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PAPER

PICRAT-Guided Integration of GenAI into a Project-Based Learning Course

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ABSTRACT

This study presents a redesign of a university project-based learning (PBL) course in which generative artificial intelligence (GenAI) was integrated using the PICRAT model that guided the incorporation of digital technologies into teaching. The course was intended for future teachers of practical and vocational subjects completing pedagogical qualifications through university study. The redesign introduced two artificial intelligence (AI)-based supports: Project Designer, which scaffolded project planning in line with Gold Standard PBL, and Project Evaluater, which provided formative feedback on drafted project designs. Using the PICRAT model as an interpretive framework, the study shows that the most meaningful uses of generative artificial intelligence (GenAI) were concentrated in the interactive and creative dimensions, particularly in project planning and revision. Initial empirical findings on participants' attitudes toward PBL are also presented. Quantitative data were collected using a semantic differential and showed that respondents evaluated PBL more positively than traditional teaching, with a statistically significant difference in the evaluation factor. Qualitative findings indicated that participants particularly valued collaboration, practical relevance, active learner involvement, and learner autonomy, while the main perceived drawback of PBL was its time and preparation demands. The study provides an initial example of didactically grounded GenAI integration in teacher education and suggests that AI-supported planning and revision may help reduce practical barriers associated with preparing project-based instruction.

KEYWORDS

PICRAT model, generative artificial intelligence (Gen AI), project-based learning, semantic differential, future teachers, teacher education

1 INTRODUCTION

Teacher education is increasingly expected to prepare future teachers to design instruction that is meaningful, practice-orientated, and responsive to technological change. This challenge is particularly relevant in the preparation of future teachers

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of practical and vocational subjects, where instructional design must be closely connected to authentic educational situations and professional practice.

In this context, project-based learning (PBL) represents a relevant but demanding instructional approach. Although its educational value is widely recognised, its implementation requires substantial planning, coherence, and pedagogical judgement. For future teachers, this creates a specific tension between recognising the potential of PBL and being able to design it effectively.

Generative artificial intelligence (GenAI) offers new possibilities for supporting instructional design in higher education. However, its value in teacher education depends not simply on its use, but on how it is integrated into learning activities so that it supports rather than replaces students' professional thinking.

The present study addresses this issue in a university course on project-based learning for future teachers of practical and vocational subjects. The course was redesigned to include two AI-based supports: Project Designer and Project Evaluater, and this redesign was interpreted through the PICRAT model (explained below) that guided the incorporation of digital technologies in the teaching. In addition, the study examines students' attitudes toward PBL in comparison with traditional teaching.

The aim of the study is therefore twofold. Firstly, to describe and theoretically frame the GenAI-supported redesign of a university PBL course using the PICRAT model. Secondly, to present initial empirical findings on student attitudes toward project-based learning in comparison with traditional teaching.

Accordingly, the study addresses the following research questions: (RQ1) How can the integration of GenAI into a university PBL course be described and interpreted using the PICRAT model? (RQ2) How do students evaluate project-based learning in comparison with traditional teaching after completing the course? (RQ3) What benefits and drawbacks of project-based learning do students perceive in their open-ended feedback?

2 LITERATURE REVIEW

The literature review outlines the three conceptual areas relevant to the present study: the PICRAT model as a framework for meaningful technology integration, artificial intelligence in education and project-based learning in education. Together, these perspectives provide the theoretical basis for the redesign of the course and for the interpretation of the study findings.

2.1 PICRAT model as a framework for meaningful AI integration

The PICRAT model is a useful framework for incorporating digital technologies into education. It combines two dimensions: the student's relationship to technology (passive, interactive, and creative) and the teacher's use of technology (replacement, amplification, and transformation). Kimmons et al. [12, 13] present the PICRAT as a student-centred and pedagogy-orientated model for teacher preparation and highlight its practical value as a clear 3×3 matrix for analysing concrete instructional uses of technology.

The relevance of the PICRAT model becomes even more pronounced in the context of GenAI. Because GenAI can quickly generate explanations, plans, or feedback, its use can easily remain at the level of passive replacement. The PICRAT model makes it possible to distinguish such low-level support from uses that foster interaction, revision, co-construction, and creative design. Philbin and Sentance [18], in their scoping review of GenAI in computing education, use the PICRAT model to show that current applications often cluster in passive and interactive modes, while creative and transformative uses remain less common but pedagogically more promising. Wang's study [28] showed that the systematic use of the PICRAT model-guided technologies helped move students from passive participation toward more interactive and creative forms of engagement and was associated with satisfactory learning outcomes.

For the present study, the PICRAT model provides an appropriate framework to interpret GenAI not only in terms of its availability but also in terms of how it supports student activity.

2.2 GenAI in Education

A central aim of contemporary education is to prepare citizens and teachers who not only understand artificial intelligence (AI) but can also evaluate it critically, govern it responsibly, and use it for the benefit of society. This orientation is reflected in international policy documents that frame AI not merely as a technological innovation but as an issue of educational quality, equity, human rights, and lifelong learning [17, 26].

Recent debate has shifted from prohibition toward guided educational integration. Kanesci et al. argue that, despite concerns associated with GenAI such as plagiarism, misinformation, data security, and widening digital inequalities, these tools are likely to remain part of educational practice and should therefore be addressed through competence development rather than rejection [11]. A similar stance was articulated by the International Baccalaureate, which emphasised the need to adapt teaching and assessment so that students use AI ethically and effectively [9]. OECD notes that intelligent systems can support personalised learning by diagnosing learner needs, adapting content, and providing immediate feedback [17]. More recent reviews suggest that with the rise of GenAI, this potential now extends to content generation, revision support, conversational assistance, and lesson planning [4, 15, 20]. In teacher education, such uses appear especially relevant when GenAI supports planning, feedback, and revision rather than merely accelerating content production [3, 5, 10].

Within this context, teacher competence becomes decisive. UNESCO's AI Competency Framework for Teachers says that educators must not only operate AI tools but also interpret and use them didactically for their own professional growth [25]. Teachers thus remain at the centre of the educational process as guarantors of pedagogical judgement, ethics, and human responsibility, while technology is expected to complement rather than replace their work [25, 26]. This is particularly important because studies in teacher education show that innovative approaches are often valued for their authenticity, collaboration, and practical relevance but are also perceived as demanding to design and implement [2, 7, 27].

The literature also identifies several recurring challenges related to GenAI in education, including hallucinations, over-reliance, ethical risks, insufficient teacher readiness, assessment concerns, and methodological limitations in the research base itself [4, 15, 20]. Overall, current scholarship suggests that the value of AI in education depends less on adoption itself than on whether it is integrated critically, transparently, and pedagogically meaningfully.

2.3 Project-based learning in education

Project-based learning is widely understood as a student-centred instructional approach in which learners acquire knowledge and skills through sustained work on a meaningful problem, question, or challenge. PBL could be framed through the Gold Standard PBL model developed by Larmer, Mergendoller, and Boss [14], which defines seven essential project design elements: a challenging problem or question, sustained inquiry, authenticity, student voice and choice, reflection, critique and revision, and a public product. These elements distinguish PBL from more loosely defined "project-like" activities and position it as a rigorous pedagogical approach rather than merely an engaging method.

In teacher education, PBL has a double pedagogical advantage. It can be taught as content, that is, as a topic future teachers need to understand conceptually, and it can also be experienced as a method through which future teachers learn how to design, implement, and evaluate richer forms of instruction. Previous studies indicate that future teachers often perceive PBL positively, particularly in relation to collaboration, authenticity, practical relevance, and learner engagement [2, 7, 27]. At the same time, the literature also shows that the implementation of PBL is demanding, especially in terms of planning, time management, assessment, and the overall coherence of project design [7, 23, 27].

These characteristics make PBL especially relevant in vocational teacher education. Because vocational and practical subjects are closely connected to real-world application, professional contexts, and authentic tasks, PBL offers a strong didactic fit. However, its successful use requires substantial pedagogical design competence. For this reason, the preparation of future teachers for PBL should address not only its educational benefits but also the practical barriers that may limit its transfer into real teaching practice.

3 MATERIALS AND METHODS

Based on the theoretical background, the following section describes the university course, its GenAI-supported redesign, and the research design used to examine participants' responses to this intervention.

3.1 Course context

The study was conducted within a semester-long university course on PBL designed for future and current teachers of practical and vocational subjects who were completing the pedagogical qualification required for teaching through university study. The course aimed to develop participants' understanding of PBL principles and to guide them toward the preparation of their own project-based teaching plan. Its structure combined conceptual work on PBL with practical design activities, including the analysis of good practice examples, the use of structured planning techniques, and the preparation and presentation of an original project design.

The final course assignment required each participant to produce a detailed methodology for a student project, including the topic, target group, objectives, activities, timeline, roles, resources, assessment, and public product. In the redesigned version of the course, this process was additionally supported by two GenAI-based tools intended to scaffold planning and formative revision.

3.2 GenAI-supported redesign of the course

The redesigned course incorporated two AI-based supports: Project Designer and Project Evaluater. Both were aligned with the principles of Gold Standard PBL and were intended to support the preparation of pedagogically coherent project-based teaching plans.

Project Designer was used during the planning phase of the course. It was developed as a system prompt intended to guide users through the preparation of a PBL plan in line with the Gold Standard PBL model [14]. It functioned as scaffolded support for the formulation and refinement of key project components, including the topic, learning objectives, activities, timeline, roles, assessment, and public product [14]. Its purpose was not to replace participants' own work, but to structure and guide the preparation of an initial project draft.

Project Evaluater was used after participants had prepared a draft of their project plan. It provided criterion-based formative feedback aligned with the Gold Standard PBL elements [14] and helped identify strengths, weaknesses, and areas requiring revision [22]. Participants used this feedback to refine their project design before the final presentation and peer discussion. The related study showed that AI-based evaluation can provide a useful first layer of assessment broadly comparable to teacher judgement, especially in areas such as authenticity and overall design structure, while weaker dimensions of student projects tend to include reflection, critique and revision, and sustained inquiry [22].

The pedagogical role of the two tools was interpreted through the PICRAT model. Their use was concentrated primarily in those phases of the course that supported project planning, revision, and refinement, rather than passive or purely substitutive forms of technology use.

3.3 Procedure

The course began with an introduction to the principles of PBL, including reflection on prior experience, discussion of differences between PBL, problem-based learning, and traditional teaching, and analysis of examples of good practice. Participants then developed initial ideas for their own student projects through guided course activities [21].

Generative AI was integrated in the later design phase of the course. At this stage, Project Designer was introduced to support the preparation of the first full draft of participants' project-based teaching plans. After drafting their projects, participants used Project Evaluater to obtain formative feedback and revise their project design. The course concluded with final project submission, presentation, and peer discussion. The overall sequence of learning phases in the course is summarised in Figure 1 [21].

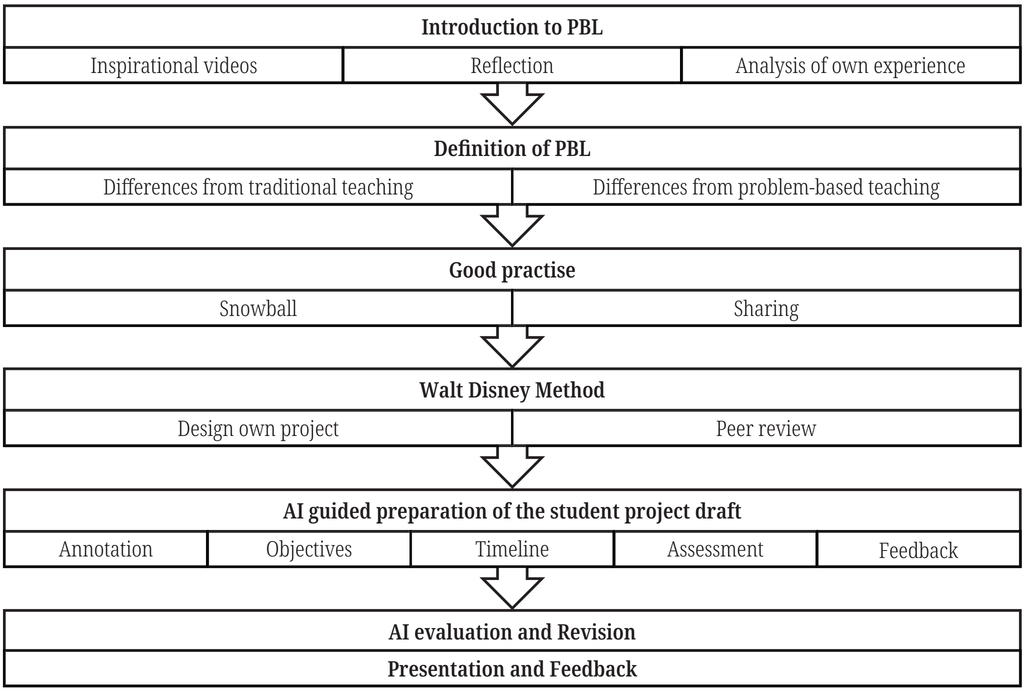

Fig. 1. Sequence of learning phases in the PBL course and the GenAI-supported redesign was integrated primarily in the project planning and revision phases

The study employed a one-group design and did not include a separate control group. All participants completed the same GenAI-supported university course. In this study, traditional teaching did not refer to a separate instructional condition implemented within the course. Rather, it functioned as a reference category in the semantic differential instrument, through which participants compared their attitudes toward PBL and traditional teaching.

3.4 Participants

The study was conducted as part of a university course in PBL designed for current and future teachers of practical and vocational subjects who were completing the pedagogical qualification required for teaching through university study. The empirical sample consisted of 35 participants who completed the course in the autumn semester of 2025 and submitted the final project assignment. The sample was purposively selected, as it included all course participants who completed the course requirements and responded to the research instruments.

Because the study examined one intact course cohort, participants were not assigned to experimental and control conditions. The purpose of the study was not to compare two instructional groups but to examine participants' responses to one GenAI-supported redesign of a university PBL course.

3.5 Research instruments and data collection

The study combined two types of data. The first type consisted of design data, including the original course structure, the GenAI-supported redesign, and its interpretation through the PICRAT model. These data were used to describe how GenAI was pedagogically integrated into the course and how the two AI assistants supported different phases of project design and revision.

The second type of data comprised student data, combining quantitative and qualitative evidence, and was collected at the end of the semester through Google Forms, after all course sessions had been completed and after participants had submitted the final version of their project-based teaching plan.

The quantitative part of the questionnaire measured participants' attitudes toward PBL and traditional teaching using a two-factor semantic differential based on seven-point bipolar scales. The instrument followed Chráska's [8] recommendation that, in educational research, a two-factor structure provides sufficient discriminatory power while reducing the interpretive ambiguity of a third factor. The first factor, evaluation, expressed the extent to which the given instructional format was perceived positively or negatively, while the second factor, energy, reflected the extent to which it was associated with effort, difficulty, or activation.

The qualitative part of the questionnaire consisted of open-ended items focusing on three areas: the perceived usefulness of PBL for future teaching practice, the perceived benefits of PBL, and the perceived drawbacks of PBL.

3.6 Data analysis

Different types of data were analysed in accordance with the research questions. The design data were analysed interpretively. The course structure, the GenAI-supported redesign, and the functions of the two AI tools were described and mapped onto the PICRAT model to interpret the pedagogical role of GenAI in the redesigned course.

The quantitative student data were analysed using descriptive and inferential statistics. For each participant, mean scores were calculated for the semantic differential factors of evaluation and energy. Descriptive statistics included means, standard deviations, and mean difference scores for PBL and traditional teaching. Because the same participants evaluated both instructional formats, paired comparisons were used to examine differences between them.

The qualitative data from open-ended questionnaire responses were analysed using inductive thematic content analysis. Two researchers independently read all responses, identified meaning units, and assigned initial codes. They then compared their coding, discussed discrepancies, and refined the coding scheme through mutual review and discussion. As a result, 7 categories were inductively identified for the perceived benefits of PBL and 8 categories for the perceived drawbacks of PBL. Because a single response could contain more than one meaning unit, individual responses could be assigned to multiple categories. Frequencies were calculated for each category, and percentages were reported based on the number of responses, not the number of respondents.

3.7 Alignment of methods with research questions

The selected methods were used to address the research questions in a differentiated manner. RQ1 was addressed through the design data, including the course structure, the GenAI-supported redesign, and the PICRAT model-based interpretation. RQ2 was addressed through the quantitative semantic differential data comparing attitudes toward PBL and traditional teaching. RQ3 was addressed through the thematic analysis of open-ended responses concerning the perceived benefits and drawbacks of project-based learning.

3.8 Ethical considerations

Participation in the study was voluntary. At the beginning of the questionnaire, participants were informed that the data were being collected for research purposes. The responses were processed anonymously and analysed only in aggregated form. Participation or non-participation had no effect on course assessment.

4 RESULTS

4.1 PICRAT model mapping of the redesign

The GenAI-supported redesign of the course can be interpreted through the PICRAT model as a progression from supportive uses of AI toward more interactive and creative forms of engagement, as presented in Table 1.

As shown in Table 1, in the redesigned course, the passive cells were present only in a limited and supportive way. Uses corresponding to cell PR (passive replacement), cell PA (passive amplification), and partly cell PT (passive transformation) appeared mainly when students used AI in a passive way to clarify the principles of PBL, obtain examples of good practice, or explore possible project topics and outputs. These dimensions were helpful for orientation, but they did not represent the pedagogical core of the course. Their role was preparatory rather than transformative.

The central part of the redesign was located in the interactive and creative domain, as indicated in grey in Table 1. During the planning phase, interactive amplification (IA) was represented primarily by the use of the Project Designer, which scaffolded students' work on project topics, objectives, activities, timelines, roles, and assessment. GenAI amplified students' capacity to structure and refine their project planning without replacing their own decision-making. In the later phase of the course, interactive transformation (IT) became especially important through the use of the Project Evaluater, which supported revision of drafted projects by providing criterion-based feedback, identifying weaknesses, and prompting further improvement. In this sense, GenAI did not merely accelerate existing work but changed the way students engaged in formative review and pedagogical reflection.

Table 1. PICRAT model mapping of the GenAI-supported redesign of the PBL course

PIC/RAT	Replacement (R)	Amplification (A)	Transformation (T)
Creative (C)	CR – GenAI-supported first draft of project methodology components.	CA – GenAI-supported co-creation of the project methodology and justification of didactic choices.	CT – Final revised and presented project design based on GenAI support, peer feedback, and reflection.
Interactive (I)	IR – GenAI-supported clarification of PBL concepts and distinctions.	IA – GenAI Project Designer supports step-by-step project planning.	IT – GenAI Feedback Assistant supports revision through criterion-based feedback.
Passive (P)	PR – GenAI explains PBL principles and Gold Standard PBL as a checklist.	PA – GenAI provides inspiration, examples, and good practice.	PT – GenAI expands choice by offering multiple project alternatives.

The final aim of the redesign was situated in the creative domain. Creative amplification (CA) was present when students used GenAI as a co-designer while developing and refining their own project methodology, comparing alternatives, and justifying didactic choices. Creative transformation (CT) was represented in the final stage of the course, where students produced an original and improved project design on the basis of their own work, GenAI-supported planning, GenAI-supported revision, peer feedback, and presentation. GenAI contributed not only to the structure of the output but also to the iterative process through which the final project became more coherent, reflective, and aligned with Gold Standard PBL principles.

The redesigned course did not aim to maximise GenAI use across all PICRAT model cells. As shown in Table 1, the redesigned course concentrated the pedagogically most meaningful uses of GenAI in the interactive and creative dimensions, particularly in IA, IT, CA, and CT.

GenAI was not intended to replace student work, teacher judgement, or peer feedback. It functioned as a scaffolded support for project design and revision. Its use, therefore, required transparency, critical evaluation of AI-generated outputs, and continued student responsibility for final pedagogical decisions.

4.2 Quantitative findings on student attitudes

Table 2 presents the mean scores and standard deviations for PBL and traditional teaching across the semantic differential items. As shown in Table 2, PBL received higher mean scores than traditional teaching across all items of the evaluation factor. The largest differences were found in practical usefulness (mean diff. 1.43), motivation (mean diff. 1.69), and respectful learning environment (mean diff. 1.32), indicating that respondents perceived PBL as more applicable, engaging, and educationally supportive. By contrast, the pattern within the energy factor was less consistent. Although PBL was rated as more cognitively stimulating, the calm/soothing–demanding/challenging item showed almost no difference between the two educational approaches. A possible explanation is that PBL may sometimes be associated also with less demanding project-like activities or thematic school events. The most robust result therefore lies in the evaluation factor, whereas the energy factor should be interpreted with greater caution because it was based on a small number of conceptually heterogeneous items.

Table 2. Mean scores and standard deviations for PBL and traditional teaching across semantic differential items

Factor	Scale (1) More Negatively—(7) More Possitively	PBL Mean	PBL SD	Trad. Teach. Mean	Trad. Teach. SD	Mean Diff.
Evaluation Factor	Incomprehensible—comprehensible	5.97	0.97	5.46	1.05	0.51
	Disconnected from practice—practically applicable	6.09	1.16	4.66	1.57	1.43
	Unclear goals—clear goals	5.91	1.16	5.34	1.55	0.57
	Demotivating—motivating	6.09	1.05	4.40	1.57	1.69
	Non-respectful environment—respectful environment	6.11	1.01	4.79	1.57	1.32
Energy Factor	Not cognitively stimulating—cognitively stimulating	6.23	1.02	4.63	1.61	1.60
	Calm/soothing—demanding/challenging	3.43	1.64	3.49	1.48	–0.06

Notes: SD = standard deviation. Standard deviations were calculated separately for PBL and traditional teaching scores for each semantic differential item.

Table 3 shows that the difference between PBL and traditional teaching was statistically significant across all three comparisons. The most robust result was observed in the evaluation factor, where the mean difference was 1.11, and the effect size was large (Cohen's d = 0.89). A similarly large effect was found for the overall score across all factors (Cohen's d = 0.88), indicating a substantial advantage of PBL over traditional teaching.

By contrast, the result for the energy factor, although statistically highly significant, should be interpreted more cautiously. The extremely high effect size (Cohen's d = 6.84) is likely influenced by the very small standard deviation of the difference scores and by the limited structure of the factor itself. Since the energy factor was based on only a small number of conceptually heterogeneous items, it provides less stable interpretive support than the evaluation factor.

Table 3. Paired comparison of PBL and traditional teaching across factors

Factor	p-Value (t-Test) * 10^3	Mean Diff	SD of Diff	Cohen's d
All factors	0.009	1.01	1.15	0.88
Evaluation factor	0.007	1.11	1.23	0.89
Energy factor	12.000	0.89	0.13	6.84

Notes: A paired t-test was calculated for evaluation of PBL vs traditional teaching by the same respondents. Mean difference = PBL – traditional teaching. SD of differences was calculated from the individual paired difference scores. Cohen's d for paired samples was computed as the mean difference divided by the standard deviation of the difference scores. The energy factor should be interpreted with caution because it was based on a small number of conceptually heterogeneous items.

Figure 2 presents the individual difference scores in the evaluation factor derived from the semantic differential questionnaire. For each respondent, the value was calculated as the mean evaluation factor score for PBL minus the corresponding mean score for traditional teaching. As shown in Figure 2, most respondents obtained positive difference scores, indicating that they evaluated PBL more positively than traditional teaching at the individual level, not only in aggregate statistics.

Although some respondents showed only small differences between the two educational approaches, and in a few cases the ratings were similar or slightly favoured traditional teaching, the dominant trend is visibly in favour of PBL. The graph supports the statistical results by showing that the higher evaluation of PBL was not driven by only a few extreme cases but reflected a broader and relatively consistent pattern across the sample.

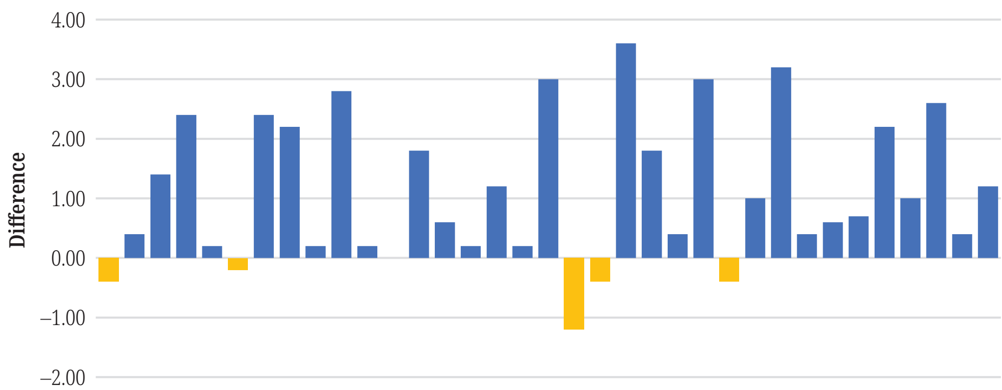

Fig. 2. Individual difference scores for the evaluation factor: PBL minus traditional teaching

4.3 Qualitative findings from open-ended responses

The qualitative analysis of open-ended responses confirmed the predominantly positive perception of the usefulness of PBL for future teaching practice. The percentages were calculated from the total number of responses to this item. Overall, 83% of respondents agreed, with 40% strongly agreeing and 43% rather agreeing. By contrast, only 9% rather disagreed, while no respondent expressed strong disagreement; the remaining 8% were undecided. This distribution suggests that PBL was generally regarded as a professionally relevant and potentially applicable educational approach.

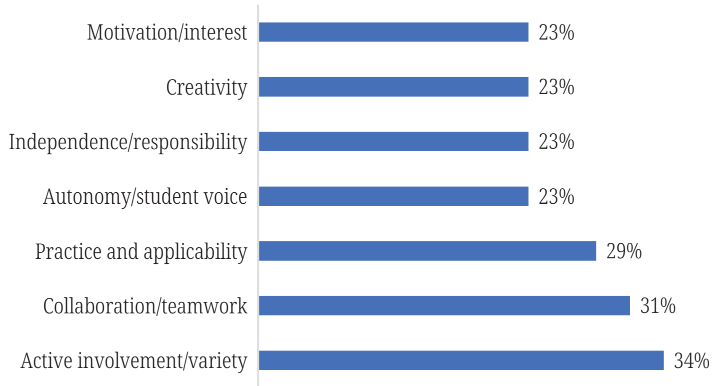

Fig. 3. Thematic categories of perceived benefits of PBL in open-ended responses

Note: Percentages were calculated from the number of coded responses; one response could be assigned to more than one category.

Figure 3 presents the thematic categories identified in participants' open-ended responses concerning the perceived benefits of PBL. The categories were developed inductively by two researchers, and the percentages were calculated from the number of coded responses rather than from the number of respondents. The perceived benefits of PBL were concentrated mainly in active involvement and variety (34%), collaboration and teamwork (31%), and practice and applicability (29%). Other frequently mentioned benefits included autonomy and student voice, independence and responsibility, creativity, and motivation and interest (all 23%). Overall, the responses suggest that participants valued PBL primarily for its ability to promote learner activity, collaboration, practical relevance, and learner agency.

Figure 4 summarises the thematic categories identified in participants' open-ended responses concerning the drawbacks of PBL. As in Figure 3, categories were developed inductively through thematic content analysis, and the percentages were calculated from the coded responses, and one response could contribute to multiple categories. The responses concerning perceived drawbacks were less varied and were dominated by references to the time and preparation demands (31%) of PBL, as illustrated in Figure 4. Other disadvantages were mentioned less frequently, including chaos and organisational demands (20%), demands of implementation and assessment (11%), and limited applicability in some subject areas (9%). At the same time, a relatively large proportion of respondents reported no negatives or no reservations (26%). Overall, these responses suggest that the perceived weaknesses of PBL were linked more to its organisational and planning demands than to its educational value.

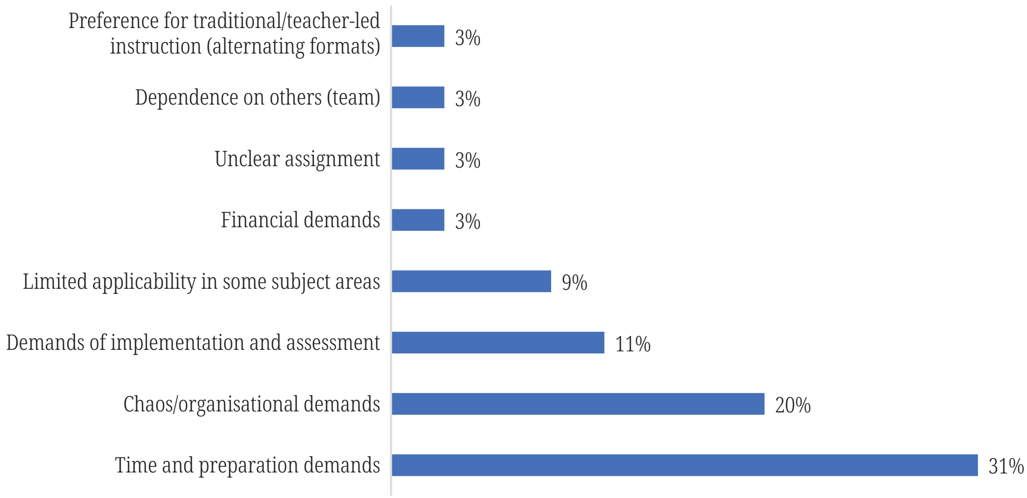

Fig. 4. Thematic categories of perceived drawbacks of PBL in open-ended responses

Note: Percentages were calculated from the number of coded responses; one response could be assigned to more than one category.

4.4 Synthesis of findings

The findings show that participants perceived PBL more positively than traditional teaching, with the clearest quantitative difference observed in the evaluation factor. The qualitative results further indicated that the main perceived benefits of PBL were active involvement, collaboration, and practical relevance, whereas its main drawback was associated with time and preparation demands. The design analysis also showed that the GenAI-supported redesign was concentrated primarily in the interactive and creative domains of the PICRAT model, especially in relation to project planning and revision.

5 DISCUSSION

The findings indicate that the GenAI-supported redesign of the university PBL course was concentrated primarily in the interactive and creative dimensions of the PICRAT model, especially in relation to project planning, revision, and refinement. This is pedagogically important because it shows that GenAI was not used mainly for passive substitution but as scaffolded support for the design and improvement of project-based instruction. In this respect, the redesign reflects the core logic of the PICRAT model by linking technology use to student activity and pedagogical function rather than to technology adoption alone. Its contribution therefore lies less in showing how technology supports project participation and more in showing how it may support the pedagogical design of project-based instruction. GenAI is most educationally valuable when it supports planning, feedback, and refinement rather than replacing teacher thinking [3, 6]. Liu [16] likewise reinforces the view that the value of AI depends on how it is pedagogically framed.

This interpretation is also consistent with the principles of Gold Standard PBL [14]. The two AI tools were integrated in those phases of the course that are most closely connected to demanding aspects of project design, such as structuring the project, aligning objectives and activities, and revising the draft. The redesign, therefore, did not simply add AI to the course but supported key PBL processes, especially reflection, critique and revision, and the development of a coherent project outcome. The present findings are also consistent with studies that show that technologically supported forms of PBL can strengthen student engagement, practical application, and the overall quality of project work. Tran and Nguyen Ngoc [24] showed that mobile e-portfolios enhanced project presentation, reflection, and student engagement. Qu and Li [19] reported that PBL in mobile learning environments supported autonomous learning and problem-solving, while Fadli et al. [5] found that PBL supported by a mobile virtual laboratory improved conceptual understanding and practical skills in vocationally orientated instruction. The present study is similar in treating technology as support for PBL but differs in that it focuses on AI-assisted project design rather than on student documentation of project outputs.

The empirical results further showed that participants perceived PBL as a valuable and professionally relevant instructional approach. The clearest quantitative result was found in the evaluation factor, in which PBL was rated more positively than traditional teaching. The qualitative findings similarly highlighted active involvement, collaboration, practical relevance, autonomy, and responsibility as the main strengths of PBL. These results are in line with previous studies reporting that teachers and student teachers tend to value PBL for its authenticity, learner engagement, and relevance for future practice [1, 2, 27].

At the same time, the study confirms a recurrent tension also identified in earlier research: although PBL is educationally valued, it is also perceived as demanding to prepare and manage. In the present study, the main perceived drawback was the time and preparation demands of PBL, which corresponds with previous findings on planning, organisation, and assessment as key barriers to implementation [7, 23, 27]. In this respect, the GenAI-supported redesign appears particularly relevant. In line with recent research on GenAI in teacher education, the findings suggest that AI is most educationally valuable when it supports planning, feedback, and revision rather than replacing teacher thinking [3, 6]. The contribution of the present study therefore lies in showing that a PICRAT model-guided integration of GenAI may help reduce some of the practical barriers associated with PBL preparation in teacher education.

Several limitations should nevertheless be acknowledged. The empirical findings are based on one course cohort, a small and context-specific sample, and a one-group design without a control group, which limits the generalisability of the results and does not allow causal claims about the effects of the intervention. In addition, the student data were collected at the end of the course and reflect participants' perceptions rather than direct observation of later teaching practice. The findings should therefore be interpreted as initial and exploratory, not as conclusive evidence of the effectiveness of AI-supported PBL redesign.

At the same time, the study has both practical and theoretical implications. Practically, it suggests that GenAI may be integrated into teacher education as structured support for project planning and revision, particularly in areas where PBL is perceived as difficult to prepare. Theoretically, it illustrates how the PICRAT model can be used to interpret GenAI not only as a digital tool but as a pedagogically differentiated form of support within complex instructional design. Future research should test this approach on larger samples, in other teacher-education contexts, and with designs that allow comparison across instructional conditions. It would be particularly important to examine whether AI-supported preparation during university study leads to a greater transfer of PBL into real classroom practice.

6 CONCLUSION

This study provides an initial example of how GenAI can be integrated into a university PBL course in a didactically grounded way using the PICRAT model. The findings suggest that the most meaningful role of GenAI lay in interactive and creative support for project planning and revision rather than in passive assistance. Participants evaluated PBL positively, perceived it as relevant for future teaching practice, and identified its main drawback in its time and preparation demands. In this respect, the GenAI-supported redesign appears promising as a way of supporting the preparation of project-based instruction in teacher education.

The study should be understood as a pilot contribution with a limited empirical scope. Its main value lies in illustrating a possible model of GenAI integration in teacher education and in providing initial evidence that such support may help address some of the practical barriers associated with PBL design. Further research should examine this approach in larger and more diverse samples and explore whether AI-supported preparation during university study leads to a greater transfer of PBL into real teaching practice.

7 REFERENCES

[1] S. Al-Busaidi and F. Al-Seyabi, "Project-based learning as a tool for student-teachers' professional development: A study in an Omani EFL teacher education program," *International Journal of Learning, Teaching and Educational Research*, vol. 20, no. 4, pp. 116–136, 2021. https://doi.org/10.26803/ijlter.20.4.7

[2] E. O. Anyolo and S. P. Nantanga, "Student teachers' perceptions of project-based learning at the University of Namibia," *Journal of Educational Research on Children, Parents & Teachers*, vol. 2, no. 1, pp. 202–215, 2021.

[3] H. Cai, B. Han, J. Sun, X. Li, and L.-H. Wong, "Harnessing AI for teacher education to promote inclusive education: Investigating the effects of ChatGPT-supported lesson plan critiques on the development of pre-service teachers' lesson planning skills," *The Internet and Higher Education*, vol. 67, p. 101022, 2025. https://doi.org/10.1016/j.iheduc.2025.101022

[4] M. Bond *et al.*, "A meta systematic review of artificial intelligence in higher education: A call for increased ethics, collaboration, and rigour," *International Journal of Educational Technology in Higher Education*, vol. 21, no. 4, 2024. https://doi.org/10.1186/s41239-023-00436-z

[5] R. Fadli *et al.*, "Effectiveness of mobile virtual laboratory based on project-based learning to build constructivism thinking," *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 18, no. 6, pp. 40–55, 2024. https://doi.org/10.3991/ijim.v18i06.47643

[6] T. J. Gurl, M. P. Markinson, and A. F. Artzt, "Using ChatGPT as a lesson planning assistant with preservice secondary mathematics teachers," *Digital Experiences in Mathematics Education*, vol. 11, pp. 114–139, 2025. https://doi.org/10.1007/s40751-024-00162-9

[7] A. Habók and J. Nagy, "In-service teachers' perceptions of project-based learning," *SpringerPlus*, vol. 5, no. 1, p. 83, 2016. https://doi.org/10.1186/s40064-016-1725-4

[8] M. Chráska, *Metody pedagogického výzkumu: Základy kvantitativního výzkumu* [Methods of educational research: Fundamentals of quantitative research]. Grada Publishing, 2016.

[9] International Baccalaureate, "Statement from the IB about ChatGPT and artificial intelligence in assessment and education," 2023. https://www.ibo.org/news/news-about-the-ib/statement-from-the-ib-about-chatgpt-and-artificial-intelligence-in-assessment-and-education/

[10] P. J. Kalenda, L. Rath, M. A. Heidt, and A. Wright, "Pre-service teacher perceptions of ChatGPT for lesson plan generation," *Journal of Educational Technology Systems*, vol. 53, no. 3, pp. 219–241, 2025. https://doi.org/10.1177/00472395241301388

[11] E. Kasneci *et al.*, "ChatGPT for good? On opportunities and challenges of large language models for education," *Learning and Individual Differences*, vol. 103, p. 102274, 2023. https://doi.org/10.1016/j.lindif.2023.102274

[12] R. Kimmons, D. Draper, and J. Backman, "PICRAT: The PICRAT technology integration model," in *EdTechnica: The Open Encyclopedia of Educational Technology*, 2022, pp. 225–233. https://doi.org/10.59668/371.5895

[13] R. Kimmons, C. R. Graham, and R. E. West, "The PICRAT model for technology integration in teacher preparation," *Contemporary Issues in Technology and Teacher Education*, vol. 20, no. 1, pp. 176–198, 2020.

[14] J. Larmer, J. R. Mergendoller, and S. Boss, *Setting the standard for project based learning: A proven approach to rigorous classroom instruction*. ASCD, 2015.

[15] B. Li, V. L. Lowell, C. Wang, and X. Li, "A systematic review of the first year of publications on ChatGPT and language education: Examining research on ChatGPT's use in language learning and teaching," *Computers and Education: Artificial Intelligence*, vol. 7, p. 100266, 2024. https://doi.org/10.1016/j.caeai.2024.100266

[16] Z. L. Liu, "Generative AI and mobile learning in higher education: Comparing student and faculty perspectives on employability impact," *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 19, no. 1, pp. 34–45, 2025. https://doi.org/10.3991/ijim.v19i01.51325

[17] OECD, *OECD Digital Education Outlook 2021: Pushing the Frontiers with AI, Blockchain, and Robots*, 2021. https://doi.org/10.1787/589b283f-en

[18] C. A. Philbin and S. Sentance, "Student use and teacher practice: A scoping review of generative AI in computing education using PICRAT," in *Proceedings of UKICER 2025*, 2025. https://doi.org/10.1145/3754508.3754513

[19] L. Qu and L. Li, "Implementation strategy of project-based learning in mobile learning environments and its effects," *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 18, no. 22, pp. 4–18, 2024. https://doi.org/10.3991/ijim.v18i22.52449

[20] Y. Shi, K. Yu, Y. Dong, and F. Chen, "Large language models in education: A systematic review of empirical applications, benefits, and challenges," *Computers and Education: Artificial Intelligence*, vol. 10, p. 100529, 2026. https://doi.org/10.1016/j.caeai.2025.100529

[21] N. Straková, J. Válek, and P. Pecina, "Kurz projektového vyučování v přípravě budoucích učitelů praktického vyučování [Course on project-based learning in the preparation of future vocational teachers]," *Lifelong Learning – celoživotní vzdělávání*, vol. 15, no. 2, pp. 65–87, 2025. https://doi.org/10.11118/lifele20251502065

[22] N. Straková, J. Válek, and P. Marinič, "Using generative AI to evaluate pre-service teachers' project-based learning designs," *RE-SOURCE: Engineering Pedagogy*, vol. 13, pp. 260–270, 2026. https://doi.org/10.53349/re-source.2026.is1.a1545

[23] M. Randazzo, R. Priefer, and R. Khamis-Dakwar, "Project-based learning and traditional online teaching of research methods during COVID-19: An investigation of research self-efficacy and student satisfaction," *Frontiers in Education*, vol. 6, 2021. https://doi.org/10.3389/feduc.2021.662850

[24] T. N. A. Tran and T. Nguyen Ngoc, "Mobile e-portfolios on Google sites: A tool for enhancing project-based learning," *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 17, no. 11, pp. 15–33, 2023. https://doi.org/10.3991/ijim.v17i11.39673

[25] UNESCO, *AI Competency Framework for Teachers*, 2024. https://doi.org/10.54675/ZJTE2084

[26] UNESCO, *Beijing Consensus on Artificial Intelligence and Education*, 2019. https://unesdoc.unesco.org/ark:/48223/pf0000368303

[27] B. P. Uyen, D. H. Tong, and L. K. Ngan, "Online project-based learning for teacher education during the COVID-19 pandemic: A systematic review," *Contemporary Educational Technology*, vol. 15, no. 3, p. ep433, 2023. https://doi.org/10.30935/cedtech/13238

[28] L. Wang, "Adoption of the PICRAT model to guide the integration of innovative technologies in the teaching of a linguistics course," *Sustainability*, vol. 15, no. 5, p. 3886, 2023. https://doi.org/10.3390/su15053886

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