, R. (2020). Exploring finnish guidance counselors' conceptions of career management skills. *SAGE Open*, *10*(4), 215824402096877. https://doi.org/10.1177/2158244020968778.

Kusuma, W. M., Sudira, P., Hasibuan, M. A., & Daryono, R. W. (2021). The Perceptions of vocational school students of video animation-based learning media to operate lathes in distance learning. *Journal of Education Technology*, *5*(2), 200. https://doi.org/10.23887/jet.v5i2.33139.

Lent, R. W. (2018). Future of work in the digital world: preparing for instability and opportunity. *Career Development Quarterly*, *66*(3), 205–219. https://doi.org/10.1002/cdq.12143.

Lent, R. W., & Brown, S. D. (2020). Career decision making, fast and slow: Toward an integrative model of intervention for sustainable career choice. *Journal of Vocational Behavior*, *120*(December 2019), 103448. https://doi.org/10.1016/j.jvb.2020.103448.

Li, C., Yin, Y., Wu, P., & Wu, W. (2021). An area merging method in map generalization considering typical characteristics of structured geographic objects. *Cartography and Geographic Information Science*, *48*(3), 210–224. https://doi.org/10.1080/15230406.2020.1863862.

Lin, Y.-N., Hsia, L.-H., & Hwang, G.-J. (2021). Promoting pre-class guidance and in-class reflection: A SQIRC-based mobile flipped learning approach to promoting students' billiards skills, strategies, motivation and self-efficacy. *Computers & Education*, *160*, 104035. https://doi.org/10.1016/j.compedu.2020.104035.

Liu, X., Chen, Y., Yang, Y., Liu, B., Ma, C., Craig, G. R., & Gao, F. (2020). Understanding vocational accounting students' attitudes towards sustainable development. *Journal of Vocational Education & Training*, 1–21. https://doi.org/10.1080/13636820.2020.1760333.

Liu, Y., Sun, J. C.-Y., & Chen, S.-K. (2021). Comparing technology acceptance of AR-based and 3D map-based mobile library applications: A multigroup SEM analysis. *Interactive Learning Environments*, *21*, 1–15. https://doi.org/10.1080/10494820.2021.1955271.

Lundahl, L., & Ydhag, C. C. (2020). Transitions and career learning: Youth and governance perspectives. *Education Inquiry*, *11*(4), 297–301. https://doi.org/10.1080/20004508.2020.1840491.

Luthfi, M. B., Rochmadi, S., Daryono, R. W., & Saputra, R. P. S. (2021). The development of interactive media based on video animation in the use of a total station for measurement stake out the building. *Budapest International Research and Critics in Linguistics and Education (BirLE) Journal*, *4*(1), 597–605. https://doi.org/10.33258/birle.v4i1.1767.

Majumdar, S. K., Moussawi, R., & Yaylacicegi, U. (2020). Merger motives and technology deployment: a retrospective evaluation. *The Antitrust Bulletin*, *65*(1), 120–147. https://doi.org/10.1177/0003603X19898903.

Mariono, A., Bachri, B. S., Kristanto, A., Dewi, U., Sumarno, A., Kholidya, C. F., & Pradana, H. D. (2021). Online learning in digital innovations. *Journal of Education Technology*, *5*(4), 547. https://doi.org/10.23887/jet.v5i4.40115.

Moffitt-Carney, K. M., & Duncan, A. B. (2021). Evaluation of a mindfulness-based mobile application with college students: A pilot study. *Journal of American College Health*, *69*(2), 208–214. https://doi.org/10.1080/07448481.2019.1661420.

Obeng, A. Y., & Coleman, A. (2020). Evaluating the effects and outcome of technological innovation on a web-based e-learning system. *Cogent Education*, *7*(1), 1–21. https://doi.org/10.1080/2331186X.2020.1836729.

Okolie, U. C., Nwajiuba, C. A., Binuomote, M. O., Osuji, C. U., Onajite, G. O., & Igwe, P. A. (2020). How careers advice and guidance can facilitate career development in technical, vocational education, and training graduates: The case in Nigeria. *Australian Journal of Career Development*, *29*(2), 97–106. https://doi.org/10.1177/1038416220916814.

Olazaran, M., Albizu, E., Otero, B., & Lavía, C. (2019). Vocational education–industry linkages: Intensity of relationships and firms' assessment. *Studies in Higher Education*, *44*(12), 2333–2345. https://doi.org/10.1080/03075079.2018.1496411.

Oliveira, Í. M., & Araújo, A. M. (2021). Career exploration as a foundation for career developmental learning and academic success in childhood. *British Journal of Guidance & Counselling*, *21*(1), 1–20. https://doi.org/10.1080/03069885.2021.1887814.

Polkowski, Z., Jadeja, R., & Dutta, N. (2020). Peer learning in technical education and it?s worthiness: Some facts based on implementation. *Procedia Computer Science*, *172*(2019), 247–252. https://doi.org/10.1016/j.procs.2020.05.039.

Popkova, E. G., Ragulina, Y. V., & Bogoviz, A. V. (Eds.). (2019). *Industry 4.0: Industrial Revolution of the 21st Century* (Vol. 169). Springer International Publishing. https://doi.org/10.1007/978-3-319-94310-7.

Poulsen, B. K. (2020). Insights and outlooks: Career learning in the final years of compulsory school. *Education Inquiry*, *11*(4), 316–330. https://doi.org/10.1080/20004508.2020.1713691.

Prabakaran, P., Rao, S. P., & Wendt, M. (2021). Animal immunization merges with innovative technologies: A new paradigm shift in antibody discovery. *MAbs*, *13*(1), 1–4. https://doi.org/10.1080/19420862.2021.1924347.

Prasetyo, M. M., & Nurhidayah, N. (2021). The effect of internet use on improving student learning outcomes. *Journal of Education Technology*, *5*(4), 511. https://doi.org/10.23887/jet.v5i4.40748.

Reigeluth, C. M., & An, Y. (2021). *Merging The Instructional Design Process With Learner-Centered Theory: The Holistic 4D Model*. Routledge. https://doi.org/10.4324/9781351117548.

Sadiq, R. B., Cavus, N., & Ibrahim, D. (2021). Mobile application based on CCI standards to help children learn English as a foreign language. *Interactive Learning Environments*, *29*(3), 442–457. https://doi.org/10.1080/10494820.2019.1579239.

Schwab, K. (2016). *The Fourth Industrial Revolution*. World Economic Forum.

Steeb, D. R., Zeeman, J. M., Bush, A. A., Dascanio, S. A., & Persky, A. M. (2021). Exploring career development through a student-directed practicum to provide individualized learning experiences. *Currents in Pharmacy Teaching and Learning*, *13*(5), 500–505. https://doi.org/10.1016/j.cptl.2021.01.020.

Stillman, D., & Stillman, J. (2019). *Generasi Z: Memahami Karakter Generasi Baru yang Akan Mengubah Dunia Kerja*. Gramedia Pustaka Utama.

Sudira, P. (2017). *TVET Abad XXI: Filosofi, Teori, Konsep, dan Strategi Pembelajaran Vokasional*. UNY Press.

Sudira, P. (2020). *Paradigma Baru Pembelajaran Vokasional Era Revolusi Industri 4.0*. UNY Press.

Triyono, B. M., Mohib, N., Kassymova, G. K., Pratama, G. N. I. P., Adinda, D., & Arpentieva, M. R. (2020). The profile improvement of vocational school teachers' competencies. *Vysshee Obrazovanie v Rossii = Higher Education in Russia*, *29*(2), 151–158. https://doi.org/10.31992/0869-3617-2020-29-2-151-158.

Valverde, J. de, Thornhill-Miller, B., Patillon, T.-V., & Lubart, T. (2020). Creativity: A key concept in guidance and career counselling. *Journal of Adult and Continuing Education*, *26*(1), 61–72. https://doi.org/10.1177/1477971420903736.

Vermeulen, B., Kesselhut, J., Pyka, A., & Saviotti, P. P. (2018). The impact of automation on employment: Just the usual structural change? *Sustainability*, *10*(5), 1–27. https://doi.org/10.3390/su10051661.

Veronica, N., Purwanta, E., & Astuti, B. (2020). Design and development of a mobile learning for career planning in senior high school. *International Journal of Scientific and Technology Research*, *9*(1), 908–913. http://www.ijstr.org/final-print/jan2020/Design-And-Development-Of-A-Mobile-Learning-For-Career-Planning-In-Senior-High-School-.pdf.

Williams, M. K. (2017). John Dewey in the 21st Century. *Journal of Inquiry & Action in Education*, *9*(1).

Xu, L. D. (2020). Industry 4.0-Frontiers of fourth industrial revolution. *Systems Research and Behavioral Science*, *37*(4), 531–534. https://doi.org/10.1002/sres.2719.

Yoon, B., Park, I., Yun, D., & Park, G. (2019). Exploring promising vacant technology areas in a technology-oriented company based on bibliometric analysis and visualisation. *Technology Analysis & Strategic Management*, *31*(4), 388–405. https:/doi.org/10.1080/09537325.2018.1516864.