THE IMPACT OF ESSENTIAL EDUCATIONAL COMPETENCIES DEVELOPMENT IN ACADEMIC PERFORMANCE OF MEDICAL IMAGING TECHNOLOGY MAJORS IN MEDICAL VOCATIONAL AND TECHNICAL COLLEGES IN YUNNAN PROVINCE

Siyu LIANG[1], Sansanee Jasuwan[2]*
[1,2]Department of Education and Society, Institute of Science Innovation and Culture, Rajamangala University of Technology Krungthep, Bangkok, Thailand
*Corresponding author: sansanee.s@mail.rmutk.ac.th

ABSTRACT

In the rapidly evolving landscape of medical education, the cultivation of Essential Educational Competencies has become crucial for ensuring student readiness in both academic and clinical settings. This study focuses on the impact of Essential Educational Competenciesspecifically problem-solving ability, collaboration skills, critical thinking, and self-directed learning on the learning performance of medical imaging technology students enrolled in higher vocational colleges in Yunnan Province, China. The primary aim of this study is to investigate how these four competencies influence students' academic outcomes and to provide evidence-based recommendations for curriculum development in medical vocational education. The study adopts a quantitative research methodology, utilizing a structured questionnaire developed from validated sources. Data were collected from 400 medical imaging technology students through convenience sampling. The research instrument was administered via the Wenjuanxing online platform, and the results were analyzed using Jamovi, focusing on multiple linear regression to assess the strength and significance of each competency's influence. The findings reveal that all four competencies significantly and positively affect learning performance. Among them, self-directed learning emerged as the strongest predictor (β = 0.371, $p < 0.001$), followed by critical thinking (β = 0.259, $p < 0.001$), collaboration skills (β = 0.159, $p < 0.001$), and problem-solving ability (β = 0.127, $p = 0.011$). The overall regression model explains 69.1% of the variance in learning performance ($R^2 = 0.691$), confirming the substantial impact of these competencies. This research highlights the need for integrating skill-based educational strategies into vocational curricula to enhance learning performance and better prepare students for the demands of the healthcare industry.

Keywords: Essential Educational Competencies, Medical Imaging Technology Majors, Problems-Solving Skills

INTRODUCTION

In the evolving landscape of healthcare education, the development of essential skillsincluding problem-solving, critical thinking, collaboration, and self-directed learning has become increasingly important for students, particularly those enrolled in medical imaging technology programs. These programs demand not only the acquisition of theoretical knowledge but also the ability to apply it in dynamic, real-world scenarios. As global work environments become more complex and fast-paced, traditional lecture-based pedagogies have shown limitations in adequately preparing students for these challenges (Cooper & Zmud, 2021). In many vocational and technical colleges across Yunnan Province, instructional methods continue to rely heavily on passive learning, with students primarily receiving and recalling information. This mode of instruction, while efficient for content delivery, often fails to cultivate the competencies required in professional healthcare settings (Howard, 2022).

The purpose of this study is to address the gap by investigating the impact of PBL on the academic performance and skills development of medical imaging technology students in

Yunnan vocational colleges. By assessing how PBL can contribute to learning outcomes, including cognitive, technical and interpersonal skills, this study aims to provide actionable insights for educators, managers and decision makers. In addition, the results of the study are expected to support efforts in curriculum improvement, teacher training and the development of assessment tools suitable for the environment (Robinson et al., 2,000). In this context, understanding the educational impact of PBL is crucial to developing evidence-based teaching strategies that align with national education goals and the evolving needs of the medical industry.

Ultimately, this research contributes to a broader discourse on innovation in vocational education. It emphasizes the need for instructional practices that not only transmit knowledge but also prepare students to adapt to complex, interdisciplinary environments. As China faces increasing healthcare demands driven by demographic shifts and technological advancement, the importance of producing graduates who are not only technically proficient but also capable of critical thought, collaboration, and lifelong learning cannot be overstated. This study, therefore, offers timely, context-specific evidence to inform the ongoing development of medical vocational education in China.

LITERATURE REVIEW

21st Century Skills Framework

The skill framework in the twenty-first Century is designed to meet the changing needs of modern society. It focuses on the skills students need to live and work successfully in a fast-developing world. The traditional education mode often emphasizes memory and passive learning. However, this method no longer meets the needs of the digitalization and globalization era. Today's students must go beyond basic knowledge. They have to think critically, solve problems and adapt quickly.

The framework also focuses on self-guidance. Guide students to be responsible for their own learning. This is important for healthcare professionals who must continue learning throughout their careers. Medical knowledge changes rapidly. New machines have been introduced. New technologies have been developed. Autonomous learning gives students the confidence to explore new tools and methods. It teaches them to set goals, monitor progress, and find resources when needed. In the context of this study, the 21st-century skills framework supports the development of self-directed learning through flexible, student-driven tasks. Students may be asked to study a new imaging method, prepare a report, or present the research results to students. These activities make them responsible for their own learning. It also makes learning more relevant and interesting.

Digital literacy is another important part of the framework. In this study, students are learning medical imaging. This field relies heavily on digital devices. Students must understand how to operate the software, adjust settings, and troubleshoot the system. They must also understand patient privacy and data protection. Digital literacy is not just a technical skill. This is also a responsibility. The 21st-century skills framework ensures that students see technology as a learning tool, not just a machine to use.

Community of Inquiry (CoI) Framework

The Community of Inquiry (CoI) Framework is a widely used model for understanding learning in online and blended environments. Developed by Garrison, Anderson, and Archer, it proposes that meaningful learning occurs when three core elements social presence, cognitive presence, and teaching presence interact (Broadbent, 2017). While originally designed for distance learning, its application has expanded into face-to-face and hybrid classrooms. It helps explain how learners build knowledge, engage with content, and interact with peers and teachers in a structured educational environment.

Importantly, the CoI model is flexible and adaptable. It can be combined with emerging teaching methods, such as the flipped classroom or technology-enhanced learning. In medical imaging technology projects that increasingly use new tools and platforms, CoI has laid the foundation for building an effective interactive learning environment (Tsekhmister et al., 2021). In a word, the community's survey framework provides a powerful tool to shape the career-setting of educational experience. Its focus on social interaction, cognition and teaching helps to create supportive and participatory learning communities. In the context of basic educational ability, it provides a theoretical basis for students to develop problem solving, critical thinking, collaboration and autonomous learning. The next section will explore its application in these core competence areas.

Related Studies

Basic educational competence (EEC) is increasingly recognized as crucial for learners in technical and vocational education. These abilities combine problem-solving, self-regulation, collaboration and critical thinking, all of which contribute to academic and professional success. Hayat et al. (2020) emphasized that medical students who demonstrate strong self-efficacy and emotional regulation skills tend to achieve higher academic performance, reflecting the core component of EEC. Their structural equation model shows that metacognitive strategies and emotions directly affect students' learning styles. Similarly, Broadbent (2017) believes that online learners and blended learners with strong self-regulation strategies perform better than those without such ability. These studies support the development of basic capabilities that can lead to better academic and long-term learning outcomes, especially in high-demand fields such as medical imaging.

Collaboration skills are essential in both academic and clinical settings. In the research of Al Rahmi et al. (2015), social media tools were used as a platform for collaborative learning. Researchers found that the collaboration platform not only enhanced interaction among learners but also improved their academic performance. Their findings suggest that digital collaboration can enhance teamwork, which is a key skill for future health professionals. In addition, Kay and Pasarica (2019) reported that when the technical support environment encourages group discussion and team-based learning, satisfaction among both students and teachers will increase. These results emphasize the view that cooperation fosters motivation, reflection and understanding. In vocational medical education, teamwork is essential in the real-world hospital environment, and cultivating collaboration skills has become an important educational goal.

In medical care education, critical thinking is the core of professional judgment. Huang et al. (2020) explored the application of the flipped classroom teaching method in medical technology training. Their research results show that, in a positive learning environment, students' evidence-based reasoning ability is significantly improved, a core function of critical thinking. Flip learning promotes analytical thinking and reflection by involving students before and during class. In addition, Neroni et al. (2019) found that learners who use analytical learning strategies in distance education environments perform better academically. Their research concluded that critical thinking is closely related to effective strategy use and deep processing. In conclusion, these findings suggest that a structured learning environment that requires independent analysis and decision-making can help medical imaging students develop critical thinking and clinical decision-making skills.

Self-directed learning (SDL) supports lifelong learning, which is crucial in the rapidly changing medical field. Broadbent (2017) emphasized that learners with strong self-regulated learning strategies perform better in online education because they plan, monitor and evaluate their own progress. These are the key features of SDL. Huang et al. (2020) also found that students in flipped classrooms are more likely to seek and apply learning materials beyond classroom content actively. The autonomous teaching method improves the students' preparation and mastery of the teaching content. Hayat et al. (2020) supported this finding by showing that self-regulated emotions and cognitive strategies strongly affect academic achievement. These results confirm that students who better manage their own learning are better prepared for clinical education and workplace needs.

Academic achievement remains the core indicator for measuring the effect of vocational education. Tsekhmister et al. (2021) believe that students who are exposed to interactive online learning and virtual reality platforms achieve higher levels of knowledge retention and application. Their findings are particularly important in medical imaging, as this technology is widely used. Quan Dong Nguyen et al. (2018) also discussed how the time spent on student participation affects learning outcomes. They found that well-designed learning activities, matched with appropriate participation time, significantly improved academic performance. These findings emphasize that not only the content but also the manner and timing of students' participation determine their success. Similarly, Hayat et al. (2020) noted that learning-related emotions and metacognitive strategies are positively correlated with performance. This is consistent with the following view: when basic abilities such as emotion regulation and self-monitoring exist, academic performance will be significantly improved.

The literature review strongly supports the inclusion of basic educational ability in medical vocational education. Collaboration, critical thinking, autonomous learning and learning performance of each variable contribute to building a broader framework that enables students to stand out in clinical and academic environments. With the continuous development of the medical industry, especially in advanced technologies such as medical imaging, training these capabilities is no longer optional; it is necessary. These findings laid the foundation for this study and provided a basis for strengthening the cultivation of students' basic educational abilities in Yunnan medical vocational colleges.

RESEARCH METHODOLOGY

This study employs a quantitative research design focusing on the impact of essential educational competencies on the academic performance of medical imaging technology students at Kunming Medical Vocational and Technical College, Yunnan Province. The research framework was constructed to explore how key competencies—problem-solving, collaboration, critical thinking, and self-directed learning—affect academic success. The researcher ensured a well-structured, time-bound data collection period between May 25 and June 10, 2025, to maintain focus and reliability. These competencies were translated into measurable variables to evaluate their role in enhancing student outcomes in vocational education, particularly within the technical and medical context of China's evolving healthcare workforce.

The study targeted a specific population of 980 students enrolled in the medical imaging technology program at Kunming Vocational College of Health. This population was chosen due to its relevance to the rapidly growing need for skilled imaging professionals in China's healthcare system. The sampling strategy included both purposive and convenience sampling, yielding a final sample of 400 students. This slightly exceeded the required 384 responses (at a 95% confidence level and a 5% margin of error), ensuring accuracy even with incomplete or invalid responses. The sample included students from diverse backgrounds and academic years, providing data diversity while maintaining a focus on those engaged in task-based learning, such as clinical diagnostics and laboratory simulations.

To collect the data, the researcher used two key instruments: Jamovi, an open-source statistical software package, for analysis; and Wenjuanxing, a Chinese online survey platform, to distribute a structured Likert-scale questionnaire. This dual approach facilitated accurate, accessible, and secure data gathering across institutions. The questionnaire design was validated by a panel of three experts using the Item-Objective Congruence (IOC) method, ensuring all items aligned with the intended variables. Items scoring above the 0.67 IOC threshold were retained. Reliability was assessed using Cronbach's Alpha, and all variables (problem-solving, collaboration, critical thinking, self-directed learning, and learning performance) had Cronbach's Alpha scores above 0.8, confirming high internal consistency.

Data analysis followed two steps: descriptive statistics were used to summarize general patterns, including means and standard deviations for each variable, along with demographic breakdowns; then inferential statistics, specifically multiple linear regression, were conducted to examine the strength and direction of the influence of each independent variable on student performance. Regression outputs included beta coefficients (β), p-values, and R^2 scores. This allowed for determining which competencies most significantly influence academic outcomes, guiding practical improvements in vocational education. The goal was not only to reveal statistically significant relationships but also to provide actionable insights for educators and policymakers aiming to optimize medical imaging training programs in China's higher vocational institutions.

The hypotheses are proposed:

H1: Problem-solving ability has a significant positive effect on students' academic performance.

H2: Collaboration skills have a significant positive effect on students' academic performance.

H3: Critical thinking ability has a significant positive effect on students' academic performance.

H4: Self-directed learning has a significant positive effect on students' academic performance

FINDINGS

To investigate the influences of Essential Educational Competencies on learning performance using a quantitative method

Table 1: Descriptive Statistics of Essential Educational Competencies

Item	Mean	Standard Deviation	Rank	Meaning
PSA1	4.04	0.83	2	Agree
PSA2	3.93	0.85	5	Agree
PSA3	4.02	0.86	3	Agree
PSA4	4.00	0.82	4	Agree
PSA5	4.08	0.85	1	Agree
Overall	4.02	0.80	-	Agree

The PSA5 project, with the highest average score (M=4.08), shows that students will have a strong sense of achievement after solving challenging problems. This emotional reward shows that solving complex problems is not only a task but also a source of internal motivation, which may further strengthen participation in problem-solving activities. In contrast, PSA2 (M=3.93) has the lowest score. PSA2 refers to the ability to propose multiple solutions. This result may indicate that although students are confident in solving problems, they may struggle to find diverse or creative solutions, possibly because the course offers limited types of open problems.

The relatively high scores of PSA1 (M=4.04) and PSA4 (M=4.00) indicate that students can identify root causes and apply theory to practical problems. This reflects the close relationship between analytical thinking and the application of knowledge. At the same time, PSA3 (M=4.02) indicates that students prefer to address real-world problems in the classroom, consistent with the increasing emphasis on experiential and project-based learning. In conclusion, these results indicate that although students are usually capable problem solvers, courses can be strengthened by including activities that promote divergent thinking and solution generation skills.

To investigate the influences of collaboration skills on learning performance using a quantitative method

Table 2: Descriptive Statistics of Collaboration Skills

Item	Mean	Standard Deviation	Rank	Meaning
CS1	4.13	0.78	1	Agree
CS2	4.05	0.81	4	Agree
CS3	4.13	0.78	1	Agree
CS4	4.09	0.82	2	Agree
CS5	4.08	0.82	3	Agree
Overall	**4.096**	**0.802**	-	Agree

The items CS1 and CS3 with the highest scores (M=4.13) show that students are particularly outstanding in the basic characteristics of group dynamic emotional intelligence, which are active listening and valuing peer views. These results show that cooperation is not only functional, but also respectful and open. Students are not only listening to others' voices but also handling and appreciating what others say, which may contribute to more harmonious, productive team cooperation.

CS2 (M=4.05) is slightly lower but still higher, indicating that students are contributing their ideas. However, this small decline may mean they are hesitant to engage in more confident oral participation compared with behaviors they are more likely to accept (such as listening). The remaining projects - CS4 (M=4.09) on team effectiveness, CS5 (M=4.08) on improving learning ability from group activities, emphasizing the belief that collaboration promotes individual and collective results. Overall, the pattern suggests that students feel both competent and comfortable in cooperative environments, but structured leadership or peer facilitation training could enhance their expressive contributions during group work.

To investigate the influences of critical thinking on learning performance using a quantitative method.

Table 3. Descriptive Statistics of Critical Thinking

Item	Mean	Standard Deviation	Rank	Meaning
CT1	3.97	0.87	4	Agree
CT2	3.96	0.82	5	Agree
CT3	4.04	0.81	2	Agree
CT4	4.02	0.83	3	Agree
CT5	4.05	0.82	1	Agree
Overall	4.008	0.83	-	Agree

Among the critical thinking items, CT5 (M = 4.05) received the highest score, showing that students feel confident making decisions based on critical analysis. This suggests that they are not just absorbing content but processing it to form their own reasoned judgments. Close behind, CT3 (M = 4.04) and CT4 (M = 4.02) indicate that students can analyze arguments and reflect on their learning process skills that indicate metacognitive engagement and a deeper level of academic maturity.

However, the slightly lower scores on CT1 (M = 3.97) and CT2 (M = 3.96) suggest less frequent practice of challenging presented information or questioning ideas. These tasks require a higher level of cognitive risk-taking and classroom empowerment, which some students may not yet feel comfortable with. This gap suggests that critical thinking is better developed in post-evaluation stages (decision-making, reflection) than in the initial information processing stages (evaluation, questioning). Instructors may want to scaffold more debate, inquiry-based learning, or Socratic questioning techniques to strengthen these early-stage critical skills.

To investigate the influences of self-directed learning on learning performance using a quantitative method

Table 4: Descriptive Statistics of Self-Directed Learning

Item	Mean	Standard Deviation	Rank	Variable
SDL1	4.05	0.81	1	Agree
SDL2	3.98	0.86	2	Agree
SDL3	3.96	0.82	3	Agree
SDL4	3.99	0.83	4	Agree
SDL5	3.99	0.83	5	Agree
Overall	3.994	0.83	-	Agree

SDL1 (M = 4.05), which reflects students' ability to set clear learning goals, ranks the highest. This finding suggests that most students possess a solid foundation in planning and structuring their academic efforts. However, items SDL2 through SDL5, while still near or slightly below the 4.00 mark, reflect slightly weaker but consistent behaviors related to self-initiative and reflective practice. SDL3 (M = 3.96), for instance, shows that fewer students are exploring content beyond what is taught—an area that may require more encouragement toward curiosity-driven or passion-based learning.

The other items—SDL2 (M = 3.98) on resource-seeking, SDL4 (M = 3.99) on progress assessment, and SDL5 (M = 3.99) on intrinsic motivation—suggest that students are moderately active in managing their own learning but may need more structured support, such as checklists, portfolios, or guided journaling, to enhance these habits. The results indicate a promising base for autonomous learning but also highlight the need for more explicit training in self-monitoring and academic risk-taking to foster lifelong learning habits.

Table 5: Multiple Linear Regression Result

Model	**R**	**R Square**	**Adjusted R-Square**	**Std. Error of the Estimate**
1	.831a	.691	.689	.3166699

Predictors: (Constant), SDL, CS, CT, PSA

Model	**Coefficient**			**t-value**	**p-value**
	Unstandardized Coefficients		**Standardized Coefficients**		
	B	**Std.Error**	**Beta**		
Constant	.612	.116		5.254	.000
X1 = Problem Solving	.118	.046	.127	2.565	.011
X2 = CollaborationSkills	.163	.043	.159	3.835	.000
X3= CriticalThinking	.248	.046	.259	5.332	.000
X4 = Self-Directed Learning	.337	.043	.371	7.872	.000

a. Dependent variable Y: Learning Performance

Based on the linear regression analysis, the overall model demonstrates strong predictive ability for the dependent variable—Learning Performance. The correlation coefficient (R) is 0.831, indicating a strong positive relationship between the independent variables (Problem Solving, Collaboration Skills, Critical Thinking, and Self-Directed Learning) and learning performance. The R-square value is 0.691, indicating that approximately 69.1% of the variance in students' learning performance is explained by the four predictors in the model. This is further supported by the Adjusted R-Square value of 0.689, which adjusts for the number of predictors in the model, confirming that the model remains robust even after accounting for degrees of freedom.

Among the individual predictors, Self-Directed Learning (X4) emerged as the strongest contributor, with a standardized Beta coefficient of 0.371 and a highly significant t-value of 7.872 ($p < .001$). This implies that students who exhibit higher levels of self-direction in their learning processes tend to perform better academically. The magnitude of the effect suggests that enhancing self-directed learning strategies could be a key driver of improving overall student competency, especially in vocational settings where independent learning is critical.

Critical Thinking (X3) also plays a substantial role, showing a Beta of 0.259 with a t-value of 5.332 ($p < .001$). This suggests that students who develop higher-order thinking skills, such as the ability to analyze, evaluate, and apply knowledge, perform better academically. In a practical context, integrating exercises and instructional strategies that promote critical thinking—such as problem-based learning or analytical discussions—may significantly boost performance outcomes.

Collaboration Skills (X2) and Problem Solving (X1), although showing slightly smaller effects, still contribute significantly to learning performance. Collaboration Skills had a Beta of 0.159, with a t-value of 3.835 ($p < .001$), suggesting that teamwork and peer interaction are essential in building competencies within medical imaging programs. Problem Solving had the smallest Beta of 0.127 but remained statistically significant ($t = 2.565$, $p = .011$), indicating that the ability to navigate academic and clinical challenges is still a key, though relatively less influential, component.

DISCUSSION

The statistical outcomes align with the study's assumptions. The assumption was that all four components problem-solving, collaboration, critical thinking, and self-directed learning would have significant effects on learning performance. The data confirms this, as all variables are positively associated with learning performance and statistically significant ($p < 0.05$). Additionally, the variance explained by the model (R^2 not shown but inferred to be substantial) suggests a well-fitted model. Furthermore, the assumption that self-directed learning would be the most dominant predictor is supported by its beta value of 0.3714, which is the highest among all. This affirms the conceptual model proposed in the research and indicates that the development of internal motivation and self-managed learning strategies is a key driver of performance in medical education.

CONCLUSION

The quantitative results of this study offer clear and strong evidence that Essential Educational Competencies significantly influence students' learning performance in Chinese higher vocational colleges, particularly among medical imaging technology majors. According to the multiple linear regression analysis, the overall model demonstrates high explanatory power, with an R value of 0.831 and R Square of 0.691. This indicates that approximately 69.1% of the variance in learning performance is explained by the four predictors: Problem Solving, Collaboration Skills, Critical Thinking, and Self-Directed Learning. The Adjusted R Square of 0.689 further confirms the model's stability and robustness, accounting for the number of predictors.

For Research Question 1.2.1, "Do Essential Educational Competencies have significant influences on learning performance?" the answer is clearly affirmative. All four competency variables demonstrated statistically significant relationships with learning performance (p <

0.05), supporting Objective 1.4.1. The regression model confirms that these competencies collectively form a strong and reliable predictor set. This underscores the importance of building core educational competencies to enhance academic outcomes in vocational training programs.

For Research Question 1.2.2, "In what way do collaboration skills, such as group learning skills, have significant influences on learning performance?", the findings show a standardized beta coefficient of 0.159, with a t-value of 3.835 and $p < 0.001$. This indicates a moderate yet significant positive influence. Students who actively participate in group discussions, share ideas, and respect peer input tend to achieve better academic results. These findings support Objective 1.4.2 and emphasize the essential role of teamwork in medical education, given the common interprofessional collaboration in clinical practice.

Research Question 1.2.3 focuses on critical thinking. The results show that Critical Thinking has a standardized coefficient of 0.259, with a t-value of 5.332 and $p < 0.001$, making it one of the stronger predictors. This supports Objective 1.4.3. Students who engage in reflection, evaluation, and in-depth analysis are more likely to apply knowledge effectively in both theoretical exams and practical scenarios. In medical imaging, where interpreting complex data is routine, critical thinking is a critical asset.

Research Question 1.2.4 asks about the role of self-directed learning. Here, Self-Directed Learning produced the highest standardized beta coefficient (0.371), with a t-value of 7.872 and $p < 0.001$, making it the most influential predictor of learning performance. This supports Objective 1.4.4. Students who set their own learning goals, seek out resources, and monitor their progress tend to excel academically. The strength of this relationship emphasizes the need to foster autonomy and responsibility in learning—particularly in vocational education settings where self-initiative often determines success in real-world job applications.

Although Problem Solving showed the lowest effect among the four predictors, it still holds statistical significance (Beta = 0.127, $t = 2.565$, $p = 0.011$). This confirms its contribution to academic performance and aligns with the broader concept of Essential Educational Competencies. Students who can identify root causes, propose solutions, and apply theoretical understanding to real-world problems are better equipped to handle academic and clinical challenges, even if the impact is slightly less than that of other competencies.

Overall, these findings confirm a multifaceted relationship between educational competencies and learning performance. Each competency contributes uniquely, and together, they account for a substantial portion of students' academic success. This provides compelling evidence for curriculum reforms that emphasize not only content mastery but also the cultivation of broader learning skills, such as collaboration, critical thinking, and self-direction. These results offer actionable insights for educators, curriculum designers, and policymakers aiming to improve student outcomes in medical vocational education.

RECOMMENDATION

1. Problem-Solving: Integrate Real-World Medical Scenarios into Courses
   To enhance students' problem-solving abilities, vocational medical colleges should introduce simulation-based learning environments that mirror real-world challenges in medical imaging. Instructors can use problem-based modules featuring clinical cases in

which students must analyze symptoms, select imaging techniques, and interpret results collaboratively.

2. Collaboration skills: promote structured peer learning projects. Improving collaboration skills requires structured team activities with clear roles and objectives. In medical imaging courses, students can be assigned to team roles in turn, such as "Chief Analyst", "Program Manager," or "Report Writer" in joint laboratory projects or case reviews.
3. Critical thinking: cultivate reflective practice and inquiry learning. To foster critical thinking, medical imaging courses should include activities that require students to question assumptions, evaluate multiple sources, and conclude limited or ambiguous data
4. Autonomous learning: Establish a learning contract and a digital portfolio. Given the strong impact of self-directed learning on performance, we should systematically encourage it through learning contracts, digital learning portfolios and other tools. Each student can create a semester-long learning plan that outlines personal goals, schedules, and strategies. Teachers act as facilitators, regularly checking progress and providing feedback.
5. Learning performance: combine assessment with competency-based education. To improve overall academic performance, assessment should be closely aligned with basic educational skills, not just theoretical knowledge. Examinations and assignments should measure not only knowledge recall but also problem-solving, teamwork, critical thinking and autonomous learning.

REFERENCES

Al-Rahmi, W., Othman, M. S., & Yusuf, L. M. (2015). The Role of Social Media for Collaborative Learning to Improve Academic Performance of Students and Researchers in Malaysian Higher Education. *The International Review of Research in Open and Distributed Learning, 16*(4). https://doi.org/10.19173/irrodl.v16i4.2326

Assimos, D., Krambeck, A., Miller, N. L., Monga, M., Murad, M. H., Nelson, C. P., Pace, K. T., Pais, V. M., Pearle, M. S., Preminger, G. M., Razvi, H., Shah, O., & Matlaga, B. R. (2016). Surgical Management of Stones: American Urological Association/Endourological Society Guideline, PART I. *Journal of Urology*, *196*(4), 1153–1160. https://doi.org/10.1016/j.juro.2016.05.090

Becker, G. (2000). Creating Comparability Among Reliability Coefficients: The Case Of Cronbach Alpha And Cohen Kappa. *Psychological Reports*, *87*(7), 1171. https://doi.org/10.2466/pr0.87.7.1171-1182

Bohland, M. A., O'Shaughnessy, S., Draze, D., & Sonsie Conroy. (2006). *Problem-based learning: mystery disease*. Prufrock Press.

Broadbent, J. (2017). Comparing Online and Blended learner's self-regulated Learning Strategies and Academic Performance. *The Internet and Higher Education*, *33*(33), 24–32. https://doi.org/10.1016/j.iheduc.2017.01.004

Brotherton, S. E., & Etzel, S. I. (2022). Graduate Medical Education, 2021-2022. *JAMA*, *328*(11), 1123–1146. https://doi.org/10.1001/jama.2022.13081

Brotherton, S. E., & Etzel, S. I. (2023). Graduate Medical Education, 2022-2023. *JAMA*, *330*(10), 988. https://doi.org/10.1001/jama.2023.15520

Cooper, R. B., & Zmud, R. W. (2021). Information Technology Implementation Research: A Technological Diffusion Approach. *Management Science*, *36*(2), 123–139.

Etty-Leal, J. (2021). Making mindfulness matter to children: Holistic, heartfelt, and creative mindful education. *The Humanistic Psychologist*, *49*(1), 190–201. https://doi.org/10.1037/hum0000184

Hayat, A. A., Shateri, K., Amini, M., & Shokrpour, N. (2020). Relationships between academic self-efficacy, learning-related emotions, and metacognitive learning strategies with academic performance in medical students: a structural equation model. *BMC Medical Education*, *20*(1). https://doi.org/10.1186/s12909-020-01995-9

Howard, D. E. (2022). Continuing Medical Education Questions: January 2022. *American Journal of Gastroenterology*, *117*(1), 25–25. https://doi.org/10.14309/ajg.0000000000001578

Huang, H.-L., Chou, C.-P., Leu, S., You, H.-L., Tiao, M.-M., & Chen, C.-H. (2020). Effects of a quasi-experimental study of using the flipped classroom approach to teach evidence-based medicine to medical imaging technology students. *BMC Medical Education*, *20*(1). https://doi.org/10.1186/s12909-020-1946-7

Kay, D., & Pasarica, M. (2019). Using technology to increase student (and faculty satisfaction with) engagement in medical education. *Advances in Physiology Education*, *43*(3), 408–413. https://doi.org/10.1152/advan.00033.2019

Neroni, J., Meijs, C., Gijselaers, H. J. M., Kirschner, P. A., & de Groot, R. H. M. (2019). Learning strategies and academic performance in distance education. *Learning and Individual Differences*, *73*, 1–7. https://doi.org/10.1016/j.lindif.2019.04.007

Quan Dong Nguyen, Huptych, M., & Rienties, B. (2018). Linking students' timing of engagement to learning design and academic performance. *Learning Analytics and Knowledge*. https://doi.org/10.1145/3170358.3170398

Rakesh, V. P., & Juyal, R. P. (2018). Challenges to Skill Development: A Gandhian Perspective. *Contemporary Social Sciences*, *27*(1), 135–144. https://doi.org/10.29070/27/57223

Robinson, E. H., Jones, K. D., & Hayes, B. G. (2000). Humanistic Education to Character Education: An Ideological Journey. *The Journal of Humanistic Counseling, Education and Development*, *39*(1), 21–25. https://doi.org/10.1002/j.2164-490x.2000.tb00089.x

Tsekhmister, Y. V., Konovalova, T., Tsekhmister, B. Y., Agrawal, A., & Ghosh, D. (2021). Evaluation of Virtual Reality Technology and Online Teaching System for Medical Students in Ukraine During the COVID-19 Pandemic. *International Journal of Emerging Technologies in Learning (IJET)*, *16*(23), 127–139. https://doi.org/10.3991/ijet.v16i23.26099

Vieira, P. C. (2016). T-Test with Likert Scale Variables. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2770035