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# AI-PACT: A structured framework for integrating Artificial Intelligence into active and contextual learning in higher education

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ABSTRACT

Higher education increasingly requires teaching approaches that move beyond content transmission towards active interpretation, contextual application and the development of higher-order thinking. Yet, lecture-centred teaching can leave students with limited opportunities to connect theoretical concepts to real-world situations, while the use of artificial intelligence (AI) in education may remain fragmented and tool-driven. This article presents AI-PACT (AI-Powered Active and Contextual Teaching), a structured and reusable teaching method that integrates AI within an Input–Process–Output (IPO) architecture and an eight-stage learning journey: Engage, Explore, Experience, Challenge, Diagnose, Solve, Reflect and Assess. The method positions AI as a pedagogical enabler rather than a substitute for teaching or student reasoning. Its design is illustrated through two undergraduate learning prototypes, Scale of Poverty and, Unemployment and Inflation, which retain the same learning architecture while addressing different content domains. In addition to describing the framework, the article incorporates exploratory feedback from interviews with 15 students who reported that the newer learning method helped them understand the subject matter better than conventional techniques. For analytical clarity, these accounts are presented as early perceptions of learning before and after exposure to AI-PACT. The findings are organised around perceived conceptual understanding, contextualisation, active participation, analytical engagement and the perceived usefulness of structured AI support. The evidence suggests that AI-PACT offers a promising pedagogical structure for connecting content, experience, inquiry, diagnosis, solution development and reflection. The article concludes with implications for implementation and a rigorous evaluation agenda using baseline and post-intervention measures, student artefacts, reflective evidence and comparison with conventional instruction.

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## 1. INTRODUCTION

Lecture-centred teaching remains useful for introducing terminology, explaining complex concepts and establishing a common knowledge base. However, when it dominates the learning experience, students may spend more time receiving and reproducing information than investigating, testing and applying it. Limited opportunities for structured inquiry can reduce the visibility of students' reasoning and make it difficult for lecturers to identify misconceptions before assessment. The problem is not the lecture as a teaching technique, but the absence of sufficient complementary opportunities for students to engage with concepts through realistic contexts, guided analysis and purposeful decision-making.

Artificial intelligence (AI) offers new possibilities for visualising concepts, generating scenarios, supporting simulation, interpreting data, analysing cases and providing feedback. Nevertheless, access to AI does not automatically produce meaningful learning. If AI is used only to generate text, provide quick answers or complete isolated tasks, it can remain peripheral to the pedagogical design. Students may receive polished outputs without developing the reasoning needed to assess whether those outputs are relevant, credible or appropriate. Effective integration therefore requires a clear relationship between the learning objective, the activity, the role of AI, the evidence produced by students and the assessment criteria.

AI-PACT (AI-Powered Active and Contextual Teaching) was developed to address this design challenge. It treats AI as a component of a coherent teaching method rather than as a collection of disconnected applications. The framework follows an Input–Process–Output (IPO) architecture. Learning content, students' prior knowledge and real-world context form the input. These inputs are transformed through eight connected stages: Engage, Explore, Experience, Challenge, Diagnose, Solve, Reflect and Assess. The intended outputs include meaningful conceptual understanding, critical thinking, analysis, decision-making, problem-solving and real-world application.

This article extends the developmental account in the AI-PACT extended abstract by integrating exploratory interview feedback from 15 students. The students reportedly expressed that they understood the subject matter better when using the newer method than when learning through conventional techniques. Their accounts offer an initial perspective on the perceived learning experience and allow the framework to be discussed in relation to the instructional problems it was designed to address. The evidence is referred to the preliminary findings regarding the method that the lecturer used and is not interpreted as proof of academic performance achievement.

The article has four objectives where the first objective, it describes the design of AI-PACT as a structured AI-powered teaching method that integrates active, contextual and experiential learning within an IPO architecture. Second, it explains how the eight-stage process connects conceptual exploration with experience, analysis, diagnosis, solution development, reflection and assessment. Third, it demonstrates the method's adaptability through the Scale of Poverty and Unemployment & Inflation prototypes and fourth, it presents an initial evidence framework for examining student perceptions of learning before and after exposure to AI-PACT and establishes priorities for a more systematic evaluation of conceptual understanding, critical thinking, problem-solving, decision-making and real-world application.

## 2. PROBLEM STATEMENT AND RESEARCH QUESTIONS

Five related instructional problems informed the development of AI-PACT. First, conventional teaching may be content-heavy and lecture-driven, encouraging students to focus on receiving and remembering information. Second, students may find it difficult to connect theoretical concepts with real-world situations, data, cases and current issues. Third, limited opportunities for active learning may constrain students' participation in exploring, experiencing and applying knowledge. Fourth, students may not receive sufficient structured practice in higher-order skills, including critical thinking, decision-making and problem-solving. Fifth, AI tools may be used as individual or supplementary applications rather than integrated within a coherent teaching and learning method.

These problems are connected when learning is organised mainly around content delivery, students may have few opportunities to test their understanding in context. When AI is added without an instructional sequence, the technology may increase access to information without necessarily strengthening students' analytical work. AI-PACT responds by connecting content and prior knowledge to authentic contexts, structuring student activity across eight stages and aligning AI-supported tasks with defined pedagogical purposes. The interview feedback is relevant because the students' reported preference for the newer method speaks directly to the perceived limitations of conventional techniques and indicates that the learning experience felt clearer, more contextual and more engaging.

## 3. CONCEPTUAL AND THEORETICAL FOUNDATION

### 3.1 Active learning and student engagement

Active learning shifts some of the cognitive work of a lesson from the lecturer to the student. Rather than relying exclusively on listening and note-taking, students engage in activities that require them to interpret information, answer questions, examine evidence, compare explanations or produce an artefact. Prince's (2004) review reported support for active learning across several educational settings, while also underscoring the importance of specifying what counts as active learning and how outcomes are assessed. In AI-PACT, activity is not treated as movement or participation alone. It requires students to perform identifiable intellectual work, including explaining concepts, interpreting cases, identifying causes and justifying solutions. The Engage and Explore stages establish the conditions for active participation. Engage activates curiosity and prior knowledge through a question, visual, problem or scenario. Explore then supports the development of conceptual understanding through guided inquiry and accessible representations. The latter stages require students to apply and interrogate the concepts. This sequence is intended to make participation purposeful.

### 3.2 Contextual and experiential learning

Contextual learning connects abstract concepts to circumstances in which they can be interpreted and used. It can help students recognise why a concept matters, what evidence is relevant and how explanations vary across settings. Experiential learning similarly emphasises the relationship between experience, reflection, conceptualisation and subsequent action. Kolb (1984) describes learning as a process in which experience and reflection contribute to the formation and testing of ideas. AI-PACT draws on this general

principle by placing students in scenarios or simulations and then requiring them to analyse, diagnose, respond and reflect. In the Scale of Poverty prototype, students can consider definitions and dimensions of poverty, examine contextual information and explore how poverty may be represented or experienced. In the Unemployment & Inflation prototype, students can investigate economic indicators, causes and effects, and the implications of alternative responses. These examples do not imply that AI can reproduce the full complexity of lived experience or economic systems. Instead, they provide structured learning contexts in which students can practise interpreting concepts and evidence while recognising the limitations of simulated or generated material.

### 3.3 AI as a pedagogical enabler

The technological pedagogical content knowledge perspective developed by Mishra and Koehler (2006) emphasises the interdependence of technology, pedagogy and disciplinary content. From this perspective, selecting an AI tool is not a sufficient instructional decision. The lecturer must determine how the tool supports a particular learning purpose and how its output relates to the subject matter and student activity. AI-PACT operationalises this principle by mapping tools to pedagogical functions, including visualisation, scenario generation, simulation, case analysis, data interpretation, reflection, feedback and assessment. The framework is tool independent. It does not require every lecturer to use the same platform, nor does it assume that one application is appropriate for all eight stages. Instead, the choice of tool is subordinate to the learning objective and task. This reduces dependence on a specific technology and supports adaptation as platforms, institutional policies and student access change. It also makes lecturer judgement essential: AI outputs should be checked for accuracy, relevance, bias and currency, particularly when the topic involves social indicators, economic data or public policy.

Research on AI in higher education has documented a diverse landscape of applications and has highlighted the need to consider educators' roles rather than treating AI adoption as a purely technical issue (Zawacki-Richter et al., 2019). AI-PACT responds to this concern by keeping the lecturer responsible for instructional design, task framing, facilitation, verification and assessment. AI can broaden the range of learning resources and scenarios, but it does not replace the need for disciplinary judgement or student accountability.

### 3.4 Integrating the foundations in AI-PACT

AI-PACT combines these ideas within one design architecture. Active learning defines what students do. Contextual learning establishes where and why concepts are applied. Experiential learning connects simulated or realistic activity with reflection and subsequent reasoning. AI provides selected forms of support across the process. The IPO model connects the starting conditions, the learning journey and the intended outputs. This alignment is the central conceptual contribution of the method.

## 4. THE AI-PACT FRAMEWORK

### 4.1 Input–Process–Output Development

The input layer contains three elements: disciplinary learning content, students' prior knowledge and real-world context. Learning content establishes the concepts and outcomes to be addressed. Prior knowledge helps the lecturer identify assumptions, misconceptions and experiences that can be activated or challenged. Real-world context provides cases, data, scenarios or current issues through which the concepts can be examined. The quality of the input matters because AI-supported activities can only be educationally useful when the underlying content and contextual materials are appropriate and sufficiently reliable. The process layer consists of eight connected stages. Although the stages are presented in a sequence, the lecturer may revisit an earlier stage when student responses reveal a misconception or when new evidence changes the analysis. The sequence provides structure without requiring inflexible delivery. AI tools are selected according to the demands of each stage, and students remain responsible for interpreting and using the outputs.

The output layer includes intended learning outcomes and student-produced evidence. Intended outcomes include meaningful understanding, critical thinking, analysis, decision-making, problem-solving and real-world application. Possible student artefacts include simulation reports, case analyses, root-cause maps, intervention proposals, policy briefs, reflective responses and assessment tasks. These artefacts are useful because they make reasoning more visible than a general impression of participation. They also create opportunities for rubric-based evaluation in future implementation.

### 4.2 The eight-stage learning development

Stage 1: Engage, introduces a question, visual, problem or short scenario designed to establish relevance and activate students' prior knowledge. AI may support the preparation of contrasting scenarios, images or prompts. The lecturer should ensure that the stimulus is accurate, accessible and aligned with the intended learning outcome.

Stage 2: Explore, develops students' initial conceptual understanding. Students examine key definitions, indicators, relationships or explanatory frameworks. AI-supported explanations and visualisations may provide alternative representations, but these should be checked against course materials and credible sources. The purpose is to build a conceptual foundation, not to encourage uncritical acceptance of generated answers.

Stage 3: Experience, places students in a realistic case, simulation or scenario. Students encounter the concepts in a context that requires interpretation. In poverty-related learning, this could involve examining a constructed household or community profile. In unemployment and inflation, it could involve interpreting a scenario involving labour-market conditions, price changes or policy trade-offs. Simulations are learning devices rather than substitutes for real-world evidence.

Stage 4: Challenge, asks students to define the central problem, distinguish relevant from irrelevant information and examine alternative interpretations. AI can help generate questions or contrasting cases, but students should articulate the problem in their own terms and explain the evidence supporting their interpretation.

Stage 5: Diagnose, requires analysis of underlying causes and causes–effect relationships. Students move beyond describing a problem to considering why it occurs, how factors interact and which explanations are supported by evidence. Tools for visualisation or data analysis may assist this work. The lecturer should encourage students to distinguish correlation from causation and to identify missing information or uncertainty.

Stage 6: Solve, requires students to develop and justify possible responses. Students compare alternatives, consider feasibility and anticipate consequences. AI may support brainstorming or scenario comparison, but generated proposals should be evaluated for evidence, context, ethical implications and practical constraints. The learning outcome is not the production of a fluent answer, but a defensible decision supported by reasoning.

Stage 7: Reflect, gives students an opportunity to examine what they learned, which assumptions changed, what evidence influenced their judgement and what remains uncertain. Reflection can reveal whether students understand the logic behind their conclusions or have merely completed an activity. AI may provide prompts or feedback, but the reflection should represent the student's own evaluation of the learning process.

Stage 8: Assess, gathers evidence of learning through quizzes, short explanations, case analyses, presentations, reports or rubric-based artefacts. Assessment should align with the stated outcomes and distinguish recall from application and reasoning. AI-supported feedback can help students revise work, but the lecturer remains responsible for judging achievement and ensuring academic integrity.

### 4.3 Adaptability across content domains

This design allows lecturers to reuse planning logic while adapting examples, data, AI tools and assessments to a particular course. Reusability does not mean that the same activity or tool should be copied without review. It means that the underlying sequence provides a consistent design template that can be adapted to disciplinary requirements, student readiness, available resources and institutional expectations.

### 4.4 Novelty and contribution

The primary contribution of AI-PACT lies in the integration of active, contextual and experience-based learning with purposefully selected AI functions within a reusable instructional sequence. This framework provides a structure for aligning learning inputs, student activities, technological support, and assessment evidence.

## 5. METHODOLOGY

### 5.1 Design orientation

AI-PACT originated as a design-oriented educational innovation. The development process translated identified instructional limitations into a structured framework, then instantiated the framework in two undergraduate topic prototypes. The article combines a description of this design process with exploratory student interview feedback as an early-stage innovation report with preliminary qualitative evidence.

### 5.2 Development of the framework and prototypes

Two prototypes were prepared to demonstrate transfer across content domains: Scale of Poverty and Unemployment & Inflation. The prototypes retain the same process architecture while adapting the learning content, context, activities and intended student outputs. Supporting materials include the framework diagram, turtle-diagram learning journeys, AI tool mapping, assessment strategies and sample learning activities.

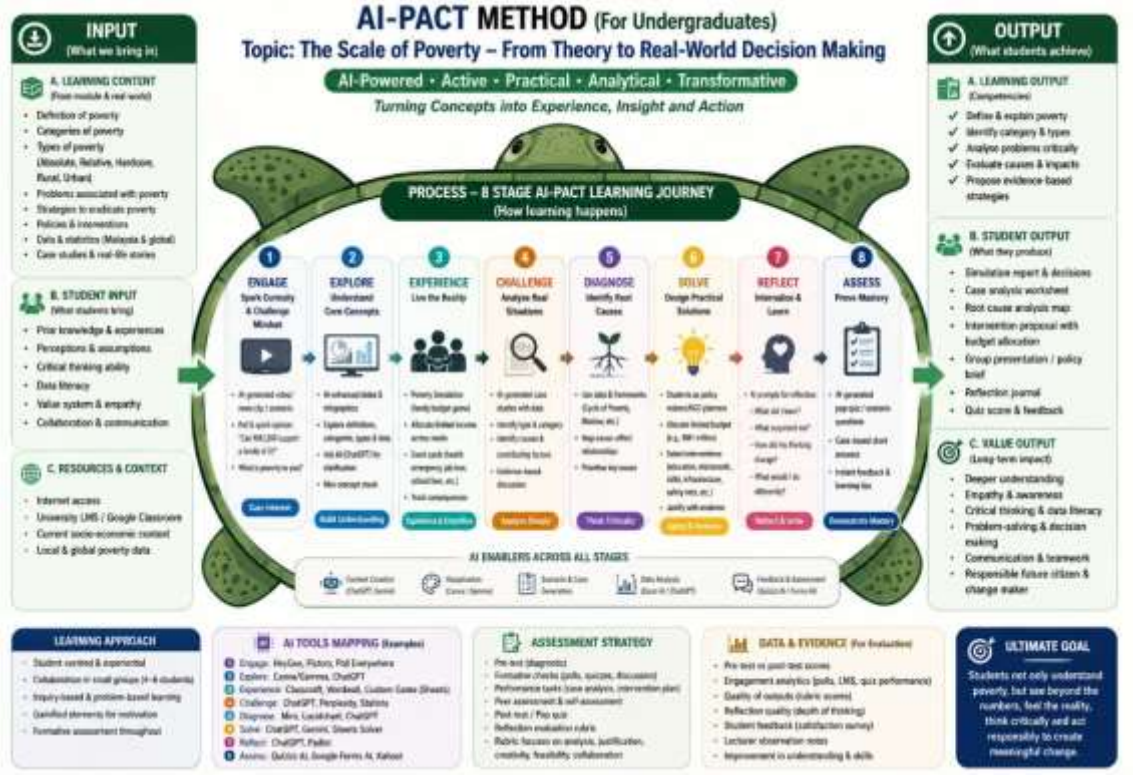



Fig. 1. AI-PACT prototype for scale of Poverty




Fig. 2. AI-PACT prototype for Unemployment & Inflation topics

### 5.3 Student interviews and the scope of the evidence

The article incorporates feedback from15 students were interviewed and that they indicated a better understanding of the subject matter when using the newer method than when using conventional teaching techniques. Based on interview and feedback given, is treated as exploratory qualitative feedback. The reported comparison between conventional teaching and the newer method is interpreted as students' perceived learning experience and it is not treated as evidence that objective achievement increased. The sample of 15 students provides a limited but potentially useful perspective on how learners experienced the approach and represent 2 groups for the subject and not covers all the undergraduate students. The purpose of the current analysis is to identify patterns in reported perceptions and relate them to the design objectives and original problem statement.

### 5.4 Pre-and post-learning comparison

The requested pre/post presentation is used here as a qualitative comparison of students' reported experience before exposure to the newer method and their perceived experience after using it. The "pre" column refers to students' reported experience of conventional techniques, while the "post" column refers to their retrospective account of learning through AI-PACT.

## 6. FINDINGS

### 6.1 Finding 1: AI-PACT provides a coherent structure for AI-supported teaching

The first finding concerns the design outcome. AI-PACT organises AI-supported learning within a consistent IPO architecture and an eight-stage learning journey. Instead of beginning with a technology and searching for a task, the framework begins with content, prior knowledge and context, then defines the learning process and intended outputs. This structure directly responds to the problem of AI being used as a disconnected or supplementary tool. It also offers lecturers a way to align the learning purpose, student activity, technological support and assessment evidence. The two prototypes show how the architecture can be retained while the content changes. Scale of Poverty and Unemployment & Inflation involve different concepts and contextual materials, yet both use the same progression from engagement and exploration to experience, challenge, diagnosis, solution development, reflection and assessment.

### 6.2 Finding 2: Students reported better perceived understanding with the newer method

The principal student-related finding based on 15 interviewed students expressed that they understood, or understood better, when using the newer method than when learning through conventional techniques. This is a positive initial signal because it aligns with the central purpose of AI-PACT: to move students beyond passive receipt of content towards a learning experience in which concepts are encountered, explored and applied. The result should be interpreted as a reported perception, not as a measured gain in knowledge. The reported comparison is especially relevant to the first two instructional problems. If students experience conventional learning primarily as the receipt and memorisation of information, they may struggle to translate definitions into explanations of real situations. A structured sequence that combines conceptual exploration with scenarios, challenges and analysis may make the relationship between abstract ideas and their applications more visible. The finding also offers a rationale for examining conceptual understanding in subsequent evaluation. Perceived clarity can indicate that a learning design is understandable and acceptable to students, but it does not establish durable retention, transfer or independent problem-solving. A student may feel that a topic is clearer while still holding misconceptions; conversely, a challenging task may increase learning even when students do not initially report greater ease.

### 6.3 Qualitative pre/post comparison of the reported learning experience

Table 1. Synthesis of the reported student feedback in a pre/post format.

| Dimension | Pre-AI-PACT: reported conventional experience | Post-AI-PACT: reported experience with the newer method |
|---|---|---|
| Overall understanding | The comparison point was conventional teaching techniques. | The 15 interviewees feedback understood the subject matter better using the newer method. |
| Conceptual clarity | Students need to move from definitions and explanations to interpretation. | The reported overall improvement suggests perceived clarity. |
| Theory-to-context connection | The original problem statement identifies difficulty connecting theory with real situations, cases and data. | The contextual and experiential design is intended to support application. |
| Active participation | The original problem statement identifies limited opportunities to explore, experience and apply knowledge in conventional settings. | AI-PACT explicitly sequences student activity across eight stages. |
| Analysis and problem-solving | The original problem statement identifies a need for more structured opportunities to develop higher-order skills. | Challenge, Diagnose and Solve create structured opportunities for analysis. |

| | | |
|---|---|---|
| Role of AI | AI may be used as a supplementary tool without a unified teaching structure. | AI-PACT maps AI to defined pedagogical functions throughout the learning journey. |

Source: Based on feedback from students

### 6.4 Finding 3: The eight-stage process creates a pathway from content exposure to application

A further design finding is that the eight stages specify a learning pathway rather than treating engagement, analysis and assessment as isolated activities. Engage and Explore establish interest and initial understanding. Experience places concepts in context. Challenge and Diagnose require students to define a problem and examine its causes. Solve requires a reasoned response. Reflect supports metacognitive review and Assess provides evidence of learning. The sequence therefore translates the broad ambition of active and contextual learning into a set of teachable and reviewable steps.

This design directly addresses the problem of insufficient opportunities for active learning. It also provides a practical response to the challenge of developing higher-order skills: rather than assuming that critical thinking emerges from exposure to content, AI-PACT builds in explicit occasions for analysis, causal diagnosis, evaluation of alternatives and justification of decisions whether these activities improve performance depends on the quality of facilitation, the authenticity of the tasks and the alignment of assessment.

### 6.5 Finding 4: Reusability is a design strength, but transfer requires evaluation

The use of a stable framework across Scale of Poverty and Unemployment & Inflation demonstrates the intended reusability of AI-PACT. Lecturers can adapt the content and contextual materials without redesigning the entire pedagogical sequence. This may reduce the planning burden associated with integrating AI and make the approach more feasible for use across courses. The tool-independent structure also allows lecturers to work with platforms available within their institutions, subject to policy and access requirements. However, design transfer should not be confused with demonstrated transfer of learning outcomes. The two prototypes establish that the framework can be populated with different content. They do not establish that students in both topics achieve similar learning gains, that the method works equally well across disciplines or that it is more effective than conventional teaching. Those questions require repeated implementation, documented adaptations and comparable outcome measures. Overall, the findings indicate that AI-PACT has reached a meaningful design and prototype stage and has received an encouraging initial response from the 15 interviewed students. The strongest empirical statement currently available is that students reported better perceived understanding with the newer method.

## 7. DISCUSSION

### 7.1 Interpreting the reported improvement in understanding

The reported perceptions of the 15 students are relevant because perceived understanding can influence students' willingness to participate, persist with difficult material and engage in subsequent learning tasks. A teaching method that makes concepts more accessible and shows how they relate to practical situations may help students build a coherent mental representation of a topic. The AI-PACT sequence is designed to

support this progression by linking initial explanation to contextual experience and then to analysis and solution development.

### 7.2 The importance of IPO structure

The IPO contributes coherence by making the relationship between starting conditions, learning activities and outcomes explicit. The input layer prevents the lesson from being designed around technology alone. Prior knowledge and real-world context give the lecturer a basis for selecting appropriate activities and anticipating misconceptions. The process layer defines the intellectual work students undertake. The output layer specifies what students should be able to explain, analyse, decide or produce. This structure can also improve instructional transparency. Lecturers can explain why an AI tool is being used and what students should do with its output. Students can be assessed on their reasoning and the quality of their evidence rather than on the mere presence of an AI-generated response. For institutions, the architecture offers a potential basis for sharing learning designs and reviewing their alignment with course outcomes.

### 7.3 From AI access to pedagogical integration

A central implication of AI-PACT is that AI literacy in education should include pedagogical judgement, not only operational competence. Students and lecturers need to know how to use AI tools, but they also need to decide when the tools are appropriate, how outputs should be verified and how responsibility for reasoning is maintained. The framework positions AI as support for a defined learning task. This is especially important when students analyse social and economic issues, where generated examples or summaries may omit contextual complexity or reproduce inaccurate claims.

### 7.4 Implications for teaching practice

For institutions, the tool-independent architecture may support professional development and cross-course adaptation. The framework could be developed into lecturer training, activity templates, assessment rubrics and contextualised learning packages. Institutional adoption should be accompanied by guidance on accessible tools, privacy, academic integrity, quality assurance and evaluation. Scalability is a potential opportunity, not an established outcome of the current prototype stage.

### 7.5 Relationship to existing literature

AI-PACT is consistent with active-learning scholarship that emphasises the value of engaging students in cognitive work rather than relying exclusively on transmission (Prince, 2004). It also reflects experiential learning principles in which experience and reflection contribute to learning and the revision of understanding (Kolb, 1984). Its approach to AI integration is compatible with the view that technology should be considered in relation to pedagogy and content rather than in isolation (Mishra & Koehler, 2006). Finally, its focus on the educator's design role responds to broader discussions of AI applications in higher education (Zawacki-Richter et al., 2019). The contribution of AI-PACT is not that it independently establishes the effectiveness of active, contextual or experiential learning. Rather, it offers a practical structure for combining these principles with AI-supported functions in a reusable sequence. Its research contribution will become stronger when subsequent studies demonstrate whether this structure improves

measured learning, under what conditions it works and which stages or AI-supported activities contribute most to the observed outcomes.

### 7.6 Limitations and alternative explanations

These limitations do not eliminate the value of the innovation. They define the appropriate status of the current claims. The framework can be reported as a developed design and prototype, and the interview response can be reported as preliminary evidence of perceived understanding. Stronger claims about learning gains, causal impact or broad generalisability should be explore in the next research and feedback from a large number of students.

## 8. IMPLICATIONS FOR FUTURE EVALUATION AND CONCLUSION

Future evaluations should assess feasibility, usability, and educational outcomes separately. Feasibility refers to the lecturers' ability to implement the eight stages within the available time and resources. Usability pertains to the extent to which lecturers and students can understand and utilize the framework. Educational outcomes concern whether the method enhances conceptual understanding, analysis, problem-solving, decision-making, or knowledge transfer. Distinguishing between these aspects will help determine whether implementation challenges stem from the framework, the selected activities, the AI tools, or the assessment design. Future studies should incorporate equivalent baseline and post-intervention measures, analysis of student artifacts, structured reflections and where feasible a comparison group receiving conventional instruction. Such a research design would allow for a more robust assessment of effectiveness compared to relying solely on retrospective self-reports.

AI-PACT presents a structured and reusable method for integrating AI with active, contextual and experiential learning in higher education. Its principal contribution is the alignment of an Input–Process–Output architecture with an eight-stage learning journey: Engage, Explore, Experience, Challenge, Diagnose, Solve, Reflect and Assess. The method positions AI as a pedagogical enabler that supports specific learning functions while preserving the lecturer’s responsibility for design, facilitation, verification and assessment. The Scale of Poverty and Unemployment & Inflation prototypes illustrate how the same architecture can be adapted across different undergraduate content domains. The reported interviews with 15 students provide an encouraging preliminary indication that learners perceived better understanding when using the newer method than when using conventional techniques. This finding is relevant to the problem of content-heavy instruction, but it remains a perception-based result. The next stage should therefore combine systematic implementation with prospective pre-test and post-test assessment, student analysis and structured reflection. Such evaluation can establish whether AI-PACT is feasible, usable and educationally effective, and can identify the conditions under which its benefits are most likely to occur. By connecting AI use to a transparent learning process and explicit evidence of learning, AI-PACT offers a promising foundation for more deliberate AI-supported teaching.

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## 10. CONFLICT OF INTEREST

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

## 11. AUTHORS' CONTRIBUTIONS

**Nor Azira Ayob**: Conceptualisation, methodology, formal analysis, investigation and writing-original draft, writing- review and editing, and validation; **Mahani Hassan**: Conceptualisation, methodology and formal analysis and conceptualisation.

## 12. DECLARATION OF GENERATIVE AI IN THE WRITING PROCESS

During the preparation of this work, the author(s) used AI Tool to develop AI learning approaches to teaching and learning process. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

## 13. DATA AVAILABILITY/SUPPLEMENTARY MATERIALS

The datasets generated during the current study are available in the international invention, innovation and design.

## 14. ETHICS STATEMENT

The authors declare that this research did not involve human or animal subjects. All experimental procedures were performed following the institutional Safety, Health, and Environmental (HSE) protocols of Universiti Teknologi MARA (UiTM).

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