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Git and GitHub Application Training Program to Support Vocational High School Students in Collaborative Computer Programming Learning

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Abstract: The training program aims to improve students' ability to operate the Git/GitHub application in collaborative computer programming learning. The partners who are the subject of training activities are three Vocational High Schools of the Computer and Informatics Engineering Expertise Program (SMK TKI) in Malang City and Batu City, East Java Province, Indonesia. The training program was developed with the ASSURE model. The learning strategy used by the training team is peer-to-peer learning. Each vocational school determines 40 students as participants in the training program. Training activity success data were collected using knowledge tests, performance tests, self-evaluation sheets, and questionnaires. The analysis design uses One-Group Pretest-Posttest. The data were analyzed with the One Sample T-test technique. The Posttest value (M=74.88; SD=6.68) is higher than the pretest (M=46.62; SD=9.28). One Sample T-test analysis on the Pretest and Posttest scores yielded $t(119)=26.28$; $p < 0.01$; $d=3.50$. The Pretest score significantly differs from the Posttest score, where the effect size score is 3.50, and the p-value is smaller than 0.05 (α).

Keywords: training programs, Git, GitHub, ASSURE, computer programming, collaborative, vocational high school

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Introduction

The Society 5.0 era not only required people to prioritize intelligence in logical-analytical thinking (critical thinking) to solve problems but also required to have the ability to work together between individuals or between platforms to achieve a collaborative society through collaboration-based activities supported by information technology such as co-construction or co-learning (Deguchi et al., 2020); (Salgues, 2018); (Litman, 2012). The ability to collaborate has now become an international educational issue where UNESCO has determined collaboration competency to be one of the critical competencies to achieve the Sustainable Development Goals (SDGs) by 2030. The Government of the Republic of Indonesia has also directed that the facilities and infrastructure provided by educational institutions can support collaborative learning. That is, the ability to work together should be familiarized through an instructional system that teachers in the school system deliberately design collaborative learning (co-learning) (Peraturan Pemerintah Republik Indonesia Nomor 57 Tentang Standar Nasional Pendidikan. In Standar Nasional Pendidikan (Issue 102501). Kementerian Sekretariat Negara Republik Indonesia, 2021); (Rieckmann, 2017). Collaborative learning is an instructional method that conditions students to work together to explore a problem or create a project. The goal of collaborative learning is that students can find a more contextual and rich learning experience through many points of view during the process of integrating new information

with old information that has been stored in long-term memory rather than discovering individual learning experiences (Collins, 2011); (Fischer & Mandl, 2005); (Hämäläinen & Vähäsantanen, 2011); (Kaendler et al., 2015); (Kirschner et al., 2004); (Van Leeuwen & Janssen, 2019). This objective is a social learning theory postulate where the construction of cognition or acquisition of the content of knowledge by the individual needs to be supported by encouragement from within the individual to master the knowledge. The individual interacts with his environment to strengthen the contextualization of the knowledge gained in the community/society

Problems related to how to familiarize students to work on a system collaboratively are also experienced by cooperation partners from the Computer Science Faculty, Universitas Brawijaya (FILKOM UB). Three partners of the Vocational School (SMK) Computer Engineering and Informatics Expertise Program (TKI) from FILKOM UB have curricular problems with how to grow students' collaboration skills in computer programming subjects. Computer programming is a subject that must be taught in all Indonesian Informatics and Computer Engineering expertise programs. The curricular problem is that the content of competencies students must master in computer programming does not explicitly require students to collaborate in compiling application source code (source code). Instructional activities in computer programming subjects feel less concrete when they are translated into collaborative learning because the content of competencies must be mastered individually. An example of competence in computer programming subjects is creating a simple application based on a user interface. If a curriculum review is carried out, the competence is only enough to be taught for one semester if the teaching focuses on individual mastery. If the teaching process is added with a collaborative element, there needs to be additional competence and class hours to master different means in the form of platforms that can be used to build applications in groups. This has not been accommodated in the curriculum (Keputusan Direktur Jenderal Pendidikan Dasar Dan Menengah Nomor 330/D.D5/KEP/KR/2017 Tentang Kompetensi Inti Dan Kompetensi Dasar Mata Pelajaran Muatan Nasional (A), Muatan Kewilayahan (B), Dasar Bidang Keahlian (C1), Dasar Program Keahlian (C2), Dan Komp, 2017).

However, SMK TKI does not yet have the readiness of means to fuse collaborative platforms and content in curricular activities at this time. If there are partners who lack resources, then the partnerships that have been established between universities and partners can be utilized to solve these obstacles (Bhagwan, 2018); (Brewster et al., 2016); (Gruber et al., 2017); (Halász & Sin, 2022); (Sasson, 2019), (Strier & Shechter, 2016).). The partnership is an expression of a collaborative culture so that there is a symbiosis of mutualism between the two sides and continuously improving services to the broader community (Groulx et al., 2014); (Guillen & Zeichner, 2018). Thus, FILKOM UB helps design activities in the form of training programs so that there is knowledge transfer and technology transfer to SMK TKI partners. Tools that can be used to familiarize collaboration capabilities in computer programming subjects are Git and Github (Git/GitHub). Several studies have proven that Git/GitHub can be a means of collaborative activities, although case studies in these studies are not directly in the case of computer programming subjects (Beckman et al., 2021); (Choi et al., 2022); (Ekuban et al., 2021); (Fiksel et al., 2019); (Glazunova et al., 2021); (Hsing & Gennarelli, 2019); (Tiwari et al., 2022); (Tushev et al., 2020); Students at partner vocational schools need to be introduced to Git and GitHub applications through the training program to have the experience that writing source code can be done collaboratively in a team.

A training program is a form of non-formal education (Simac et al., 2021). Non-formal education cannot only be applied in industry, society, or ecosystems outside the school system (González & Bonal, 2021); (Lanzi et al., 2019); (Osafo & Yawson, 2019). Knowledge and skills that the school curriculum cannot accommodate can be programmed as training (González & Bonal, 2021). The training program can be co-curricular or extra-curricular to assist students in acquiring additional skills or knowledge. Non-formal education in schools refers to learning

activities outside the formal classroom setting but within the school environment (Debarliev et al., 2022). These activities are designed to complement and enhance formal education by providing students with practical skills, knowledge, and experiences that are not typically covered in the standard curriculum (Roosmaa et al., 2019).

Method

The training program was developed based on the ASSURE model. The ASSURE model is an instructional design model that instructional designers use to develop training programs that better use technology integration. The ASSURE model is generally considered a model geared toward learners through the utilization of technology and media (Adedapo & Oppola, 2021); (Kim & Downey, 2016); (Olayinka et al., 2018).The ASSURE process is divided into six stages, each with its characteristics and goals. The six stages are (1) analyze learners, (2) state standards and objectives, (3) select methods and media, (4) utilize media and technology, (5) require learner participation, and (6) evaluate and revise (Choi et al., 2022); (A. et al., 2021). Figure 1 shows that the stages in the ASSURE model have iterative characteristics and are not predictive

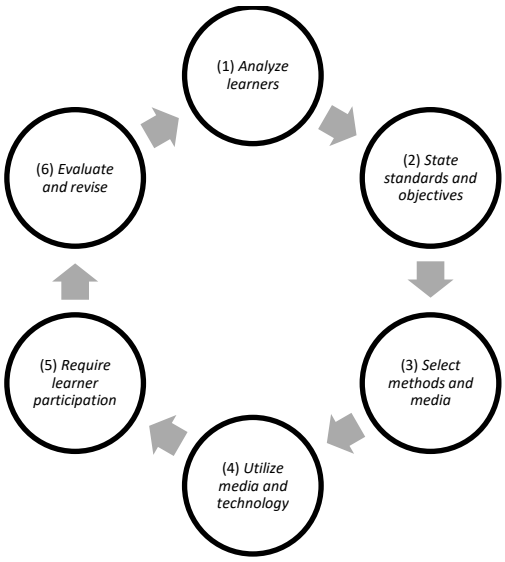

Figure 1. The ASSURE Model Stages

At the analyze learner stage, the training team is tasked with conducting a needs analysis related to the target of the training program. The training team visited three partners of SMK TKI directly and held discussions with relevant stakeholders. Two partners of SMK TKI are located in Malang City, while one partner is located in Batu City, East Java Province, Indonesia. At that stage, the training team also studied concepts related to Git/Github and peer-to-peer learning, which will later be used in the training process. Examples of references include the book Version Control with Git and GitHub from Magana & Muli (Magana & Muli, 2018).

At the state standards and objectives stage, the training team formulates what competencies will be the objects to be trained. In addition, the training team also compiled a mapping of learning objectives, a training syllabus framework, and materials relevant to the learning objectives. The training team cuts to complex competencies to get simpler ones. If a need is felt to have emerged at this stage, the training team also updates what has been produced at the analyze learner stage.

At the select method and media stage, the training team began compiling teaching and learning resources that would later be used in the training process. Products made at this stage are still based on the criteria produced at the state standards and objective stage. The team will

revise the resulting criteria to state standards and objectives if any requirements are deemed deficient or excessive. Each product produced at this stage will be consulted with the partner, and the partner can provide feedback on any parts that need to be updated.

At the stage of utilizing media and technology and requiring learner participation in principle is the inability to implement or implement direct learning. The implementation of in-person learning is divided into ten (10) meetings and one meeting for final evaluation. The learning strategy used is peer-to-peer learning because the process is scientifically proven to foster collaborative work skills in students. The learning syntax is the same as using a syntax similar to direct instruction, where there is a demonstration from the trainer or training instructor that the trainee must imitate. However, in peer-to-peer learning, students are conditioned to learn in pairs/teams where each team contains two students. The activities allow for a division of roles between training participants. At the initial training meeting, trainees were given a pretest by the training team as a benchmark for the training program's success later.

In the evaluation and review stage, the training team collects data related to trainees' abilities and training participant feedback on the quality of the training program. Data on the ability of trainees is obtained through tests, performance tests, and self-assessment. Data related to feedback on the quality of the training program was obtained by filling out a questionnaire. Pretest, posttest, performance test, and self-assessment data take the form of quantitative data. Questionnaire data is in the form of quantitative and qualitative data. The resulting quantitative data were analyzed with descriptive statistics and the One Sample T-test. The data obtained from the questionnaire was analyzed by how the training team conducted joint discussions internally.

Table 1 shows what stages need to be passed to develop a training program based on the ASSURE model. Table 1 also shows the output targets for each step of the ASSURE model in the context of this article's training program. If the duration is added up as a whole, then this training program will take ten months. The resource planning process is carried out in the first month to the third month. The method of core training activities is carried out from the fourth month to the tenth month. In the ninth and tenth months, mentoring/follow-up activities are performed after completing knowledge transfer and training activities. The training program was developed and implemented at SMK TKI based on the ASSURE model from March to December 2022.

Table 1. Stages, Activities, and Output Targets Based on the ASSURE Model

No.	Phase	Activities	Output Targets	Duration
1	Analyze learner	Survey three partner vocational schools; calculate the required budget; establish the place and time of training;	Partner needs specification document	One month
2	State standards and objectives	Formulate competency targets to be trained; formulate learning objectives and the content of the training syllabus; develop a framework of material relevant to the targeted competencies.	Lesson map; plan training scenario; training administration documents (attendance list for participants and training team, as well as the design of training certificates)	One month
3	Select methods and media	Prepare learning objectives and training syllabus content, teaching materials and handouts; set up the	Training module documents; evaluation sheets;	One month

No.	Phase	Activities	Output Targets	Duration
		Git/Github platform; prepare support libraries, study aids, and other supporting resources, such as computers and the Internet; choose the method of training to be used; select training evaluation techniques; appoint training instructors; and draw up a training schedule.	and presentation slides.	
4	Utilize media and technology	Instructors train trainees with peer-to-peer learning strategies through the Git/GitHub platform.	Pretest and posttest assessment result documents.	Six months
5	Require learner participation			
6	Evaluation	Measure the achievement of training objectives.	Plan of action evaluation documents; self-evaluation; evaluation of the performance of the instructor; evaluation of training programs; and post-training evaluation.	One month
		Intensive Assistance: Measure the achievement of training objectives after the training activity is completed	Evaluate online when using the Git/ GitHub platform.	
		Total		Ten months

Result

Table 2 shows three main types of outputs in the training program based on the initial analysis stage: the implementation of training programs, training modules, and increasing student competencies. The training program is intended to train ten (10) types of competencies. Each competency is carried out in one training meeting, where each training meeting has a duration of approximately 2 to 4 hours. The training modules produced in the training program are ten (10) modules/handbooks, each representing each competency to be trained. Handbooks are still designed to be a self-study resource after the training meeting. The training modules contain materials and are equipped with self-assessment sheets, exercises, and questions tailored to the competencies of each module.

Table 2. Training Program Outputs Types and Indicators

No.	Output Type	Indicators
1.	Training programs	Train 10 specific competencies, namely: a. Installing Git; b. Check status and commit; c. Manage staging environment; d. Deleting files; e. Manage logs; f. Manage branches; g. Analyze the project structure with GitHub;

No.	Output Type	Indicators
		h. Jumping the GitHub repository; i. Jumping branches; and j. Use the GitHub branch as a template.
2.	Training modules/ handbooks	Train 10 handbooks, namely: a. Git mounting module; b. Status and commit checking modules; c. Environment staging management module; d. File deletion module; e. Log management module; f. Branch management module; g. Project structure analysis module with GitHub; h. GitHub repository blocking module; i. Branch jumping module; and j. The module uses the GitHub branch as a template.
3	Improved student competence in using Git and GitHub applications for Collaborative Source Code Version Management	a. There is an increase in mastery of competencies after completing the training program (analyzed by the mean formula). b. There are differences in the mastery of competencies before and after attending the training program (passed by the One Group Post Test-Pre Test method and tested with the One Sample T-test Method technique)

The Mean score in Table 3 indicates that the posttest score (M=74.88; SD=6.68; N=120) is greater than the pretest score (M=46.62; SD=9.28; N=120). It means that the trainee's ability has increased when compared between before attending and after attending the training. Elementary school scores also indicate that post-training scores are more homogeneous than pre-training scores. The results of the One Sample T-test Method review of the Pretest and Posttest scores in Table 4 show scores $t(119)=26.28$, $p < 0.01$, and $d=3.50$. It means a significant difference exists between the scores before and after training. The analysis shows that the training program has significantly improved trainees' abilities with an effect size of 3.50.

Table 3. Pretest and Posttest Descriptive Statistical Analysis Results

Calculation	Pretest	Posttest
Mean	46.62	74.88
Standard Error	0.85	0.61
Median	46.22	74.73
Mode	45.11	79.19
Standard Deviation	9.28	6.68
Sample Variance	86.20	44.62
Kurtosis	-1.12	-1.02
Skewness	0.15	0.11
Range	31.47	24.57
Minimum	31.37	63.01
Maximum	62.84	87.58
Sum	5594.87	8985.66
Count	120	120
Confidence Level (95.00%)	1.68	1.21

Table 4. One Sample T-Test Results on Pretest and Posttest Scores

Calculation	Pretest	Posttest
Mean	46.62	74.88
Variance	86.20	44.62
Observations	120	120
Pearson Correlation	-0.06	
Hypothesized Mean Difference	0.00	
Df	119	
|t Stat|	26.28	
P(T<=t) one-tail	0.00	
t Critical one-tail	1.66	
P(T<=t) two-tail	0.00	
t Critical two-tail	1.98	
Cohen's d	4.35	

Table 5. The Analysis Results of the Training Program Evaluation Questionnaire

Calculation	Score
Mean	91.22
Standard Error	0.51
Median	92.83
Mode	97.74
Standard Deviation	5.63
Sample Variance	31.71
Kurtosis	-1.12
Skewness	-0.30
Range	19.34
Minimum	80.65
Maximum	99.99
Sum	10946.89
Count	120
Confidence Level (95.00%)	1.02

Table 5 shows that trainee feedback on the quality of implementation of training programs running for approximately seven months is high based on a score range of 0.00 to 100.00 (N=120, M=91.22, SD=5.63). As viewed from the ASSURE model, the 7-month activity utilizes media and technology, requiring learner participation and evaluation. Qualitative data from the evaluation questionnaire shows that Most trainees want advanced activities related to Git/GitHub training. The main reason for this desire arises because training materials about Git/ GitHub are new to students and can provide insight into how to learn computer management in pairs/groups.

Discussion

The partnership between the university and the community aims to utilize the knowledge generated by the university to develop and empower the community. The community in the context of this partnership can be in the form of community groups, educational institutions, or industry. (Kindred & Petrescu, 2015) Partnerships between universities and industry can encourage student readiness for competition in the job market, integrating university curricula with industry, university internationalization, and research collaboration (Nguyen, 2022). . As a party from the university, the training team establishes a

partnership with SMK TKI so that there is a collaboration that provides mutual benefits related to using products or knowledge for partners.

Limited access from SMK TKI so that they can use the Git / GitHub platform as a learning strategy is one opportunity for the training team to assist them. The training program is designed to follow ASSURE's scientific principles so that SMK TKI can follow transparency and procedures in the context of other fields of study or needs. Another benefit of the partnership between the university and society is transmitting scientific values (Collier et al., 2016); (Medved & Ursic, 2021). . The ASSURE model that is used as a guideline for the development of training programs in this article has been scientifically proven to be used to produce technology-based learning programs that are effective or have a tangible impact (Choi et al., 2022); (Karakis et al., 2016); (Kim & Downey, 2016); (Zubaedi & Hakim, 2020). This evidence is further corroborated by analyzing the pretest and posttest scores of the Git/GitHub training program in this article. This analysis's results can improve students' competence in utilizing the Git / GitHub platform. The training program also has implications for students' habits in using the Git/GitHub platform to learn computer programming collaboratively. The training program products produced by the training team at the select methods and media stage can be used by SMK TKI partners to disseminate knowledge to other students or teachers who are not trainees.

Learning computer programming in pairs has become a trend that is still valid today. Many studies have proven that learning computer programming in teams can accelerate students' mastery of computer programming knowledge and skills (Chung et al., 2021); (Lu et al., 2017); (Stephany et al., 2021). This advantage is the main reason the training team used a peer-to-peer learning strategy in the training process and combined it with the Git/GitHub platform. However, collaborative learning in computer programming must be balanced with advanced knowledge management and innovative learning strategies and supported by adequate means to create student flexibility. Flexibility is the learning process between students without being limited by physical space (Bravo et al., 2013); (Briggs & Ammigan, 2017); Extensive knowledge management, innovative learning strategies, and adequate tools can be the object of the partnership between universities and schools to develop these three things collaboratively.

Special needs from partners related to additional learning outside the regular curriculum (intra-curricular) can be classified into non-formal learning mechanisms (González & Bonal, 2021). In the case of this research, the partners (SMK TKI) asked for help to create a training program related to the use of the Git/GitHub application. The hope is that students can use the application to learn computer programming collaboratively. Additional learning related to the Git/GitHub application cannot be carried out in the regular school schedule because it will disrupt intra-curricular activities. The conceptual solution to this case can only be explained from the point of view of non-formal education.

Non-formal education refers to learning outside traditional formal education settings, such as schools or universities (Fordham et al., 2020); (Acero Pereira et al., 2018). It is an intentional and structured form of learning that is often designed to meet the specific needs of a particular group or community (Márquez-García et al., 2021). Non-formal education programs can take many forms, including workshops, training sessions, and community-based programs (Kerdnoonwong, 2016). One of the primary benefits of non-formal education is its ability to reach individuals who may not have access to traditional formal education (Simac et al., 2021). Non-formal education programs are often designed to be flexible and accessible, allowing people to learn at their own pace and on their schedule (Catini, 2021). It can be precious for individuals with work or family responsibilities, making attending traditional classes difficult (Romi & Schmida, 2009). Non-formal education can also provide valuable skills and knowledge not typically covered in formal education programs (Guilherme & Morgan, 2009); (Morton & Montgomery, 2012). For example, a community-based program might offer training in practical skills like cooking, gardening, or woodworking or provide opportunities to

learn about local history and culture. Finally, non-formal education can be important for promoting social inclusion and empowerment (Morton & Montgomery, 2012). By providing individuals with the skills and knowledge they need to participate fully in their communities, non-formal education programs can help to break down barriers and promote greater understanding and cooperation (Márquez-García et al., 2021). Many studies have proven that non-formal education can help acquire new skills or knowledge that cannot be obtained through intra-curricular activities (Armoni, 2017); (Debarliev et al., 2022); (Denkowska et al., 2020); (Morton & Montgomery, 2012); (Roosmaa et al., 2019); (Simac et al., 2021). An example is research that utilizes additional training activities to foster entrepreneurial will (Suryanto et al., 2020).. The reason for conducting this research is that the regular curriculum does not explicitly accommodate how to promote or trigger students' entrepreneurial intentions.

Conclusion

The competence of trainees increases after following the training based on the pretest and posttest scores analysis results. Students utilize the competencies trained to support their productivity in school, such as using Git/Github for source code version management and using Git/Github to practice collaborative skills. It proves that the training programs carried out have positive implications for partners. This training activity is only limited to delivering material totaling ten training handbooks, so the training program needs to be continued to train more complex modules and transfer the knowledge to the teacher. The results of the training program implementation can also be used as a basis for further research on measuring the collaboration skills of SMK TKI students. It needs to be done as an effort to integrate the results of training programs with scientific research activities, and the results of scientific research will later be used for the development or empowerment of communities or partners.

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