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Career-focused teaching and its effects on students' biology-technical-vocational-fused skills

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ABSTRACT

The K to 12 program in the Philippines, initiated in 2012, brought about challenges like job mismatch among senior high school (SHS) graduates. Addressing this issue requires integrating technical-vocational-livelihood (TVL) skills with core subject skills, particularly in biology. This study explores how the career-focused teaching approach (CFTA) nurtures biology-technical-vocational-fused skills (BTVFS). Using a pretest-posttest quasi-experimental design, two grade 11 classes (35 students each) participated-one exposed to CFTA and the other to conventional teaching. Quantitative data from a researcher-made BTVFS questionnaire were analyzed with an independent samples t-test, revealing significant differences in all BTVFS subcomponents; $t(68)=3.670$, $p<0.036$. Qualitative data from reflective journals aligned with BTVFS subskills (metacognition, communication, problem-solving, and collaboration). CFTA proved instrumental in enhancing the BTVFS of students, emphasizing its importance in the curriculum across SHS core subjects to mitigate job mismatch for K to 12 graduates.

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1. INTRODUCTION

The Enhanced Basic Education Act of 2013 (RA 10533), or the K to 12 program in the Philippines, aimed to establish a robust education system for lifelong learning and employment [1]. Despite its implementation, senior high school (SHS) graduates faced challenges. As revealed in 2018, the Department of Education reported 1.2 million SHS graduates, with 24.8% in the technical-vocational-livelihood (TVL) track. Only 9.7% of TVL graduates in the workforce faced low employment rates despite programs like the joint-delivery voucher [2]. The limited integration of career skills in core subjects contributed to this issue [3]. Similar observations in Western countries revealed academic emphasis over career competencies [4].

Moreover, job readiness in the Philippines requires skills like critical thinking and collaboration [5]. The education-occupation mismatch aggravates job mismatch [6]. Hence, strengthening employment skills development is crucial [7]. Integrating career-focused teaching (CFT) into the curriculum enhances the employability of SHS learners [8]. Four shared skills exist in biology and technical-vocational education: metacognitive, communication, collaborative, and problem-solving. Implementing CFT in core subjects contextualizes learning, fostering skill development [9]. While studies praise CFT for promoting career skills and job readiness [10]–[12], none explore its impact on integrated SHS skills. This research aims to incorporate CFT in core subjects like biology, investigating its effects on the biology-technical-vocational-fused skills (BTVFS) of learners.

The Philippine K to 12 program aims to equip students with career skills, yet job mismatch issues persist. In the local context, job mismatch among SHS graduates is attributed to poor curriculum design, lack of industry-driven education, and overemphasis on college education [13]. Addressing this requires a comprehensive approach, including curriculum enhancement, industry partnerships, and technical and vocational education promotion.

Internationally, countries like Tanzania face job mismatch due to inadequate skills, wrong field choices, poor communication skills, and ineffective career guidance [14]. This problem leads to lower wages, job dissatisfaction, underemployment, and instability [15], [16]. Thus, tackling job mismatch is crucial for productivity, job satisfaction, and economic performance. CFT is a didactic approach emphasizing practical skills and knowledge linked to specific careers or industries. It prepares learners for the workforce through hands-on training, real-world projects, and industry collaborations [10], [11]. CFT enhances career readiness, bridges skills gaps, and fosters economic success, creating a focused learning environment [12].

Various research studies demonstrate the impact of CFT on education. In Florida, a game-based programming tool aligned with the career-oriented model prepared graduates for the gaming industry [17]. The United States of America drew inspiration from the vocational education of Germany, aligning curricula with global industry demands [11], [18], [19]. In the Philippines, efforts include industry partnerships, career guidance, and technical education. However, curriculum enhancements, especially integrating CFT with non-specialized subjects, are essential for fostering industry-based skills [20]–[22].

Science aims to foster critical thinking and scientific methods through basic and integrated science process skills [23]. Combining specialized and non-specialized (e.g., TVL and biology) SHS subjects can address job mismatch by developing holistic skills [24]. This broad skill set, including soft skills like communication and problem-solving, enhances adaptability to dynamic labor markets, reducing the risk of job mismatch [25], [26].

Research by Shukla [9] identifies four intersecting skills in specialized (TVL) and non-specialized (biology) SHS subjects: metacognition, communication, problem-solving, and collaboration. For metacognitive skills, creating a reflective learning atmosphere and encouraging curiosity and exploration are essential [27]–[29]. Improving communication involves enhancing reading, writing, and oral presentation activities through innovative methods like role plays and reflective writing [30]–[33].

Problem-solving skills, crucial for adult performance, are developed through vocational education, addressing the demand for soft skills alongside technical expertise [34], [35]. Teaching approaches like project-based learning enhance problem-solving skills by exposing students to real-life scenarios [36]. Lastly, fostering classroom collaboration builds social interdependence, conflict resolution, and effective communication, preparing students for collaborative work in professional settings [37]–[39].

Aside from the researcher's first-hand experience with the problem, this research took inspiration from various research gaps that other studies have. These gaps served as the guidepost to conceptualize this investigation. CFT, as an emerging innovative teaching approach, offers opportunities for educational stakeholders to improve learning quality and make learners job-ready. However, a considerable amount of literature sought the effect of CFT career skills, which are focused solely on developing skills in specialized subjects [17], [20]–[22]. Furthermore, in this study, the effects of CFT on the skills where non-specialized (biology) and specialized (TVL) subjects converge were explored [9]. In addition, a lot of studies explored the implementation of CFT at the tertiary level [12], [18], [19], and limited studies have ranged over its effects at the secondary level, especially in SHS. Therefore, this research investigated the influence of CFT on the BTVFS of TVL students in biology.

The conceptual framework in Figure 1 illustrates the impact of two teaching approaches, career-focused teaching approach (CFTA) and non-career-focused teaching approach (NCFTA), serving as independent variables on the BTVFS of students. This study delves into the effects of CFT on the development of the BTVFS of learners. CFT is utilized as an independent variable to ensure the application of career skills among TVL students in specialized and core subjects, encompassing metacognitive, communication, collaboration, and problem-solving skills, as identified in the study of Shukla [9] study on science-related employability skills. The primary inquiry guiding this research is to determine how students exposed to CFT exhibit superior BTVFS compared to those exposed to conventional teaching.

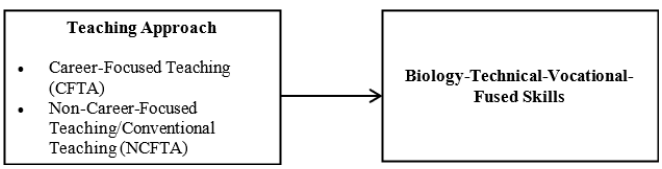

Figure 1. Conceptual framework of the study

2. RESEARCH METHOD

This quantitative journal article details our research methods, systematically exploring relationships within numerical data. Transparent participant selection, design, intervention, and analysis procedures contribute to reproducibility. We aim to provide empirical evidence for our research questions through rigorous statistical analyses, offering valuable insights into our scholarly domain with reliable and generalizable results.

2.1. Participants

This study focused on the biology component of an earth and life science subject for 11th-grade students in the TVL track at a regular public high school in an urban area of the Philippines. The intervention spanned nearly eight weeks, covering one quarter of the academic year, with the science class meeting five times a week for one hour each session. The participants included 70 students from two intact heterogeneous classes, with a higher proportion of male students due to the class composition and an age range of 15-17 years. To ensure fairness, the researcher randomly assigned each intact class to either an experimental or control group using a coin toss. Then, each class was further divided into eight groups comprising five members. The researcher employed a differentiated but parallel teaching approach across all classes.

2.2. Research design

This study applied a pretest-posttest quasi-experimental design. The researcher utilized this design to determine the effects of CFT on the BTVFS of students. Of the two intact groups of students, one was experimental and was exposed to the CFTA. At the same time, the other was the NCFTA or the control group exposed to the conventional teaching approach.

2.3. Teaching intervention

This research implemented the CFTA in the biology component of earth and life science, spanning six learning cycles with seven contents. Employing the proven 5Es learning cycle (engage, explore, explain, elaborate, and evaluate), a well-established inquiry-based teaching method, the intervention aimed to enhance higher-order thinking skills [40]. Group-based activities with assigned roles were central to fostering a cooperative learning atmosphere, focusing on developing BTVFS, including metacognition, communication, problem-solving, and collaboration.

The range of CFT activities included think-pair-share, metacognitive learning logs, debates, concept mapping, group discussions, interactive quizzes, role-playing, critical analysis of research papers, data analysis, inquiry-based projects, collaborative problem-solving, group laboratory experiments, problem-solving challenges, and community service projects. In contrast, the NCFTA employed a conventional teaching method, adhering solely to the typical 5Es learning cycle. Notably, the NCFTA group did not engage in activities to develop BTVFS. Instead, they focused on traditional science learning activities such as lectures, reading assignments, laboratory experiments, classroom demonstrations, worksheets, assignments, and recitation.

2.4. Instrument

The researchers designed and validated the BTVFS questionnaire to assess the impact of the two teaching approaches on the dependent variable of the study. This instrument gauges four employability skills-metacognition, communication, problem-solving, and collaboration-identified by Shukla [9]. The questionnaire consists of 29 items, utilizing a 4-point Likert scale: 4 (strongly agree), 3 (agree), 2 (disagree), and 1(strongly disagree).

To ensure reliability and validity, the BTVFS questionnaire was scrutinized by four experts from the University of the Philippines, specializing in science and educational psychology. Their evaluation covered content, format, item difficulty, variety, and statement composition. The instrument was revised based on their feedback while retaining its original items. Subsequently, it underwent pilot testing, achieving an internal consistency and reliability value of α=.89, indicating acceptable reliability and close item relationships.

2.5. Data collection and analysis

The researchers obtained the permission of the school head and the parental consent for the participation of learners, emphasizing their rights, including the option to decline or withdraw without consequences. All parents committed to participation. The study involved administering the pretest BTVFS questionnaire, implementing the teaching intervention, and collecting journal reflections. A posttest of the BTVFS questionnaire followed. Quantitative data underwent analysis with a two-way independent samples *t*-test for pretest scores and a one-way independent samples *t*-test for posttest scores, assessing intervention effects on BTVFS.

Qualitative data from reflective journals underwent thematic analysis. The researcher immersed in data, identified codes, and iteratively grouped them into themes. Then, the rigor of the data analysis was maintained through an audit trail. Lastly, the findings were interpreted and presented, offering comprehensive insights from the perspectives of the participants. Thematic analysis enriched the qualitative dimension of the investigation.

3. RESULTS AND DISCUSSION

3.1. Initial comparability in biology-technical-vocational-fused skills

The overall descriptive analysis of the BTVFS pretest score was *M*=1.583 (*SD*=.141), indicating that students initially disagreed that they perceived not possessing BTVFS. Since the *p*-value of Levene's test, *F*(1.69)=.916, *p*=.341, was greater than the significance value, the variances were assumed to be equal. To satisfy this assumption, the data were subjected to a two-way independent samples *t*-test. At a .05 level of significance, the two-way independent samples t-test showed no significant difference in pretest scores of both groups, CFTA and NCFTA, *t*(68)=-.069, *p*=.945, which implied that all students had comparable BTVFS before the intervention.

3.2. Effects of teaching approaches on biology-technical-vocational-fused skills

The study employed a one-way independent samples *t*-test on posttest BTVFS questionnaire scores to assess the impact of the intervention on the BTVFS of students. The descriptive results in Table 1 indicate that, following the intervention, the CFTA class (*M*=3.463, *SD*=.154) exhibited higher mean posttest ratings on the BTVFS questionnaire than the NCFTA class (*M*=2.965, *SD*=.283). These findings suggest an enhanced perception of BTVFS in Life Science (Biology), a core subject, for both groups post-intervention. Notably, the CFTA-exposed group demonstrated a superior level of BTVFS in biology compared to the NCFTA-exposed group.

Table 1. Descriptive analysis of BTVFS post-test

Group	Mean	*SD*	*SE*
CFTA	3.463	.154	.026
NCFTA	2.965	.283	.048

Note. *N*=35 on each group, BTVFS maximum mean rating=4.0

To establish whether there was a significant difference in the BTVFS in life science (biology) classes between the CFTA and NCFTA groups, a one-tailed independent samples *t*-test was performed on their BTVFS mean posttest ratings. The t-test results in Table 2 exhibited that the CFTA and NCFTA mean posttest ratings in the BTVIFS questionnaire have statistically significant differences, *t*(68)=-3.670, *p*=.036. These results suggest that CFT significantly improves the BTVFS of students in Life Science (Biology).

Table 2. Independent samples t-test of BTVFS posttest

Group	*t*	*p*
BTVFS	3.670	0.036*

Note. *indicates *p*<.05; *df*=68

This study examined the effects of CFT on the BTVFS of students. Based on this aim, findings have proven that the CFT approach significantly influenced the development of BTVFS. The results confirmed the findings and perspectives of several previous studies. According to the study of Shukla [9], four crucial subskills of BTVFS include metacognition, communication, problem-solving, and collaboration. These subskills are vital in integrating competencies from specialized and non-specialized subjects in SHS.

Regarding metacognitive skills, students in the CFT group exhibited diverse approaches to learning, including self-discovery and independent learning, aligning with [29] findings. Metacognitive intervention strategies significantly impacted the vocational performance of students, with gains in academic performance linked to classroom strategies like hands-on activities and self-discovery learning techniques. Reflective journals from students exposed to CFT-guided activities indicated enhanced learning through self-discovery and independent study.

CFTA Student 21: "*Sinusubukan kong pukawin ang aking interes sa Life Science sa pamamaginan ng self-discovery at pagkuha ng mga kasanayan kalaunan.Sinusubukan kong magtanong sa aking sarili kung ano ito at tinitignan sa internet kung sakaling hindi ko alam.* [I am trying to awaken my interest in Life Science through self-discovery and acquiring skills later. I am attempting to ask myself what it is and searching on the internet in case I don't know.]"
CFTA Student 30: "*Natututo ako mag-isa. Minsan, kapag nahihirapan ako sa mga aralin, humihingi ako ng tulong sa aking guro o nagreresearch ako sa internet.* [I am learning on my own. Sometimes, when I struggle with my lessons, I seek help from my teacher or do research on the internet.]"

In the NCFTA group, respondents mainly used metacognitive strategies like studying lessons in advance and recognizing their impact on life science performance—a finding supported by research emphasizing the influence of metacognitive strategies on in-class achievement tests [41]. Conversely, some preferred collaborative learning with peers. For communication skills, CFTA students were permitted bilingual communication (English and Filipino) to overcome language barriers. This approach significantly improved communication skills, aligning with the study [33] on innovative methods fostering workplace communication competency. Paryono [30] suggested integrating communication skills into the TVET curriculum, supported by students' journal extracts mentioning improvements through peer interaction and reflective writing activities.

CFTA Student 2: "*Kadalasan, hindi na naming napaghahandaan ang mga gawain kasi binibigay ito nang 'di inaasahan. Kung kaya, nag-uusap kami maigi ng aking mga kamag-aral at nagrereview ng sama-sama at sinusubukang gumamit ng mga salita para maipaliwanag ang aming topic.* [Often, we are not able to prepare for the tasks because they are given unexpectedly. That's why we discuss thoroughly with my classmates and review together, trying to use words to explain our topic effectively.]"
CFTA Student 14: "*Masasabi kong mahusay ako sa pakikipagtalastasan. Sa tulong ng pagbabahagi ng mga nalalaman sa mga gawain at pagsulat ng reflection.* [I can say that I am skilled in communication. With the help of sharing knowledge during activities and writing reflections.]"

The bilingual approach in NCFTA improved communication skills, allowing expression in English and Filipino. Some practiced presentations echo a study on bilingual children transferring skills from a second language [42]. For problem-solving, students enhanced their skills through systematic laboratory activities and cooperative learning, seeking information from various sources. This aligns with Techanamurthy *et al*. [37] on real-life problem exposure improving skills. The demand for soft skills in the workforce was noted, with project-based learning identified to enhance problem-solving alongside technical and academic skills [36]. Students' journals further affirmed that CFT improved problem-solving through group activities and scientific methods.

CFTA Student 22: "*Sinosolve namin ng tulong-tulong ang mga gawain/problem na binibigay ng aming guro.* [We solve the tasks/problems given by our teacher together with the help and cooperation of each other.]"
CFTA Student 26: "*Karamihan sa mga gawain na binibigay sa amin ng aming guro ay may kaugnayan sa aming. Sinusunod naming ang scientific method upang maayos na ma-solve ang mga ito.* [Most of the tasks given to us by our teacher are related to our field of study. We follow the scientific method to properly solve them.]"

Students in NCFTA solved problems through cooperative learning, deviating from the scientific method. While effective, studies suggest enhancing problem-solving by exploring alternative solutions [43]. Regarding collaborative skills, group tasks were completed efficiently, showcasing leadership abilities. Research by Child and Shaw [38] supports the idea that collaboration fosters social interdependence, conflict resolution, idea generation, resource sharing, task division, and workplace communication. Qualitative data from students' journals confirm that CFT improved collaboration skills, mainly when students took on leadership roles, enhancing interpersonal skills during group activities.

CFTA Student 10: "*Madalas akong ina-assign na leader.Siguro may nakita ang aking guro na katangian na kaya kong maging pinuno. Bilang isang pinuno, sinisiguro ko na lahat ng ideya ng aking mga kagrupo ay tinatangap ko at hindi ko pinipilit na masunod ang gusto ko kahit ayaw ng mga kagrupo ko.* [I am often assigned as the leader. Perhaps my teacher saw qualities in me that

made me capable of being a leader. As a leader, I ensure that I accept all ideas from my team members and do not impose my preferences if my team disagrees.]"
CFTA Student 21: "*Isa akong miyembro lamang sa isang grupo depende sa sitwasyon at sa gawaing ibinigay ng aming guro. Gumagawa ako ng ayon sa responsibilidad na ibinigay sa akin para sa kaayusan ng grupo.* [I am just a member in a group depending on the situation and the task given by our teacher. I fulfill my responsibilities assigned to me for the organization of the group.]"

Furthermore, their engagement in active idea-sharing sessions notably facilitated the NCFTA group's enhancement of collaboration skills. The findings from a complementary study underscore the importance of educators' awareness of students' preexisting methods for asserting authority and resolving conflicts within group dynamics when striving to cultivate effective teamwork skills [44]. This suggests a comprehensive understanding of students' interpersonal behaviors within collaborative settings can inform targeted pedagogical approaches to promote more productive group interactions. By acknowledging and addressing these dynamics, educators can better support students in developing essential teamwork competencies, fostering a conducive collaborative learning and achievement environment.

4. CONCLUSION

This research affirms the effectiveness of the CFTA in enhancing BTVFS, supported by compelling one-way independent samples t-test results. The intervention significantly impacted metacognition, communication, problem-solving, and collaboration. Based on established practices like problem-based learning and team-based learning (TBL), CFTA effectively fostered these essential skills. Incorporating reflective prompts within CFTA further strengthened metacognitive development, highlighting the success of this multifaceted approach.

Moreover, the study recommends employing context-based and career-oriented pedagogies, particularly in core subjects like earth and life science in SHS, to improve problem-solving and application of competencies within the curriculum. Proposing CFTA adoption as a practical solution to address job mismatch among SHS graduates, the research extends implications beyond academics to the broader community. Acknowledging limitations in generalizability to all SHS students, the study advocates future research into social and emotional learning skills, future thinking through CFT, and creative implementation in resource-constrained schools, aiming to contribute valuable insights to secondary education challenges.

REFERENCES

[1] Congress of the Philippines Republic of the Philippines, *Republic Act No. 10533*. 2013. [Online]. Available: http://www.senate.gov.ph/republic_acts/ra 10533.pdf
[2] M. T. Montemayor, "2018 senior high school implementation exceeds DepEd outlook," *Philippine News Agency*, Manila, 2018. [Online]. Available: https://www.pna.gov.ph/articles/1057609
[3] D. Fisher and N. Frey, "Access to the core curriculum," *Remedial and Special Education*, vol. 22, no. 3, pp. 148–157, May 2001, doi: 10.1177/074193250102200303.
[4] A. Draaisma, F. Meijers, and M. Kuijpers, "The development of strong career learning environments: the project 'Career Orientation and Guidance' in Dutch vocational education," *Journal of Vocational Education & Training*, vol. 70, no. 1, pp. 27–46, Jan. 2018, doi: 10.1080/13636820.2017.1392995.
[5] C. A. Maripaz and A. I. Ombra, "Graduates' competence on employability skills and job performance," *International Journal of Evaluation and Research in Education (IJERE)*, vol. 5, no. 2, pp. 119–125, 2016.
[6] M. D. A. Jasa, M. A. A. Jasa, and E. L. Corpuz, "Labor mismatch in the Philippines: analysis of the impact of education-occupation mismatch on wage and analysis of the Beveridge curve," M.S. thesis, Department Economics, University of Santo Tomas, Manila, Philippines, 2013.
[7] M. Mourshed *et al.*, "Policy debate | Education and employment mismatch," *Revue internationale de politique de développement*, vol. 5, no. 3, Aug. 2014, doi: 10.4000/poldev.1802.
[8] J. Kim, "Study: career-based teaching leads to more motivated students," *89.3 KPCC*, 2013. [Online]. Available: https://archive.kpcc.org/blogs/education/2013/07/25/14347/study-career-based-teaching-leads-to-more-motivate/ (accessed Dec 19, 2023).
[9] A. Shukla, "Review of efforts to integrate core skills for employability in vocational education and training systems," in *Integrating core work skills into TVET systems: Six country case studies*, New Delhi: ILO Publications, 2015, pp. 49–60.
[10] D. J. Fischer and J. Bowles, "Schools that work," New York, NY: Center for an Urban Future, 2008. [Online]. Available: https://eric.ed.gov/?q=career-oriented+education&id=ED501331
[11] S. J. Jerome, "Unique academic skillsets," *Journal of the National Collegiate Honors Council*, vol. 16, no. 2, pp. 79–82, 2015.
[12] M. Lanford and W. G. Tierney, "From vocational education to linked learning: the ongoing transformation of career-oriented education in the U.S," Los Angeles, CA: Pullias Center for Higher Education, 2015. [Online]. Available: https://eric.ed.gov/?id=ED574633
[13] J. R. Demetrio, "The truth about mismatch between college graduates and the needs of the industry: an update," *PROGRESSIO Journal on Human Development*, vol. 11, pp. 1–12, 2018.
[14] J. Amani, "Prevalence of, and factors associated with, unemployment among graduates: evidence from Tanzania," *Africa Education Review*, vol. 14, no. 3–4, pp. 230–244, Oct. 2017, doi: 10.1080/18146627.2017.1300064.

[15] C. Béduwé and J.-F. Giret, "Mismatch of vocational graduates: what penalty on French labour market?" *Journal of Vocational Behavior*, vol. 78, no. 1, pp. 68–79, Feb. 2011, doi: 10.1016/j.jvb.2010.09.003.
[16] R. Zhu, "The impact of major–job mismatch on college graduates' early career earnings: evidence from China," *Education Economics*, vol. 22, no. 5, pp. 511–528, Sep. 2014, doi: 10.1080/09645292.2012.659009.
[17] P. P. Wu, "Development of a career-oriented instructional design model for game programming," Ph.D. dissertation, Nova Southeastern University, Fort Lauderdale, FL, USA, 2012.
[18] D. Frost and M. Worthen, "iNACOL issue brief: state policy & K-12 competency-based education," Vienna, VA, 2017.
[19] S. E. Eaton *et al.*, "Understanding faculty perceptions and approaches to academic integrity in a Canadian school of education," in *2018 International Conference: International Centre for Academic Integrity*, 2018, pp. 1–7.
[20] A. R. Lorenzo, "Effectiveness of the computer and internet literacy project in public high schools of Tarlac Province, Philippines," *Turkish Online Journal of Educational Technology-TOJET*, vol. 15, no. 2, pp. 38–46, 2016.
[21] C. T. Sumande, C. L. Castolo, and B. E. V. Comendador, "The ICT level of confidence of course specialists in distance education: the Polytechnic University of the Philippines experience," *Turkish Online Journal of Distance Education*, vol. 17, no. 4, pp. 175–189, Oct. 2016, doi: 10.17718/tojde.25498.
[22] L. S. Castillo, "Call of duty: a case study of ICT integration in Philippine provincial public schools in San Isidro Davao oriental post K-12 implementation," *JPAIR Multidisciplinary Research*, vol. 30, no. 1, pp. 1–16, Oct. 2018, doi: 10.7719/jpair.v30i1.551.
[23] H. E. Abungu, M. I. O. Okere, and S. W. Wachanga, "The effect of science process skills teaching approach on secondary school students' achievement in chemistry in Nyando District, Kenya," *Journal of Educational and Social Research*, vol. 4, no. 6, pp. 359–372, Sep. 2014, doi: 10.5901/jesr.2014.v4n6p359.
[24] C. T. K. Tilakaratnea and T. M. S. S. K. Y. Ekanayake, "Achievement level of science process skills of junior secondary students: based on a sample of grade six and seven students from Sri Lanka," *International journal of Environmental Science and Technology*, vol. 12, no. 9, pp. 2089–2108, 2017.
[25] P. Sermsirikarnjana, K. Kiddee, and P. Pupat, "An integrated science process skills needs assessment analysis for Thai vocational students and teachers," *Asia-Pacific Forum on Science Learning and Teaching*, vol. 18, no. 2, pp. 1–26, 2017.
[26] K. Changwong, A. Sukkamart, and B. Sisan, "Critical thinking skill development: analysis of a new learning management model for Thai high schools," *Journal of International Studies*, vol. 11, no. 2, pp. 37–48, Jun. 2018, doi: 10.14254/2071-8330.2018/11-2/3.
[27] S. Jaleel and R. P, "A study on the metacognitive awareness of secondary school students," *Universal Journal of Educational Research*, vol. 4, no. 1, pp. 165–172, Jan. 2016, doi: 10.13189/ujer.2016.040121.
[28] V. Harandi, H. E. Sharbabaki, M. A. Dehand, and A. Darehkordi, "The effect of metacognitive strategy training on social skills and problem-solving performance," *Journal of Psychology & Psychotherapy*, vol. 3, no. 4, pp. 1–5, 2013, doi: 10.4172/2161-0487.1000121.
[29] J.-L. Berger, N. Kipfer, and F. Büchel, "Effects of metacognitive intervention in low-performing vocational students," *Journal of Cognitive Education and Psychology*, vol. 7, no. 3, pp. 337–367, Jan. 2008, doi: 10.1891/194589508787724060.
[30] Paryono, "Transferable skills in technical and vocational education and training (TVET) in Brunei Darussalam," *TVET Online Asia*, no. 3, pp. 1–15, 2014.
[31] E. M. Young and L. V. Rodenborn, "Improving communication skills in vocational courses," *Journal of Reading*, vol. 19, no. 5, pp. 373–377, 1976.
[32] M. Abdikarimova, N. Tashieva, A. T. Kyzy, and Z. Abdullaeva, "Developing students verbal communication skills and speech etiquette in English language teaching," *Open Journal of Modern Linguistics*, vol. 11, no. 1, pp. 83–89, 2021, doi: 10.4236/ojml.2021.111007.
[33] R. Darmi and P. Albion, "Enhancing oral communication skills using mobile phones among undergraduate English language learners in Malaysia," in *Mobile learning in higher education in the Asia-Pacific Region*, Singapore: Springer Nature Singapore, 2017, pp. 297–314, doi: 10.1007/978-981-10-4944-6_15.
[34] G. Brunello and L. Rocco, "The effects of vocational education on adult skills, employment and wages: what can we learn from PIAAC?" *SERIEs*, vol. 8, no. 4, pp. 315–343, Nov. 2017, doi: 10.1007/s13209-017-0163-z.
[35] S. Sai'en, T. T. Kiong, J. M. Yunos, L. M. Foong, Y. M. Heong, and M. M. Mohamad, "The needs analysis of learning inventive problem solving for technical and vocational students," *IOP Conference Series: Materials Science and Engineering*, vol. 226, p. 12198, Aug. 2017, doi: 10.1088/1757-899X/226/1/012198.
[36] H. Singmaster, "Teaching collaborative problem-solving skills through career and technical education," *EducationWeek*, 2017. [Online]. Available: https://www.edweek.org/teaching-learning/opinion-teaching-collaborative-problem-solving-skills-through-career-and-technical-education/2017/11 (accessed Dec 19, 2023).
[37] U. Techanamurthy, N. Alias, and D. Dewitt, "Problem-solving skills in TVET: current practices among culinary arts instructors in community colleges in Malaysia," *Turkish Online Journal of Educational Technology*, vol. 2015, pp. 467–475, 2015.
[38] S. Child and S. Shaw, "Collaboration in the 21st century: implications for assessment," *A Cambridge Assessment Publication*, no. 22, pp. 17–22, 2016.
[39] M. G. Gonzales and A. V. Dinagsao, "Collaborative skills of pre-service teachers," *Asia Pacific Journal of Social and Behavioral Sciences*, vol. 17, pp. 1–6, Jan. 2021, doi: 10.57200/apjsbs.v17i2599-4891.221.
[40] R. W. Bybee *et al.*, "The BSCS 5E instructional model: origins, effectiveness, and applications," Colorado Springs, CO: BSCS, 2006. [Online]. Available: https://www.researchgate.net/publication/242363914_The_BSCS_5E_Instructional_Model_Origins_Effectiveness_and_Applications
[41] U. E. Nett, T. Goetz, N. C. Hall, and A. C. Frenzel, "Metacognitive strategies and test performance: an experience sampling analysis of students' learning behavior," *Education Research International*, vol. 2012, pp. 1–16, 2012, doi: 10.1155/2012/958319.
[42] M. Özerk and K. Özerk, "A bilingual child learns social communication skills through video modeling-a single case study in a norwegian school setting," *International Electronic Journal of Elementary Education*, vol. 8, no. 1, pp. 551–566, 2015.
[43] S. Skėrė, A. Žvironienė, K. Juzėnas, and S. Petraitienė, "Optimization experiment of production processes using a dynamic decision support method: a solution to complex problems in industrial manufacturing for small and medium-sized enterprises," *Sensors*, vol. 23, no. 9, p. 4498, May 2023, doi: 10.3390/s23094498.
[44] A. Djunaidi, "Improving collaboration abilities and students' learning outcomes through presentation based cooperative," *Mathematics Education Journal*, vol. 5, no. 1, pp. 37–45, Mar. 2021, doi: 10.22219/mej.v5i1.15246.

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