ŌTAUTAHI CHRISTCHURCH AOTEAROA NEW ZEALAND
35TH AUSTRALASIAN ASSOCIATION FOR ENGINEERING EDUCATION ANNUAL CONFERENCE
8-11 DEC 2024
THE ENGINEER AND THE WORLD

A Hybrid Assessment Design Framework for Collaborative Learning

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ABSTRACT

CONTEXT

Collaborative learning is recognised for enhancing student engagement, success, and learning experiences by fostering peer interaction and developing essential skills. However, challenges like social loafing can undermine its effectiveness. This study introduces a hybrid assessment design framework that addresses these issues, emphasising individual contributions in a group work to maximise the benefits of collaborative learning.

PURPOSE OR GOAL

This study aims to evaluate the effectiveness of the proposed assessment design framework in integrating collaborative learning and enhancing student outcomes and experiences. This is achieved by implementing the framework in System Software (11489), a second-year software engineering unit at the University of Canberra, and comparing student performance and satisfaction before and after its integration.

APPROACH OR METHODOLOGY/METHODS

Student performance in take-home assignments and invigilated assessments, and overall unit marks were analysed to evaluate the framework's effectiveness in promoting collaborative learning and improving student outcomes. Additionally, quantitative and qualitative data on student satisfaction were examined to gauge the impact of the collaborative learning approach and evaluation mechanisms on learning experience.

ACTUAL OR ANTICIPATED OUTCOMES

The results provide valuable insights into the relationship between assessment strategies, student outcomes and learning experience. Integration of collaborative learning through implementation of the hybrid assessment design framework significantly improves student performance and learning experiences. These findings highlight the effectiveness of the framework for integrating collaborative learning in engineering curriculum.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

The shift to collaborative learning through group assessments following the hybrid design framework improves student performance and satisfaction, demonstrating the value of structured group work and evaluation mechanisms for assessing individual contributions in promoting collaborative learning. These findings support the continued refinement and implementation of collaborative learning to foster an inclusive educational environment.

KEYWORDS

Collaborative learning, assessment design, student outcomes, learning experience.

Introduction

Collaborative learning is widely recognised for its ability to enhance student engagement, success, and learning experiences (Johnson, 1991; Springer et al., 1999). By encouraging peer interaction, it leverages diverse skills and knowledge to foster a deeper understanding of the subject matter. These environments not only promote active participation and critical thinking but also develop interpersonal skills essential for both academic and professional success (Fuchs et al., 1997).

The benefits of collaborative learning are well-documented (Laal & Ghodsi, 2012). Students often display higher motivation and a stronger sense of belonging within their academic community (Freeman et al., 2007). Collaborative settings have been shown to improve retention rates and academic performance (Springer et al., 1999), while also preparing students for the workforce by enhancing their teamwork abilities—skills highly valued across many professions (Boud, 2015).

However, collaborative learning is not without challenges, particularly social loafing (Latané et al., 1979). Effective facilitation and evaluation by instructors are crucial in addressing these issues and fostering an inclusive and productive learning environment (Webb, 2009; Aggarwal & O'Brien, 2008; Kreijns et al., 2003). Peer evaluation has been a common approach to managing social loafing and promoting successful collaboration (Tosuntaş, 2020; Rajaguru et al., 2020), yet concerns about peer bias affecting such evaluations remain (Sherrard et al., 1994; Baker, 2008).

To address these challenges and further enhance collaborative learning, this study proposes a hybrid assessment design framework. This framework aligns assessment strategies with collaborative learning objectives, ensuring that assessments not only evaluate individual performance but also promote essential skills such as teamwork, communication, and problem-solving. By incorporating mechanisms that emphasise individual contributions within group work, the hybrid framework addresses common pitfalls like unequal participation and peer bias.

The effectiveness of this framework was investigated through its implementation in a second-year software engineering unit at the University of Canberra. Quantitative results were used to assess the impact of assessment strategies on collaborative learning, student outcomes, and satisfaction. Qualitative data from student feedback were also examined to corroborate the quantitative results.

Hybrid Assessment Design Framework

To overcome the challenges and fully leverage the benefits of collaborative learning, the framework combines group and individual evaluation components, as shown in Figure 1.

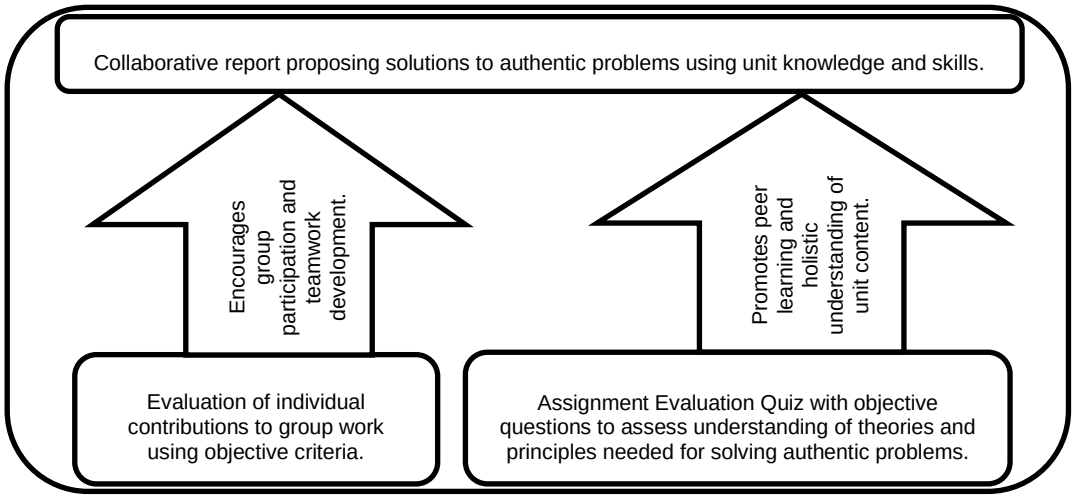

Figure 1: Conceptual diagram of the hybrid assessment design framework

The key components of the framework include authentic assessments, collaborative tasks, an evaluation quiz, peer evaluation, scaffolded learning activities, and a structured group formation process. These elements are strategically combined to enhance student engagement, promote peer learning, and ensure fair assessment of individual contributions within group work (Smith, 1996).

Authentic Assessments

To effectively engage students, it is crucial to demonstrate the relevance of their learning. Authentic assessments play a key role in this by requiring students to apply their knowledge and skills to practical situations, thereby motivating them and fostering active learning (Wiggins, 1998). These assessments should reflect real-world scenarios, whether conducted individually or collaboratively, allowing students to solve practical problems using the concepts they have learned.

The suitability of subjects for collaborative learning depends on the complexity of the content and the level of cognitive engagement required, as outlined in Bloom's Taxonomy. Advanced subjects that involve higher-order thinking skills such as analysis, synthesis, and evaluation are particularly well-suited for project- or problem-based learning. In these subjects, tasks are often interconnected, where the output of one phase feeds into the next, fostering a continuous collaborative process essential for solving complex problems (Hmelo-Silver, 2004; Wright, 1986).

While introductory subjects typically focus on lower-order thinking skills like memorisation and basic comprehension, collaborative learning can still be effective in first-year units. Well-structured group work can help first-year students build connections and develop key graduate attributes (Beccaria et al., 2014). The challenge lies in designing collaborative assessments that require meaningful group effort, drawing on the diverse skills and perspectives of all participants to encourage true collaboration regardless of the unit level (Johnson & Johnson, 1987).

Collaborative Task

The collaborative task includes a set of authentic problems covering a significant portion of unit content, culminating in a group report. This report is assessed holistically against a rubric, without attributing specific marks to individual members. The number of problems (sub tasks) in the collaborative task dictates group size, ensuring an equitable distribution of work and promoting active participation from all group members. To prevent students from working in isolation on separate tasks, mechanisms must be in place to encourage collective engagement (Slavin, 1996).

Evaluation Quiz

Following the collaborative task, an individual evaluation quiz assesses each student's understanding of the material. This quiz consists of objective questions designed to test students' comprehension and application of the underlying theories and principles. It ensures that all group members are accountable for the entire task, encouraging them to engage with their peers' work and promoting peer learning (Wood et al., 1976).

Peer Evaluation

To mitigate the issue of unequal participation or social loafing, an objective peer evaluation (PE) system, shown in Table 1, is required. The purpose of the peer evaluation scheme is to promote teamwork and the development of associated skills rather than measuring students' mastery of subject matter.

Table 1: Objective Peer Evaluation scheme

Evaluation Criteria	Ratings			Score (%)
Cooperation on common goal	Excellent (21 -25) Not only fully cooperates on common goal but takes the initiative to work towards achieving set objectives.	Good (16 - 20) Mostly cooperates on common goal and works towards achieving set objectives.	Minimal (0 - 15) Rarely cooperates on common goal and works towards achieving set objectives.	Max 25
Communication with team members	Excellent (21 -25) Actively communicates with team members and provides updates.	Good (16 - 20) Communicates with team members intermittently.	Minimal (0 - 15) Hardly communicates with team members.	Max 25
Meeting attendance	Excellent (21 -25) Attended almost all team meetings and actively contributed to discussions.	Good (16 - 20) Attended most meetings made reasonable contributions to discussions.	Minimal (0 - 15) Attended a few meetings and barely contributed to discussions.	Max 25
Task completion	Excellent (21 -25) Completed all assigned tasks timely and satisfactorily.	Good (16 - 20) Completed most assigned tasks satisfactorily and with minimal delay.	Minimal (0 - 15) Completed some of the assigned tasks with significant delay.	Max 25
				0 - 100

This system quantifies individual contributions based on criteria such as cooperation, communication, and overall contribution to group goals. The Individual Contribution Score (ICS), calculated from these evaluations, adjusts the group report grade to reflect each member's contribution:

$$\text{ICS} = \text{Average (Peer Evaluation Scores)}$$

$$\text{Weighted Report Mark} = \text{ICS} \times \text{Report Mark}$$

A student's overall mark for the assignment is then determined as follows:

$$\text{Assignment Mark} = \text{Weighted Report Mark} + \text{AEQ Mark}$$

This method promotes accountability by ensuring that grades reflect individual effort and contribution (Johnson & Johnson, 1987), while also encouraging all group members to engage with the topics covered in the group work (Tosuntaş, 2020; Rajaguru et al., 2020). The Assignment Evaluation Quiz (AEQ) complements the peer evaluation system, as each group member must fully understand all aspects of the group work to succeed in the quiz. If a group member fails to complete their assigned tasks, it negatively affects not only the group work but also the AEQ results for everyone. Although peer bias cannot be completely ruled out, it is less likely that group members will give high scores to peers who did not complete their tasks, as doing so would work against their own interests.

It should be noted that while a group report may receive full marks, the Individual Contribution Scores (ICS) for all group members could be less than 100%, meaning no one in the group would achieve full marks. This reflects that, despite mastering the subject matter and producing an excellent report, group members may still need to further develop key teamwork skills.

Scaffolding Learning Activities

To support students in meeting the challenges of collaborative tasks, it is important to integrate scaffolded learning activities into the curriculum. These activities should be designed to develop the necessary skills for the collaborative tasks, aligning tutorial and lab sessions with the assessment tasks. This scaffolding encourages continuous engagement and allows students to apply their acquired knowledge and skills effectively in their collaborative work.

Group Formation

Effective group formation and determining optimal group size are crucial to the success of collaborative learning. To address common challenges, a deliberate and structured process needs to be implemented. Students should be given sufficient information about the group assessment task and ample time during tutorials and labs to interact with their peers before forming their own groups. This allows them to make informed decisions about group membership, fostering better collaboration. Those who do not form a group within the given timeframe can be randomly put into groups by the unit convenor.

As mentioned previously, group size can typically be aligned with the number of tasks in the assignment to ensure a fair distribution of workload. However, a minimum of three members is recommended, as it guarantees each student receives at least two peer evaluations, leading to a more accurate assessment of individual contributions. This approach also reduces the likelihood of a student being left to complete the assignment alone in case of dropouts and minimises the need for unit convenor intervention. While dropout rates can be higher in elective units, potentially disrupting group dynamics and requiring more active management by the unit convenor, this structured group formation process minimises such risks.

Although this study does not explore the impact of different group formation methods on group dynamics and collaboration, there is no clear evidence on how social loafing behaviours differ between groups formed by students and those assigned by the convenor. Understanding these effects would require further investigation.

Effectiveness of the Framework

The hybrid assessment design framework was implemented in System Software (11489), a second-year software engineering unit, focused on modern operating systems design principles and their application in software development. The unit content is well-suited for designing authentic assessment tasks involving application of principles such as synchronisation and mutual exclusion for developing efficient applications that produce accurate and consistent output.

Previously, the unit assessments consisted solely of individual tasks, including two assignments and a final exam. Overall student performance was poor, and there was a significant disparity between results in take-home and invigilated assessments, raising concerns about academic integrity. To address these issues, the assessments were redesigned using the hybrid framework to integrate collaborative learning. This shift significantly improved overall student performance and narrowed the gap between take-home and invigilated assessment results.

The new group assignment featured four tasks, each requiring the application of concepts learned in the unit to solve practical problems in programming. Students were informed in Week 1 about the collaborative learning approach and evaluation methods, with the assignment details published early, giving them ample time to form groups of four by the end of Week 5. Students who had not formed groups by the deadline were randomly assigned by the unit convenor.

Peer evaluations followed the group report submission, requiring members to assess their peers. Although this comprehensive approach required early planning and execution, it significantly reduced the convenor's workload in managing group dynamics and grading.

The analysis below compares assessment strategies before and after the introduction of collaborative learning using the hybrid framework. Quantitative data on student performance and experience were analysed, providing a comprehensive understanding of these pedagogical changes driven by the hybrid assessment design framework, corroborated by student feedback.

Student Performance in Assessments

The assessments in the System Software unit were redesigned using the proposed assessment design framework to integrate collaborative learning and address a significant gap in student performance between take-home and invigilated assessments. The data shows substantial improvements in student outcomes for both the Take-Home assignment (Report) and the Invigilated assessment (AEQ), as well as an overall improvement in student performance in the unit, as depicted in Figure 2.

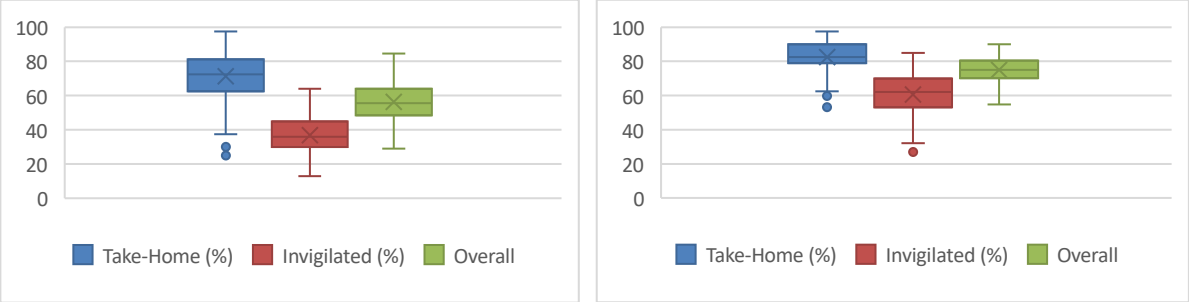

Figure 2: Comparison of marks in Take-Home and Invigilated assessments before (left) and after (right) integration of collaborative learning

Student Feedback and Satisfaction

Student experience and performance data for this study were obtained from a university-wide survey conducted during teaching periods. Table 2 summarises the number of enrolments in the unit (N), survey participants (n), and the corresponding response rate.

Table 2: Summary of enrolments in the unit and participation in surveys

Year	Before	After
Number of enrolments (N)	126	104
Participants in surveys (n)	36	40
Response rate	28.7%	38.5%

Student satisfaction, calculated as the percentage of responses that strongly agreed (SA) or agreed (A) relative to the total number of responses (n), i.e., (SA + A) / n, improved significantly from 77% to 92% after the integration of collaborative learning, as shown in Figure 3. This high satisfaction level reflects positive student perceptions of the assessment strategy in the unit.

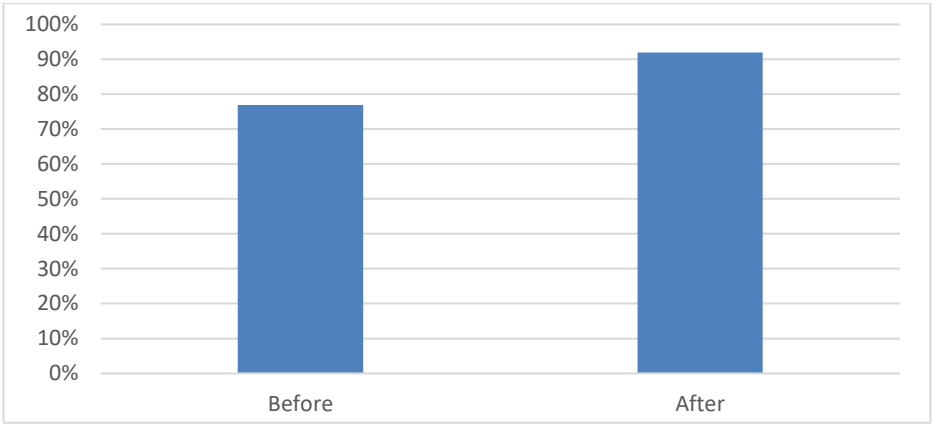

Figure 3: Comparison of student satisfaction in the unit before and after the integration of the collaborative learning

The correlation between high satisfaction and improved performance underscores the effectiveness of the implemented assessment strategies in fostering a positive learning environment that supports student success. Overall, the analysis indicates that the introduction of collaborative learning approaches, particularly through structured group work and evaluation mechanisms that promote fairness and individual accountability, has had a substantial positive impact on student performance and satisfaction. These findings support the continued use and further refinement of such strategies to enhance learning outcomes and student experiences.

Discussion

The redesign of assessment strategies in the unit highlights the impact of collaborative learning on student outcomes. The data demonstrate clear improvements in both performance and satisfaction, aligning with the principles of active learning and engagement in higher education.

Student Success

The significant increase in student performance reflects the effectiveness of well-designed collaborative assessment strategies. This aligns with the goals of inclusive education and highlights the potential of collaborative learning to elevate overall student achievement, as affirmed by student feedback.

> *Overall, I believe the assignment's structure as a group work with an evaluation quiz effectively promoted collaborative learning by providing a great opportunity for us to engage in meaningful discussion, exchange insights, and explain our understanding of the topics which also solidified our own grasp of the concepts. Through active participation and contribution, we were able to gain different perspectives from each other, which broadened our own understanding of the concepts. Additionally, the final evaluation quiz has also motivated each group member to be accountable for their contributions and critically evaluate our own understanding of the subjects.*

Student Experience

High student satisfaction indicates that students positively perceived the changes in assessment strategies, as eloquently summarised by student comments.

> *…a group assignment designed to encourage collaborative learning and teamwork. Our group decided that the best way to approach this assignment was to do our individual research and then get into discussion meetings to put forth our ideas on the table. The structure of the unit and the assignment helped us develop our retention capacity and improved our communication and team skills. It was a gateway into the importance of accommodating diverse perspectives and increased problem-solving skills. I enjoyed doing this unit and learnt a lot.*

Implications for Teaching and Learning

The findings underscore the benefits of a well-rounded assessment strategy that includes both individual and collaborative elements. The use of an objective peer evaluation scheme in conjunction with AEQ has been shown to be effective in ensuring individual accountability within group work, thereby addressing common concerns such as unequal participation, free riding and peer bias. The improvement in student performance and satisfaction levels further supports the effectiveness of this approach in enhancing student learning and experience.

The data also highlight the importance of scaffolding learning activities to prepare students for both collaborative and individual assessments. Ensuring that students are equipped with the necessary skills and knowledge to succeed in various assessment formats is crucial for their overall academic development, as corroborated by student feedback.

> *The way this unit has integrated the lecture material with the tutorial and final assignment has been the most effective approach I've ever experienced. When working on the assignment, I felt well-equipped and had a good understanding of the content. Most units fail to apply the complete learning cycle, so it was a pleasant surprise to see it implemented here. I eagerly anticipate every tutorial.*

Conclusion

The transition to collaborative assessment strategies in the unit has had a profound and positive impact on student outcomes. The findings demonstrate that collaborative learning, supported by structured group work, evaluation of individuals' understanding of content covered in group assessments through AEQ, and peer evaluations, enhances student performance and satisfaction. These results advocate for the continued refinement and implementation of collaborative approaches to foster an inclusive and engaging educational environment that supports all students in achieving their full potential. Future research could explore the impact of GenAI on the effectiveness of the proposed assessment design framework, as well as its applicability across different subjects within the STEM curriculum.

References

Aggarwal, P., & O'Brien, C. L. (2008). Social loafing on group projects: Structural antecedents and effect on student satisfaction. *Journal of marketing education*, *30*(3), 255-264. https://doi.org/10.1177/0273475308322283

Baker, D. F. (2008). Peer assessment in small groups: A comparison of methods. *Journal of Management Education*, *32*(2), 183-209. https://doi.org/10.1177/1052562907310489

Beccaria, L., Kek, M., Huijser, H., Rose, J., & Kimmins, L. (2014). The interrelationships between student approaches to learning and group work. *Nurse Education Today*, *34*(7), 1094-1103. https://doi.org/10.1016/j.nedt.2014.02.006

Boud, D. (2015). Feedback: ensuring that it leads to enhanced learning. *Clinical teacher*. https://doi.org/10.1111/tct.12345

Freeman, T. M., Anderman, L. H., & Jensen, J. M. (2007). Sense of belonging in college freshmen at the classroom and campus levels. *The Journal of Experimental Education*, *75*(3), 203-220. https://doi.org/10.3200/JEXE.75.3.203-220

Fuchs, D., Fuchs, L. S., Mathes, P. G., & Simmons, D. C. (1997). Peer-assisted learning strategies: Making classrooms more responsive to diversity. *American Educational Research Journal*, *34*(1), 174-206. https://doi.org/10.3102/00028312034001174

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn?. *Educational psychology review*, *16*, 235-266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

Johnson, D. W. (1991). *Cooperative Learning: Increasing College Faculty Instructional Productivity. ASHE-ERIC Higher Education Report No. 4, 1991*. ASHE-ERIC Higher Education Reports, George Washington University, One Dupont Circle, Suite 630, Washington, DC 20036-1183.

Johnson, D. W., & Johnson, R. T. (1987). *Learning together and alone: Cooperative, competitive, and individualistic learning*. Prentice-Hall, Inc.

Kreijns, K., Kirschner, P. A., & Jochems, W. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments: a review of the research. *Computers in human behavior*, *19*(3), 335-353. https://doi.org/10.1016/S0747-5632(02)00057-2

Laal, M., & Ghodsi, S. M. (2012). Benefits of collaborative learning. *Procedia-social and behavioral sciences*, *31*, 486-490. https://doi.org/10.1016/j.sbspro.2011.12.091

Latané, B., Williams, K., & Harkins, S. (1979). Many hands make light the work: The causes and consequences of social loafing. *Journal of personality and social psychology*, *37*(6), 822.

Rajaguru, R., Narendran, R., & Rajesh, G. (2020). Social loafing in group-based learning: student-created and instructor-created group perspectives. *Education+ Training*, *62*(4), 483-501. https://doi.org/10.1108/ET-01-2019-0018

Sherrard, W. R., Raafat, F., & Weaver, R. R. (1994). An Empirical Study of Peer Bias in Evaluations: Students Rating Students. *Journal of Education for Business*, *70*(1), 43–47. https://doi.org/10.1080/08832323.1994.10117723

Slavin, R. E. (1996). Research on cooperative learning and achievement: What we know, what we need to know. *Contemporary educational psychology*, *21*(1), 43-69. https://doi.org/10.1006/ceps.1996.0004

Smith, K. A. (1996). Cooperative learning: Making" groupwork" work. *New directions for teaching and learning*, 71-82.

Springer, L., Stanne, M. E., & Donovan, S. S. (1999). Effects of small-group learning on undergraduates in science, mathematics, engineering, and technology: A meta-analysis. *Review of educational research*, *69*(1), 21-51. https://doi.org/10.3102/00346543069001021

Tosuntaş, Ş. B. (2020). Diffusion of responsibility in group work: Social loafing. *Journal of Pedagogical Research*, *4*(3), 344-358. https://doi.org/10.33902/JPR.2020465073

Webb, N. M. (2009). The teacher's role in promoting collaborative dialogue in the classroom. *British Journal of Educational Psychology*, *79*(1), 1-28. https://doi.org/10.1348/000709908X380772

Wiggins, G. (1998). *Educative assessment: Designing assessments to inform and improve student performance*. San Francisco: Jossey-Bass.

Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of child psychology and psychiatry*, *17*(2), 89-100. https://doi.org/10.1111/j.1469-7610.1976.tb00381.x

Wright, D. L. (1986). Teaching the introductory-level course: A special challenge. Retrieved May 12, 2024, from https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1117&context=podimproveacad.

Acknowledgements

The author would like to acknowledge student cohorts and members of the teaching team who were involved in the unit for their respective roles in the implementation of the pedagogical approaches presented in this paper. The author also acknowledges the use of OpenAI ChatGPT [Large Language Model] for editing and proofreading.

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