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Collaboration Skills in Vocational Schools in The Information and Communication Technology (ICT) Sector

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Abstract: In 2018, the technology, business and ICT (information and communication technology) sectors were the sectors that received the newest students at the vocational school level. Jobs in the ICT sector are one of the sectors that are really needed in Indonesia. There are more job vacancies in the ICT sector for vocational schools than for high schools. However, in the 2015-2019 period, the number of ICT sector workers with high school graduates was higher than vocational school graduates. The soft skill that is most needed in ICT sector jobs is collaboration. The main objective of this literacy study is to describe learning methods to improve collaboration skills in vocational high school students in the ICT field. Systematic literacy study using the PICOC framework is the method used. The results of this literacy study are in the form of descriptions related to: 1. The concept of collaboration; 2. Challenges and obstacles; 3. Learning activities to improve collaboration skills. It was found that problem-based learning (PBL) can improve collaboration abilities. To be suited to the world of work, it is necessary to integrate the Scrum model to develop vocational school students' collaboration skills in the field of ICT.

Kata Kunci:
Collaboration; ICT; Learning Method; PICOC; Vocational School

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Abstrak: *Pada tahun 2018, sektor teknologi, bisnis dan ICT (teknologi informasi dan komunikasi) menjadi sektor yang menerima peserta didik terbaru pada tingkat sekolah vokasi. Pekerjaan di bidang ICT merupakan salah satu sektor yang sangat dibutuhkan di Indonesia. Lowongan kerja sektor TIK untuk SMK lebih banyak dibandingkan SMA. Namun pada periode 2015-2019, jumlah pekerja sektor TIK yang berpendidikan tamatan SMA lebih banyak dibandingkan lulusan SMK. Soft skill yang paling dibutuhkan dalam pekerjaan di sektor ICT adalah kolaborasi. Tujuan utama dari kajian literasi ini adalah untuk mendeskripsikan metode pembelajaran untuk meningkatkan keterampilan kolaborasi pada siswa SMK bidang ICT. Kajian literasi sistematis dengan kerangka PICOC adalah metode yang digunakan. Hasil kajian literasi ini berupa uraian terkait dengan: 1. Konsep kolaborasi; 2. Tantangan dan hambatan; 3. Kegiatan pembelajaran untuk meningkatkan keterampilan kerjasama. Ditemukan bahwa pembelajaran berbasis masalah (PBL) dapat meningkatkan kemampuan kolaborasi. Agar sesuai dengan dunia kerja, maka perlu dilakukan integrasi model Scrum untuk mengembangkan kemampuan kolaborasi siswa SMK di bidang ICT.*

INTRODUCTION

TVET (Technical and Vocational Education and Training) is lifelong learning at secondary, post-secondary and tertiary levels, which includes work-based learning, professional

development and continuing education (M. Yusop et al., 2023). In TVET, presentations and assessments are focused on obtaining and applying applied skills in real or simulated work environments (Bunning et al., 2022). Governments and policy makers in the world have agreed that skills development in TVET aims to obtain appropriate skills to get jobs with the aim of achieving sustainable development (Pavlova & Singh, 2022).

Vocational High Schools are part of TVET, which is education based on a spectrum of skills composed of areas of expertise as well as skills programs and skill competencies (Tamrin et al., 2018). This difference in the spectrum of expertise is intended so that students can focus on learning and applying skills that are appropriate to the needs of the world of work. The differences in the spectrum of expertise cause differences in the number of enthusiasts from each spectrum of expertise. In 2018, the technology, business and ICT (information and communication technology) sectors were the sectors that accepted the most new students at the vocational school level, with a portion of 80.8% of the total population of vocational school students with a distribution of 33.1% technology and engineering, 25.7% businesses and 22% ICT (OECD/ADB, 2020). This is good news in facing technological transformation in Indonesia.

Technological transformation is important for a country's economic growth, it is estimated that by 2040 economic growth in Indonesia will increase to 2.8 trillion dollars through the adoption of technology (Asian Development Bank, 2020). In Indonesia, many new jobs are digital-related. Based on reports from LinkedIn, as the largest social media platform in the world, the most needed job in the future is the field of Artificial Intelligence (AI), which is included in Indonesia's development. AI is a job that is included in the ICT sector (Thakur, 2021). Followed by the Jobstreet report in 2021, software-related jobs will dominate the job vacancy market in Indonesia by 23%. So, based on the results of this report, work in the ICT sector is the sector that is most needed in Indonesia. There is a minimum educational qualification required for ICT sector job vacancies, for upper secondary education level, ICT sector job vacancies at high school level are 13.30% and vocational school level is 17.66% (Wiryasti et al., 2020).

So, based on the available ICT sector job vacancies and the jobs that will most appear in the future, the number of vocational school graduates in the technology, business and ICT sectors, and the minimum qualifications for ICT sector job vacancies at the upper secondary education level, then vocational school graduates are more advantaged than high school graduates to get jobs in the ICT sector. However, in the 2015-2019 period, the number of workers in the ICT sector who graduated from high school was more than those who graduated from vocational school, data on the number of workers who graduated from high school and vocational school who worked in the ICT sector were as follows: 1. in 2015 the number of workers who graduated from high school was superior to 41,681 people compared to vocational school graduates; 2. in 2016 the number of workers who graduated from high school was 87,159 people ahead of those who graduated from vocational school; 3. in 2017 the number of workers who graduated from high school was 75,548 people ahead of those who graduated from vocational school; 4. in 2018 the number of workers graduating from high school was 86,185 people ahead of vocational school graduates; 5. in 2019 the number of workers graduating from high school was 23,211 people ahead of vocational school graduates; (International Labour Organization, 2021b). On the other hand, work is one of the main goals of vocational education (Rahayu, 2023).

Soft skills and hard skills have an influence on employee performance (Jaya & Maryanto, 2023). In terms of hard skills, vocational school students are equipped with applied knowledge in their education process because the vocational school curriculum is based on a spectrum of skills that are adapted to the world of work (Salleh & Sulaiman, 2020), but not necessarily from the soft skills side. Soft skills in the world of work can influence how well a person can work or interact with other people (Chavan, 2020). The soft skill that is most needed in ICT sector jobs is collaboration with a portion of 33.72% of job vacancy offers in Indonesia (Wiryasti et al., 2020). There is a framework regarding core skills for life and work which is structured on 4 main pillars, namely: 1. social and emotional skills; 2. Cognitive and metacognitive skills; 3. Fundamental digital skills; 4. Basic expertise for green jobs, each of these skills has aspects. Cooperation and

collaboration skills are included in the social and emotional skills pillar. Cooperation and collaboration skills are the skills to work in a diverse team effectively and respect and assume joint responsibility for the results of work and show willingness and flexibility (International Labour Organization, 2021a).

The main objective of this literacy study is to describe learning methods to improve collaboration skills for vocational school students in the ICT sector. In order to achieve this goal, it is necessary to study certain topics from various sources. The sources that will be studied discuss: 1. The concept of collaboration skills in general; 2. Challenges and barriers; 3. Learning methods to improve the collaboration skills of vocational school students. To describe the main objective which is based on 3 aspects for consideration, conducting a literacy study uses the SLR (Systematic Literature Review) method, because the SLR method can be used to identify, evaluate and interpret based on various articles in a particular field. In carrying out the identification, evaluation and interpreting process, it is necessary to decompose the various components using the PICOC framework to make it easier to define questions (García-Peñalvo, 2022).

METHOD

The Systematic Literature Review (SLR) model was used in this research. Systematic Literature Review is an instrument to conceptualize existing research fields (Ghorbani et al., 2022). With the aim of harmonizing various perspectives regarding certain fields (Billore & Anisimova, 2021). In preparing an SLR question, the thing that must be done is to formulate criteria using the PICOC framework. PICOC is composed of 5 components, namely: 1. Population (a group of individuals who represent the problem/situation that must be handled); 2. Intervention (consideration of intervention by providing options to resolve the problem); 3.Comparsion (alternative comparison of this aspect is not mandatory); 4. Outcomes (something you want to achieve); 5.Context (scope of problem) (García-Peñalvo, 2022). Below in Table 1 is the PICOC components.

Table 1. PICOC Formulation of Collaboration Capabilities in Vocational Schools

Population	Vocational students
Intervention	1. Collaboration concept 2. Challenges and Hurdles 3. Learning activity to improve Collaboration skills in vocational school students
Comparsion	Taking sources from various countries for intervention aspects
Coutcomes	Learning activity to improve the Collaboration abilities of vocational school students in the ICT sector
Context	Collaboration skills in vocational schools

The next stage after formulating the components of PICOC is to prepare questions based on the results of the formulation. The following in Table 2 are the results of questions from the PICOC formulation.

Table 2. PICOC Formulation Questions

Aspect	Questions
Collaboration concept	-1A Collaboration in general -2A Factors that influence collaboration -3A The influence collaboration in the workplace/workplace simulation
Challenges and Hurdles	-1B Challenges and hurdles to collaboration -2B Challenges and hurdles for students majoring in ICT
Learning activity to improve collaboration skills in vocational school students	-1C Efforts to increase collaboration in general -2C Learning activities to increase collaboration

After finding a question, the next stage is determining the inclusion criteria (sources that are used as study material) and exclusion criteria (sources that are not used as study material). The following in Table 3 are the inclusion criteria and exclusion criteria.

Table 3. Inclusion Criteria and Exclusion Criteria

Criteria	Topics
Inclusion Criteria	Studies that discuss: The concept of collaboration skills or Challenges and obstacles or Learning activities to improve collaboration skills in vocational schools
Exclusion Criteria	Studies that do not discuss: The concept of collaboration skills and Challenges and obstacles and Learning activities to improve collaboration skills in vocational schools

The strategy for finding relevant sources is as follows: 1. Search for keywords related to the intervention stage in Figure 1 on *Google Scholar* sorted by relevance; 2. Look for sources that are relevant to the last 10 years (2014-2023); 3. Review the source search results in accordance with the PICOC question formulation in Figure 2; 4. Document the number of appropriate and inappropriate sources so that the number is counted. 5. Answer the questions in Figure 2 based on appropriate sources. The source search strategy aims to look for strong foundations in studying appropriate learning methods to improve the collaboration abilities of vocational school students in the ICT sector. Through this learning method, it is hoped that more vocational school graduates will be accepted into employment, especially in the ICT sector.

After determining the inclusion criteria and exclusion criteria as well as strategies for searching for relevant sources, to carry out efficiency it is necessary to screen articles. The 3 main considerations in screening articles are based on: 1. Title; 2. Abstract; 3. Contents. Based on these 3 considerations, it produces 4 criteria, namely: 1. Not an indexed journal; 2. The title and abstract are not appropriate; 3. The title and abstract are appropriate but the contents are not appropriate; 4. Appropriate articles. The amount of each of these criteria will be documented. Article screening results can be seen in Table 4.

Table 4. Summary of Screening Results

No	Screening Criteria	Number of Articles
1	Not an indexed journal	17
2	Title and abstract do not match	19
3	The title and abstract match but the content does not match	20
4	Appropriate article	29
Total		85

Based on table 4, only suitable articles are used as study material. Apart from these articles, they are not included in the study material, but the numbers are still documented, as stated in Table 4.

RESULT AND DISCUSSION

The first thing that needs to be studied from the intervention component in PICOC is the concept of collaboration. By searching for sources related to questions 1A, 2A, and 3A. Below in Table 5 are the results from these sources which are summarized based on the sources and results related to question 1A.

Table 5. Basis of Collaboration Based on Question 1a

No.	Author	Purpose and Result
1	(van Laar et al., 2017)	**Purpose:** Examines the relationship between 21st century skills and digital skills and provides a conceptual overview related to 21st century digital skills. **Result:** Discussions related to 21st century skills are broader than digital skills.
2	(Driskell et al., 2018)	**Purpose:** Explain the basis of Collaboration. **Result:** Explain the process, dimensions and activities of Collaboration.

3	(Mohammed & Ismail, 2014)	**Purpose:** To develop a definition of employability skills and a framework for TVET graduates in Nigeria. **Result:** Describe the soft skills for getting a job along with the indicators

Table 5 is sources that discuss the concept of collaboration. Basically, humans are social creatures, therefore humans need a relationship to achieve common goals. Collaboration is the solution to human challenges in survival. Initially, cooperation could occur in small groups for survival, in the sense that individuals in the group could share work to hunt more effectively and survive enemy attacks. From this, cooperation is defined as the process of working in a team to support team performance effectively in achieving certain goals by respecting fellow team members (Driskell et al., 2018; Koehorst et al., 2021). Collaborating is part of the soft skills of the 21st century (Koehorst et al., 2021; van Laar et al., 2017, 2020). Collaboration in various countries has different keywords. In Australia, based on Mayer, collaboration competency is working with other people, in the UK, core competency (NCVC) collaboration competency is a person's skill to collaborate with other people. In Canada, based on expertise, employability of collaboration is positive attitudes and behavior to work with other people and adapt, in UK based (SCANS) collaboration is an interpersonal skill (Mohammed & Ismail, 2014). So, collaboration is the interpersonal ability to work together to achieve goals by respecting other people in a team.

Table 6. Factors That Influence Collaboration Based on Question 2A

No.	Author	Purpose and Result
1	(Koehorst et al., 2021)	**Purpose:** To summarize the influencing organizational factors. 21st century skills at the individual level. **Result:** Produce factors that influence 21st century skills based on: 1. Leadership relationships; 2. Employment relationships; 3. Organizational relationships.
2	(van Laar et al., 2020)	**Purpose:** To provide a comprehensive picture and measure the determinants of 21st century skills. **Result:** Produces significant and insignificant effects on 21st century skills.
3	(M. Khawam et al., 2017)	**Purpose:** Examining the effects of workplace collaboration by gender and ethnicity. **Result:** Generates collaborative influence in the workplace based on gender and ethnicity.

Resources related to factors influencing collaboration can be found in table 6. Collaboration abilities are influenced by several factors. Collaboration capabilities are influenced by allying with external expert/collaboration companies (Koehorst et al., 2021). In general, collaboration is influenced by (in order from most dominant): personality, motivation, social economy, social conditions. However, when it is related to digital skills, collaboration abilities are influenced by (in order from most dominant): motivation, social economy, personality, social circumstances, and material support (van Laar et al., 2020). Apart from that, the ability to collaborate is also influenced by ethnicity (M. Khawam et al., 2017). Next we will discuss the impact of collaboration on the workplace or workplace simulation. which will be packaged in Table 7. By collaborating, one can grow a person's commitment to completing work through the *Agile* paradigm. Collaboration skills are skills needed in the world of work (Abdullah et al., 2022; Bassah & Noor, 2022; Mohammed & Ismail, 2014). Based on the opinions of experienced TVET trainers (34 people) and beginners (137 people), the ability to Collaborate is the ability to get the most important job number 3 out of 8 employability skills. If examined in more detail, based on the perspective of an experienced TVET trainer, the ability to collaborate ranks number 2 and 3 are: the ability to respect other people, behavior and beliefs; the ability to work effectively as a participant in a group (Bassah & Noor, 2022).

Table 7. Impact of Collaboration In The Workplace Based On Question 3A

No.	Author	Purpose and Result
1	(Strode et al., 2022)	**Purpose:** This article presents the Agile teamwork effectiveness model (ATEM) for co-located Agile development teams. **Result:** Description of various soft skills for implementing the ATEM model. The ATEM model can facilitate: 1. Shared leadership; 2. Peer reciprocity; 3. Redundancy; 4. Adaptability; 5. Team orientation.
2	(Qureshi et al., 2014)	**Purpose:** To support the implementation of the Agile framework in terms of the importance of teamwork for the success of software projects. **Result:** The survey results relate to the importance of the ability to collaborate.
3	(Abdullah et al., 2022)	**Purpose:** To find out the importance of job skills based on the perspectives of novice teachers and experienced teachers in TVET. **Result:** Provides a list of the soft skills that are most important in getting a job from the perspective of experienced and novice teachers in tvet.
4	(Bassah & Noor, 2022)	**Purpose:** To identify job skills needed by industry from the perspective of industry experts with a qualitative approach. **Result:** In the form of a description of the urgency of abilities: social and communication, technological literacy, cooperation, and leadership.
5	(Fernandes et al., 2021)	**Purpose:** To determine the influence of teamwork on Agile teams in a higher education environment. **Result:** Describe the influence of collaboration components on Agile teams.

When related to the world of ICT, there is a framework that can be used when collaborating, namely the *Agile* paradigm (Qureshi et al., 2014; Strode et al., 2022). There is a case study to measure collaboration towards team success through the *Agile* paradigm. There are 2 hypotheses, the first hypothesis is that cooperation influences the success of team members, the first hypothesis is accepted because it produces a value of $p = 0$, because $p < 0.05$ it can be concluded that cooperation has a big influence on the success of the team members. Meanwhile, the second hypothesis is that cooperation influences time performance. This hypothesis is accepted because it produces a value of $p = 0.000023$, because $p < 0.05$, the conclusion is that cooperation influences time performance (Fernandes et al., 2021). Table 8 discusses barriers to improving collaboration skills as well as general barriers experienced by students in the ICT sector. Common obstacles experienced by students in the ICT sector in terms of collaboration are related to collaboration between industry and academia. Barriers and best practices related to collaboration include: 1. Results obtained through research are not relevant for practice, one solution is to work as a team (collaboration to produce socialization and transfer); 2. Lack of software engineering education, one solution is to work in teams (using a collaborative approach to knowledge transfer) (Garousi et al., 2016). Apart from that, another obstacle experienced by students in the ICT sector is the lack of student commitment in completing the assignments given by the teacher. Solution to this problem is to adopt methods from the world of work into the world of education.

Table 8. Challenges and Hurdles Based on Questions 1B and 2B

No.	Author	Purpose and Result
1	(Towey et al., 2019)	**Purpose:** Examines the delivery of technical subjects in traditional higher education (THE) and technical and vocational education and training (TVET). **Result:** Presents a number of common characteristics and challenges identified in both THE and TVET.
2	(Rohanai et al., 2020)	**Purpose:** Proving that there is a positive relationship between work skills and active learning. **Result:** This research states that there is a positive relationship between work skills and the PBL method.
3	(Garousi et al., 2016)	**Purpose:** To identify (a) challenges to avoid risks to collaboration, (b) to provide appropriate solutions when planning and implementing collaborative projects.

		Result: The results identified 10 challenge themes and 17 best practice themes.
4	(Salza et al., 2019)	**Purpose:** Reviewing Agile methodology in education. **Result:** Description of the application of Agile and Scrum in education. To ensure student commitment in completing the project.

Scrum is the framework most widely used by employees in implementing *Agile* values. The following are the stages of *Scrum* in the world of education: 1. Initial discussion of the sprint, aimed at determining team formation, learning objectives and work planning; 2. Each meeting sets aside 5 minutes to adjust activities and plan activities for the next meeting; 3. Review the sprint activities at the previous meeting to describe something learned for each group member; 4. Evaluate the sprint at the previous meeting as material for improvements to be made in the next sprint (Salza et al., 2019).

Table 9. Efforts to Increase Collaboration in General Based On Question 1C

No.	Author	Purpose and Result
1	(Kanwar et al., 2019)	**Purpose:** Reviewing work-based and community-based learning, which can foster transformative and lifelong learning. **Result:** Innovative and technology-based work-based and community-based learning models have the potential to prepare students to face the ever-changing world of work.
2	(Lacerenza et al., 2018)	**Purpose:** Provides an overview of four types of evidence-based TDI (Team Development Intervention) including team training, leadership training, team building, and team debriefing. **Result:** Description related to efforts to improve the ability to collaborate.
3	(Ahmed et al., 2020)	**Purpose:** Systematically review the role of problem-based learning (PBL) in developing soft skills in the field of Technical and Vocational Education and Training (TVET) and other fields of study. **Result:** PBL as a learning approach has an important role in developing the soft skills of students from various disciplines including TVET.
4	(Vance & Smith, 2019)	**Purpose:** Developed a framework that includes five essential components of statistical collaboration: ASCCR Attitude, Structure, Content, Communication, and Relationships to learn collaboration skills. **Result:** Definition of the ASCCR framework.
5	(Gillies, 2016)	**Purpose:** To review cooperative learning and find out the factors that influence the success of cooperative learning. **Result:** There are 5 main things to successfully implement collaborative learning.

Collaborative activities between students can develop effective collaboration skills (Okolie et al., 2020). Fulfilling the need for cooperation between students can be done by dividing into small groups (Ariyanto & Muslim, 2019; Davidson & Major, 2014; Devedzic et al., 2018; Gillies, 2016; Indarta et al., 2022; Okolie et al., 2020).

Table 10. Learning Activities to Increase Collaboration Based on Question 2C

No.	Author	Purpose and Result
1	(Davidson & Major, 2014)	**Purpose:** Comparing cooperative learning, collaborative learning, and problem-based learning approaches based on: 1. Uniqueness; 2. Equality; 3. Difference. **Result:** Describe the differences, similarities and uniqueness of learning approaches, cooperative learning, collaborative learning and problem-based learning.
2	(Okolie et al., 2020)	**Purpose:** To find out how to develop students' work skills. **Result:** Shows how TVET teachers develop students' work skills.
3	(Sakulvirikitkul et al., 2020)	**Purpose:** Analyze project-based learning concepts and Agile software development concepts and evaluate them to encourage students' collaboration skills.

		Result: The model can be applied in learning.
4	(Okolie et al., 2021)	**Purpose:** Exploring the application of problem-based learning (PBL) in the technical and vocational education training (TVET) system in Nigerian higher education (HE) can improve the quality of graduates. **Result:** The results show that PBL in the Nigerian TVET system has positive implications for the quality of TVET graduate outcomes.
5	(Indarta et al., 2022)	**Purpose:** To determine the role of innovative student-centered learning models in vocational education. **Result:** Describe various types of cooperative learning models.
6	(Ariyanto & Muslim, 2019)	**Purpose:** To find out the benefits of collaboration skills implemented through GI type cooperatives for vocational school students. **Result:** GI type cooperative learning can improve vocational school students' collaboration abilities.
7	(Devedzic et al., 2018)	**Purpose:** Define, implement, evaluate, refine, and revise student soft skill metrics. **Result:** Introduces a set of principles that can be used to guide the specification of concrete, evidence-based indicators for a variety of soft skills.
8	(Missiroli, Russo, & Ciancarini, 2017)	**Purpose:** To compare software development methodologies among millennial high school students. **Result:** Comparative description of the advantages of the Waterfall and Scrum methods
9	(Barriocanal et al., 2018)	**Purpose:** Provides an overview of the scrum model integrated through pbl **Result:** Instructional description of implementing the scrum model

There are models that can improve collaboration capabilities. However, Problem Based Learning (PBL) is a model that is proven to be able to improve collaboration abilities, the collaborative learning and Project Based Learning models have the assumption that they can improve collaboration abilities but there is a lack of resources on Google Scholar that measure cooperation abilities by applying these models. The PBL model can train problem solving between fellow group members, by respecting fellow group members (Rohanai et al., 2020). Apart from that, based on a literature review from various disciplines, it is proven that 1 study related to TVET, 3 studies in fields other than TVET, and 1 conceptual study stated that the PBL model can improve students' collaboration abilities (Ahmed et al., 2020). There are several similarities related to the PBL, Collaborative Learning, and Cooperative Learning models, namely the division into small groups in the learning.

However, what differentiates PBL from Cooperative Learning and Collaborative Learning is that in PBL the tasks are based on real-world problems (Davidson & Major, 2014). The following are the stages of PBL: 1. explicit instruction, where the teacher directly explains the skills to be worked on; 2. guided practice, where the teacher acts as a collaborator to guide and assist students in self-mastery; and 3. cooperative practices, where group work can facilitate interaction between groups so that they can collaborate to solve problems. By explaining, elaborating, and considering other groups' points of view as alternative solutions, greater awareness, reflection, and control over one's own cognitive processes can be promoted; 4. Individual exercises are activities that allow students to practice their learning in individual assignments. Regarding tasks, it is important to emphasize that activities should be aimed not only at acquiring declarative knowledge (factual information known to a person), but also procedural knowledge (knowledge about how to do something) (Rivas, Saiz, & Ossa, 2022). The following in table 8 is an example of an assessment of the ability to collaborate in the Software Engineering (RPL) department (Devedzic et al., 2018). There is research to compare the *Scrum* and *Waterfall* methods for upper secondary students in RPL lessons. Comparison based on aspects: 1. progress is the fulfillment of product needs; 2. grade is an indicator of the impact of the method on the learning experience; 3. score-xf is a measurement related to processes such as work speed and artifacts; 4. score-f is a non-functional related measurement such as usability. The

results of this measurement are that overall *Scrum* is better than *Waterfall*, but in terms of score-xf, *Waterfall* is superior (Missiroli et al., 2017).

So, based on existing literacy studies, there are findings that: (1) PBL is a model that can improve students' collaboration abilities. because in PBL there is a cooperative practice stage in phase 3. cooperative practice, where group work can facilitate interaction between groups so that they can collaborate to solve problems; (2) To guarantee the completion of a project it is necessary to adapt the agile paradigm within it. The scrum model is one of the agile paradigms. the scrum model as a whole is proven to be better than waterfall. The Scrum model can be broken down into 15 weeks for each phase, the first 3 weeks for sprint 1, and every subsequent 4 weeks for sprints 2 to 4; (3) There are also findings related to the student collaboration assessment rubric, so it can help teachers find out students' collaboration abilities.

Collaboration is a work process in a team to support team performance effectively in achieving certain goals by respecting fellow team members. Collaboration ability is influenced by: personality, motivation, social economy, social circumstances, material support and ethnicity. From a quantitative research perspective, these influences are only variables whose instruments need to be formulated as a reference in creating questions. The resulting questions need to be tested for validity and reliability (Heale & Twycross, 2015). By knowing the variables that influence collaboration abilities, it can be useful for further research that wants to know the causes of low collaboration abilities of vocational school students. Another solution to the low ability to collaborate is to consult with a guidance and counseling teacher. Because student career services are the responsibility of the guidance and counseling teacher (Macharia, 2019). Collaboration is part of the skills of the 21st century. By having the appropriate soft skills, it is hoped that it will make it easier for vocational school graduates to get a job or maintain a job (Dean, 2017).

Collaboration skills are one of the abilities most needed in the world of work (Wiryasti et al., 2020). The *Agile* approach and the *Scrum* model are popular models for collaborating, especially in the ICT sector (Salza et al., 2019). Because the *Agile* Approach and the *Scrum* model can answer the main problem of students in the ICT sector, namely the lack of student commitment in completing a task. However, the challenge here is that teachers are less familiar with the *Scrum* development method (Missiroli et al., 2017). So that teachers have an understanding of *Scrum*, this can be done through DUDI (business and industrial world). DUDI can hold workshops with productive teachers at vocational schools (Hasanah, Haryadi, Nur, & Putra Pratama, 2017). The *Scrum* model has been proven to have an impact on collaboration capabilities, and there is research related to the PBL method which can improve collaboration capabilities, therefore integrating the *Scrum* model with the PBL method is expected to improve the collaboration capabilities of ICT sector vocational schools. Integration is based on Charles Prosser's first principle regarding the effectiveness of implementing learning in vocational education. Increasing collaboration skills is very important in the ICT sector because collaboration is the most sought-after skill in ICT sector job vacancies. Activities related to collaboration can foster collaboration skills. Division into small groups can meet the need for collaboration between students. Below in Table 11 below is the division of weeks based on the *Scrum* model.

Table 11. Daily *Scrum*

Week	Learning Activity
1	**Group Forming, Problem Formulation, Task Formulation**
2	
3	Planning sprint 1
4	**Sprint 1**
5	
6	
7	Sprint 1 review meeting planning sprint 2
8	**Sprint 2**
9	
10	

11	Sprint 2 review meeting planning sprint 3
12	**Sprint 3**
13	
14	
15	Sprint 3 review meeting

In table 11 are the stages in *Scrum* which are divided into 15 weeks. In general, the stages in Scrum consist of 4 sprints. The first sprint is carried out for 3 weeks, the second sprint is carried out for 4 weeks and the same goes for the third and fourth sprints (Barriocanal et al., 2018). and below in Figure 1 are the conventional stages of problem based learning which have been integrated with the *Scrum* model.

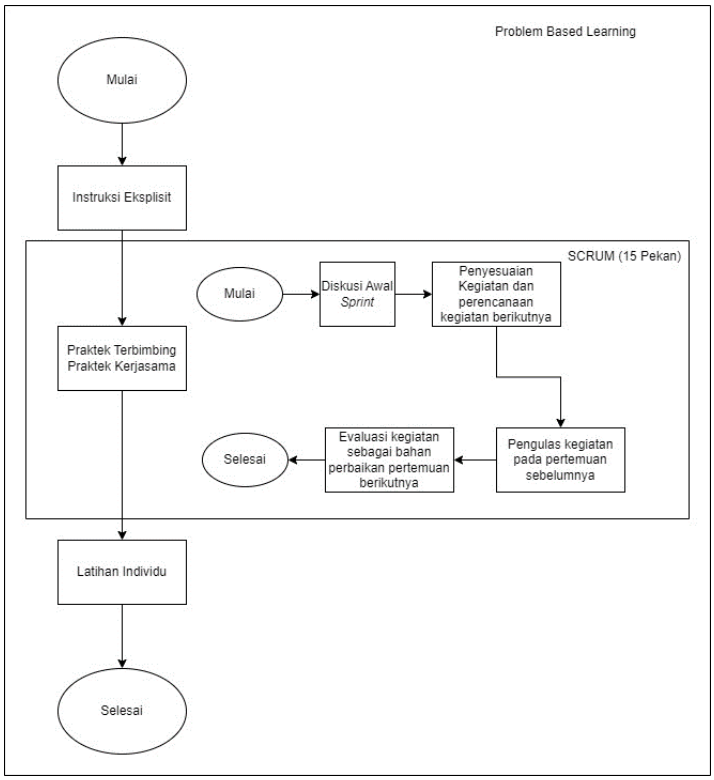

Figure 1. Scrum integration in PBL

Figure 2 is an illustration of the stages of the PBL learning method which has been integrated with the *Scrum* model. A learning method that is proven to increase student collaboration is PBL, so that learning is more suited to the world of work and fosters student commitment in completing assignments, it is necessary to integrate the *Agile* approach and the *Scrum* model in learning, this is in accordance with Charles Prosser's argument that vocational education will be efficient if it is appropriate to the world of work or a replica of the world of work (Okon, 2019). Based on Figure 2, the first phase of PBL is for the teacher to explain the learning objectives, the next phase is the collaboration phase, in the collaboration phase with teacher guidance for each meeting students need to do: 1. Initial discussion of the sprint, making an agreement on team formation, learning objectives and learning plan; 2. Adjust activities and plan activities for the next meeting; 3. Reviewing activities to find out the understanding of colleagues in one team; 4. Evaluate the current meeting as material for improvement in the next meeting; If the learning objectives have been achieved then they enter the individual training phase. Assessments related to students' collaboration abilities can use the RPL department's collaboration rubric (Devedzic et al., 2018). The following in table 12 is an assessment rubric to measure students' collaboration abilities.

Table 12. Collaborative Assessment Rubric for RPL Departments

Collaboration Domain	Evidence of Collaborative Efforts	Indicator	Measurement
Programming	Based on Program Code	Students/groups produce imported program code	Based on the number of lines of code and the number of code commits
Write Documents	Based on Writing	Students/groups produce imported documentation	Based on contributed documentation
Making Presentations	Based on Presentation Activities	Students/groups produce imported presentations	Based on presentation contributions
Design/Develop Product Services	Based on Product Results	Students/groups produce product imports	Based on the length of time in developing the product

The assessment rubric is universal. Which means it can be used at diploma or vocational school level. Therefore, when using this rubric reference, it is necessary to consider the level of difficulty/adjust the RPL major vocational school curriculum. Assessments are important to measure student learning achievements (Black & Wiliam, 2018).

So, the role of the PBL method is to accommodate students' collaboration needs because in the PBL model there is a collaborative practical learning phase with teacher guidance. Meanwhile, the role of the Scrum model is to ensure students' completeness in completing the teacher's assignments. Teachers can use the assessment rubric according to table 11 to measure students' collaboration abilities. However, the limitation of this research is that a trial needs to be carried out to measure students' collaboration abilities using the PBL method and the Scrum model, ideally carried out for 15 weeks.

CONCLUSION

The results of this study are studies related to the collaboration abilities of vocational school students in the ICT sector. This study produces a concept about collaboration related to definition, factors that influence collaboration and the impact of collaboration in the workplace. By understanding collaboration and its influence and importance in the world of work, guidance and counseling teachers/researchers can help diagnose the causes that most influence students' collaboration abilities.

The main obstacle in the ICT sector is the lack of commitment to completing tasks. The appropriate model to accommodate these problems is *Scrum*. Because in the *Scrum* model tasks are mapped into smaller tasks and every meeting/sprint there is an evaluation session regarding activity achievements and plans for the next activity. The *Scrum* model can be packaged through the PBL method which is also proven to improve collaboration capabilities. The application of these methods and models is very important considering that collaboration is the soft skill that is most sought after in the ICT sector job market.

Suggestions for future researchers are that experimental research needs to be conducted for vocational school students in the ICT sector regarding increasing collaboration skills using problem-based learning methods compared to other methods, for example cooperative learning methods or collaborative learning methods. These two methods can be integrated with the *Scrum* Model so that learning is more like the world of work and in accordance with the principles of effectiveness of vocational education based on Charles Prosser's postulates. Collaboration Ability can be measured using related instruments. So it will be clearer which learning methods are more appropriate in improving collaboration abilities.

REFERENCES

Abdullah, W. F. W., Salleh, K. M., Sulaiman, N. L., & Kamarrudin, M. (2022). Employability Skills in the TVET Trainer Training Program: The perception Between Experienced Trainers and Novices Trainers. *Journal of Technical Education and Training*, *14*(1), 150–157. https://doi.org/10.30880/jtet.2022.14.01.013

Ahmed, S., Suleman, A., Abbas, N. Z., Naza, M., Shaheen, U., & Razzaq, H. (2020). The Problem-Based Learning Approach towards Developing Soft Skills: A Systematic Review Skills: A Systematic Review. *HCAS Publications*, *25*(11), 4029.

Ariyanto, S. R., & Muslim, S. (2019). PENINGKATAN KETERAMPILAN KOLABORASI SISWA SMK MELALUI IMPLEMENTASI PEMBELAJARAN KOOPERATIF TIPE. *Jurnal Vokasi Teknik Otomotif*, 25–33.

Asian Development Bank. (2020). *INNOVATE INDONESIA UNLOCKING GROWTH THROUGH TECHNOLOGICAL TRANSFORMATION* (Vol. 6). 1550 Metro Manila.

Barriocanal, E. G., Sicilia, M. A., Cuadrado, J. J., & Sánchez-Alonso, S. (2018). Agile methods as problem-based learning designs: Setting and assessment. *ACM International Conference Proceeding Series*, 339–346. https://doi.org/10.1145/3284179.3284237

Bassah, N. 'Adnin S. H., & Noor, M. A. M. (2022). Employability Skills Needed for TVET Graduates in Malaysia: Perspective of Industry Expert. *Journal for TVET Practioners*. www.tvet-online.asia

Billore, S., & Anisimova, T. (2021). Panic buying research: A systematic literature review and future research agenda. *International Journal of Consumer Studies*, *45*(4), 777–804. https://doi.org/10.1111/ijcs.12669

Black, P., & Wiliam, D. (2018). Classroom assessment and pedagogy. *Assessment in Education: Principles, Policy and Practice*, *25*(6), 551–575. https://doi.org/10.1080/0969594X.2018.1441807

Bunning, F., Spottl, G., & Stolte, H. (2022). *Technical and Vocational Teacher Education and Training in International and Development Co-Operation*. https://link.springer.com/bookseries/6969

Chavan, S. V. (2020). The Importance of Soft Skills. *International Journal of Science and Research*. https://doi.org/10.21275/SR20508183938

Davidson, N., & Major, C. H. (2014). Boundary cross-ings: Cooperative learning, collaborative learning, and problem-based learning. In *Journal on Excellence in College Teaching* (Vol. 25, Issue 4).

Dean, S. A. (2017). Scholar Works Soft Skills Needed for the 21st Century Workforce. *WALDEN DISSERTATIONS AND DOCTORAL STUDIES COLLECTION*. https://scholarworks.waldenu.edu/dissertations

Devedzic, V., Tomic, B., Jovanovic, J., Kelly, M., Milikic, N., Dimitrijevic, S., Djuric, D., & Sevarac, Z. (2018). Metrics for Students' Soft Skills. *Applied Measurement in Education*, *31*(4), 283–296. https://doi.org/10.1080/08957347.2018.1495212

Driskell, J. E., Salas, E., & Driskell, T. (2018). Foundations of teamwork and collaboration. *American Psychologist Association*, *73*(4), 334–348. https://doi.org/10.1037/amp0000241

Fernandes, S., Dinis-Carvalho, J., & Ferreira-Oliveira, A. T. (2021). Improving the performance of student teams in project-based learning with scrum. *Education Sciences*, *11*(8). https://doi.org/10.3390/educsci11080444

García-Peñalvo, F. J. (2022). Developing robust state-of-the-art reports: Systematic Literature Reviews. *Education in the Knowledge Society*, *23*, E28600. https://doi.org/10.14201/eks.28600

Garousi, V., Petersen, K., & Ozkan, B. (2016). Challenges and best practices in industry-academia collaborations in software engineering: A systematic literature review. *Information and Software Technology*, *79*, 106–127. https://doi.org/10.1016/j.infsof.2016.07.006

Ghorbani, M., Karampela, M., & Tonner, A. (2022). Consumers' brand personality perceptions in a digital world: A systematic literature review and research agenda. In *International Journal of Consumer Studies*. John Wiley and Sons Inc. https://doi.org/10.1111/ijcs.12791

Gillies, R. M. (2016). Cooperative learning: Review of research and practice. *Australian Journal of Teacher Education*, *41*(3), 39–54. https://doi.org/10.14221/ajte.2016v41n3.3

Hasanah, N., Haryadi, B., Nur, G., & Putra Pratama, I. (2017). Vocational High School Readiness In Facing The Asean Economic Community. *Advances in Social Science, Education and Humanities Research*.

Heale, R., & Twycross, A. (2015). Validity and reliability in quantitative studies. *Annals of Spiru Haret University. Economic Series*, *18*(3), 66–67. https://doi.org/10.1136/eb-2015-102129

Indarta, Y., Ambiyar, A., Rizal, F., Ranuharja, F., Samala, A. D., & Dewi, I. P. (2022). Studi Literatur : Peranan Model-Model Pembelajaran Inovatif Bidang Pendidikan Teknologi Kejuruan. *EDUKATIF : JURNAL ILMU PENDIDIKAN*, *4*(4), 5762–5772. https://doi.org/10.31004/edukatif.v4i4.2721

International Labour Organization. (2021a). *Global framework on core skills for life and work in the 21st century* (1st ed.). International Labour Organization.

International Labour Organization. (2021b). *Labour Market Analysis for ICT courses at Technical and Vocational Education and Training (BBPLK) Bekasi* (1st ed.). International Labour Office. www.ilo.org/publns

Jaya, U. A., & Maryanto, T. (2023). *EFFECT OF HARDSKILL AND SOFTSKILL ON EMPLOYEE PERFORMANCE*. *1*(1). https://e-journal.naureendigition.com/index.php/mj

Kanwar, A., Balasubramanian, K., & Carr, A. (2019). Changing the TVET paradigm: new models for lifelong learning. *International Journal of Training Research*, *17*(sup1), 54–68. https://doi.org/10.1080/14480220.2019.1629722

Koehorst, M. M., van Deursen, A. J. A. M., van Dijk, J. A. G. M., & de Haan, J. (2021). A Systematic Literature Review of Organizational Factors Influencing 21st-Century Skills. *SAGE Journals*, *11*(4). https://doi.org/10.1177/21582440211067251

Lacerenza, C. N., Marlow, S. L., Tannenbaum, S. I., & Salas, E. (2018). Team development interventions: Evidence-based approaches for improving teamwork. *American Psychologist Association*, *73*(4), 517–531. https://doi.org/10.1037/amp0000295

M. Khawam, A., DiDona, T., & S. Hernández, B. (2017). Effectiveness of Teamwork In the Workplace. *International Journal of Sciences: Basic and Applied Research (IJSBAR)*. http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

M. Yusop, S. R., Rasul, M. S., Mohammad Yasin, R., & Hashim, H. U. (2023). Identifying and Validating Vocational Skills Domains and Indicators in Classroom

Assessment Practices in TVET. *MDPI Journal*, *15*(6), 5195. https://doi.org/10.3390/su15065195

Macharia, M. S. (2019). Reengineering mass career acquisition through technical vocational education training counseling in Kenya. *International Journal of Research in Business and Social Science (2147- 4478)*, *8*(6), 212–218. https://doi.org/10.20525/ijrbs.v8i6.533

Missiroli, M., Russo, D., & Ciancarini, P. (2017). Agile for millennials: A comparative study. *Proceedings - 2017 IEEE/ACM 1st International Workshop on Software Engineering Curricula for Millennials, SECM 2017*, 47–53. https://doi.org/10.1109/SECM.2017.7

Mohammed, D. S., & Ismail, S. (2014). EMPLOYABILITY SKILLS FRAMEWORK FOR TVET GRADUATES EMPLOYMENT IN NIGERIA. *CORE*.

OECD/ADB. (2020). *Employment and Skills Strategies in Indonesia*. OECD. https://doi.org/10.1787/dc9f0c7c-en

Okolie, U. C., Elom, E. N., Igwe, P. A., Binuomote, M. O., Nwajiuba, C. A., & Igu, N. C. N. (2021). Improving graduate outcomes : Implementation of problem-based learning in TVET systems of Nigerian higher education. *Higher Education, Skills and Work-Based Learning*, *11*(1), 92–110. https://doi.org/10.1108/HESWBL-12-2018-0140

Okolie, U. C., Elom, E. N., Igwe, P. A., Nwajiuba, C. A., Binuomote, M. O., & Igu, N. (2020). How TVET teachers foster employability skills: insights from developing countries. *International Journal of Training Research*, *18*(3), 231–249. https://doi.org/10.1080/14480220.2020.1860301

Okon, E. E. (2019). VOCATIONALISATION OF TVET THROUGH INSTITUTION INDUSTRY COLLABORATION: BRIDGING THE SKILL GAP. In *Nigerian Journal of Business Education (NIGJBED)* (Vol. 6, Issue 2). http://www.nigjbed.com.ng

Pavlova, M., & Singh, M. (2022). *Education for Sustainability 5 Recognizing Green Skills Through Non-formal Learning A Comparative Study in Asia* (Vol. 5). Springer Nature Singapore Pte Ltd. https://doi.org/https://doi.org/10.1007/978-981-19-2072-1

Qureshi, M. R. J., Alshamat, S. A., & Sabir, F. (2014). SIGNIFICANCE OF THE TEAMWORK IN AGILE SOFTWARE ENGINEERING. *Science International-Lahore*, *26*(1), 117–120. http://agilemanifesto.org/.

Rahayu, S. T. (2023). WORKPLACE LEARNING IN TVET: THE ROLE OF MENTORING AND COACHING IN DEVELOPING VOCATIONAL COMPETENCIES. In *International Collaboration Book Chapter*.

Rivas, S. F., Saiz, C., & Ossa, C. (2022). Metacognitive Strategies and Development of Critical Thinking in Higher Education. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.913219

Rohanai, R., Othman, H., Mat Daud, K. A., Omar, N. H., Ahmad, M., Ismail, M. E., & Sulaiman, A. (2020). Concept of Correlation between Active Learning and Employability Skills in TVET. *Online Journal for TVET Practitioners*, *5*(1). https://doi.org/10.30880/ojtp.2020.05.01.003

Sakulvirikitkul, P., Sintanakul, K., & Srisomphan, J. (2020). The design of a learning process for promoting teamwork using project-based learning and the concept of agile software development. *International Journal of Emerging Technologies in Learning*, *15*(3), 207–222. https://doi.org/10.3991/ijet.v15i03.10480

Salleh, K. M., & Sulaiman, N. L. (2020). Reforming Technical and Vocational Education and Training (TVET) on Workplace Learning and Skills Development. *International Journal of Recent Technology and Engineering (IJRTE)*, *8*(5), 2964–2967. https://doi.org/10.35940/ijrte.E6553.018520

Salza, P., Musmarra, P., & Ferrucci, F. (2019). Agile Methodologies in Education: A Review. *SPRINGER LINK*, 25–45. https://doi.org/10.1007/978-981-13-2751-3_2

Strode, D., Dingsøyr, T., & Lindsjorn, Y. (2022). A teamwork effectiveness model for agile software development. *Empirical Software Engineering*, *27*(2). https://doi.org/10.1007/s10664-021-10115-0

Tamrin, A., PH, S., & Soenarto. (2018). THE LINK AND MATCH OF THE DEMAND AND SUPPLY FOR PRODUCTIVE VOCATIONAL SCHOOL TEACHERS WITH REGARD TO SPECTRUM OF VOCATIONAL SKILLS IN THE PERSPECTIVE OF EDUCATION DECENTRALIZATION. *Jurnal Pendidikan Vokasi*, *8*(1), 40–52. http://journal.uny.ac.id/index.php/jpv

Thakur, A. Kr. (2021). Artificial Intelligence (AI) in Information and Communication Technology (ICT): An Overview. *International Journal of Research and Analysis in Science and Engineering*.

Towey, D., Walker, J., & Ng, R. (2019). Embracing ambiguity: Agile insights for sustainability in engineering in traditional higher education and in technical and vocational education and training. *Interactive Technology and Smart Education*, *16*(2), 143–158. https://doi.org/10.1108/ITSE-10-2018-0088

van Laar, E., van Deursen, A. J. A. M., van Dijk, J. A. G. M., & de Haan, J. (2017). The relation between 21st-century skills and digital skills: A systematic literature review. *Computers in Human Behavior*, *72*, 577–588. https://doi.org/10.1016/j.chb.2017.03.010

van Laar, E., van Deursen, A. J. A. M., van Dijk, J. A. G. M., & de Haan, J. (2020). Determinants of 21st-Century Skills and 21st-Century Digital Skills for Workers: A Systematic Literature Review. *SAGE Journals*, *10*(1). https://doi.org/10.1177/2158244019900176

Vance, E. A., & Smith, H. S. (2019). The ASCCR Frame for Learning Essential Collaboration Skills. *Journal of Statistics Education*, *27*(3), 265–274. https://doi.org/10.1080/10691898.2019.1687370

Wiryasti, C. H., Gunawan, J., & Muhamad, T. (2020). Rapid Assesment of Information and Communication Technology Skills Demand in Indonesia. *International Labour Office*. www.ilo.org/publns.