



## Teaching Advanced Mathematics for Economics Students in Alignment with Programme Learning Outcomes under the AUN-QA Framework: A Case Study at Lac Hong University, Vietnam

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### ABSTRACT

The AUN-QA framework requires programs to demonstrate coherence among expected learning outcomes, curriculum design, teaching and learning strategies, assessment, and evidence-based continuous improvement. In economics-related programs, Advanced Mathematics is not merely a foundational quantitative course; it is also a learning environment for developing modeling, problem-solving, collaboration, and decision-making competencies. Drawing on a theoretical review and a reflective synthesis of teaching practices at Lac Hong University, Vietnam, this paper proposes a course-level design for teaching Advanced Mathematics that aligns with program learning outcomes under AUN-QA. The design consists of three mutually reinforcing instructional measures: using Kolb's experiential learning model to introduce mathematical knowledge through economic scenarios, guiding students through an explicit real-world problem-solving procedure, and strengthening project-based tasks connected to practical economic problems. The paper contributes an alignment matrix linking course learning outcomes, learning activities, and assessment evidence, and offers implementation recommendations for instructors and program managers. The findings support evidence-based course governance, authentic assessment, and semester-by-semester improvement in the attainment of outcomes in economics education. As a design-oriented study, the paper does not aim to test causal effects on student achievement; rather, it develops an instructional framework and assessment evidence system that can be used for future empirical evaluation of CLO attainment.

## 1. INTRODUCTION

The ASEAN University Network's AUN-QA framework has been widely adopted by higher education institutions across the ASEAN region as a reference model for outcomes based curriculum development and quality assurance grounded in evidence and continuous improvement. At the programme level, AUN-QA Version 4.0 emphasises a closed loop relationship among expected learning outcomes, programme structure and content, teaching and learning strategies, student assessment, resources, and graduate outcomes, with quality assurance mechanisms embedded within the criteria to drive progressive enhancement.

Within economics related programmes, Advanced Mathematics is a compulsory course that provides the foundation for quantitative reasoning, modelling, and the optimization of economic decisions. However, teaching practices indicate that economics students frequently experience difficulties in translating professional situations into

mathematical representations and often exhibit anxiety towards mathematics courses. This raises a key question: how should Advanced Mathematics be taught to ensure disciplinary knowledge standards while simultaneously fostering core competencies aligned with AUN-QA programme learning outcomes, in ways that can be measured through assessable evidence.

At Lac Hong University, the development of AUN-QA-aligned programmes constitutes a significant innovation. Based on the programme learning outcomes (PLOs) and course learning outcomes (CLOs) for economics-related programmes, this paper proposes three instructional measures for Advanced Mathematics that support outcomes alignment under AUN-QA, and outlines approaches to designing learning activities and assessment to enable continuous improvement across semester cycles. The programme learning outcomes and the course learning outcomes for Advanced Mathematics are presented in the tables below.

*Table 1. Programme Learning Outcomes (illustrative example: Finance and Banking programme)  
(Lac Hong University, 2024)*

<b>PLOs</b>	<b>Output Standards</b>
PLO1	Apply basic knowledge of natural sciences, social sciences, and economics to solve problems.
PLO2	Apply knowledge of accounting, finance, and banking to solve practical problems
PLO3	Effective application of digital technology in the workplace
PLO4	Work effectively in teams
PLO5	Build effective financial solutions
PLO6	Demonstrate the ability to engage in lifelong learning.
PLO7	Build a startup project
PLO8	Adhere to standards of professional ethics and practice social responsibility
PLO9	Communicate ideas effectively through written, visual, and verbal communication

*Table 2. Course Learning Outcomes for Advanced Mathematics for students in economics-related disciplines and their alignment with PLOs (Lac Hong University, 2024)*

<b>CLOs</b>	<b>Output standards</b>	<b>Bloom domain/Bloom level</b>	<b>PLOs</b>
CLO1	Apply matrix operations to solve problems in economics.	Knowledge (3)	PLO1
CLO2	Apply linear equations to solve problems in economics.	Knowledge (3)	PLO1
CLO3	Apply differential calculus to solve economic application problems.	Knowledge (3)	PLO1
CLO4	Read and research self-study and advanced sections of the course	Skills (3)	PLO6
CLO5	Have a positive attitude and cooperate with teachers and other students during learning and group assignments.	Attitude (4)	PLO4

Accordingly, this study addresses the following two questions:

RQ1. How can the CLOs of Advanced Mathematics be operationalised into learning activities and assessment evidence under the AUN-QA framework?

RQ2. What instructional measures can support economics students in translating practical economic situations into mathematical models and interpreting mathematical results in economic contexts?

## 2. LITERATURE REVIEW

### 2.1. *AUN-QA and Outcomes-Based Quality Assurance*

At programme level, AUN-QA emphasises the formulation of appropriate expected learning outcomes, the alignment from course learning outcomes to programme learning outcomes, and the requirement to demonstrate outcome attainment through teaching and learning methods, assessment, and evidence (ASEAN University Network Quality Assurance, 2020). In practice, a recurring challenge lies at the course level: translating course learning outcomes into purposefully designed learning activities and constructing assessment tasks that generate credible evidence to inform continuous improvement.

### 2.2. *Outcome-Based Teaching and Learning*

The principle of constructive alignment constitutes a key theoretical foundation for outcome-based teaching and learning. Biggs (2014) argues that learning outcomes should be specified first, and that learning activities and assessment should then be designed coherently so that students engage in the cognitive operations required by the outcomes.

Large scale empirical evidence in higher education indicates that active learning approaches tend to improve achievement and reduce failure rates compared with passive instruction. A meta analysis by Freeman et al. (2014), synthesising 225 studies, reports that active learning increases assessment performance and reduces the risk of non-passing outcomes in STEM courses.

Regarding assessment, authentic assessment is widely viewed as well suited to an outcome-based approach because it evaluates learning through tasks that approximate professional and real world practice, allowing concurrent appraisal of knowledge, skills, and attitudes. A systematic literature review by Vlachopoulos and Makri (2024) indicates that authentic assessment supports the development of competencies such as critical thinking, problem solving, and collaboration.

### 2.3. *Teaching Advanced Mathematics for Students in Economics-Related Disciplines*

Recent studies suggest that students in economics, management, and business programmes often experience difficulties in Advanced Mathematics due to a persistent gap between mathematical representations and their economic meanings (Landgärds-Tarvoll, 2024; McCullagh et al., 2024; Munárriz & Rodríguez Rincón, 2025). In learning Advanced Mathematics, the central challenge is not solely procedural competence, but the ability to interpret mathematical concepts within economic contexts (Feudel & Biehler, 2022; Voßkamp et al., 2025). Accordingly, the literature recommends strengthening mathematical modelling and the use of tasks anchored in professional contexts; in particular, the modelling cycle from a real world situation to a mathematical model and subsequent model processing should be taught explicitly (Cevikbas et al., 2022). At the instructional design level, project-based learning and authentic assessment are regarded as well aligned with competency-based learning outcomes, as project artefacts and assessment rubrics facilitate the concurrent evaluation of cognitive attainment, skills development, and attitudinal gains (Guo et al., 2020; Vlachopoulos & Makri, 2024). Synthesised evidence further indicates that rubrics can positively influence academic achievement and self regulated learning when they are clearly specified and used as formative tools for feedback and self assessment (Panadero et al., 2023; Taylor et al., 2024).

In Vietnam, scholarship on teaching Advanced Mathematics for students in economics-related disciplines has steadily grown along three strands. First, descriptive studies examine current teaching and learning practices and identify recurring issues, including compressed curricula, limited differentiation for heterogeneous students, and instructional approaches that insufficiently connect mathematical content to practical economic contexts. These studies typically recommend integrating authentic situations, combining active learning approaches, and strengthening personalised academic support (Hue, 2024; Thang et al., 2020). Second, an outcome-based and professional competency-oriented strand emphasises embedding workplace-relevant applications within the instruction of Advanced Mathematics in order to enhance students' capacity to apply mathematics and make decisions in economic contexts. This strand is exemplified by proposals to strengthen practical applications in Advanced Mathematics at Lac Hong University (Tran, 2016) and by work on teaching mathematics courses through professional skills development, aligned with the CDIO approach (Tran, 2022; Tran, 2019). Third, doctoral-level studies focus on specific pedagogical frameworks or targeted competencies, such as CDIO-based teaching to support learning-outcome attainment and instructional designs aimed at developing analytical thinking, thereby providing a stronger theoretical basis for competency-based learning activity design and assessment (Dung, 2020; Tran, 2019). Overall, domestic studies have highlighted major challenges and proposed promising directions such as

contextualisation in economic settings, increased modelling and practice-oriented tasks, and assessment innovation. However, further intervention studies with rigorous designs and outcome-aligned evidence systems are needed to quantify impacts at both the course and programme levels.

With regard to research on outcomes-based mathematics teaching, Tran (2018) proposed a set of professional skills that can be developed for students in economics-related disciplines through teaching mathematics courses. Subsequently, Tran (2022) examined an instructional approach that emphasises skills development as a means of supporting the attainment of programme learning outcomes. To date, however, there has been no comprehensive study on the teaching of Advanced Mathematics that explicitly targets the programme learning outcomes of economics-related programmes under the AUN-QA framework.

The contributions of this paper are threefold: (1) it proposes a course design framework linking course learning outcomes, learning activities, and assessment evidence in line with AUN-QA requirements; (2) it operationalises three instructional measures that can be implemented consistently throughout an Advanced Mathematics course; and (3) it outlines an assessment and data collection system to support continuous improvement at the course level.

### 3. MATERIALS AND METHODS

The study adopts a design-based development approach to instructional design, integrating (i) theoretical inquiry to establish a scientific basis for the proposed measures and (ii) practice-based inquiry in the form of a reflective synthesis of teaching experience. This approach is consistent with the paper's aim of proposing pedagogical solutions that are both theoretically grounded and implementable in classroom practice.

The study was conceptualised in the context of the Advanced Mathematics course for economics related students at Lac Hong University. The course is compulsory and is usually offered to students in the early stage of their undergraduate programme. In this context, students often have heterogeneous mathematical backgrounds and may experience difficulties in connecting mathematical techniques with economic meanings. Therefore, the proposed instructional design focuses on contextualised learning activities, explicit modelling support, and assessment evidence aligned with CLOs.

For the theoretical component, the author analyses and synthesises international literature on AUN-QA and outcome-based teaching and learning. In addition, the author examines the prescribed learning outcomes and the content structure of the Advanced Mathematics course for economics-related discipline majors, with reference to AUN-QA requirements and the official course syllabus at Lac Hong University.

For the practical component, the author synthesised his own teaching experience accumulated through teaching the Advanced Mathematics course for economics-related students at Lac Hong University, complemented by classroom observations and analyses of student learning artefacts, such as written work, student worksheets, project reports, presentations and learning journals. These inputs are used to (a) identify recurring student difficulties, (b) refine the organisation of learning activities, and (c) select assessment evidence aligned with each CLO.

This study is design-oriented rather than experimental. Its purpose is to develop and justify an AUN-QA aligned instructional design framework for Advanced Mathematics, not to test causal effects on student achievement. Therefore, classroom observations and student learning artefacts were used to support the design logic, the alignment among CLOs, learning activities and assessment tasks, and the feasibility of implementation. Future studies may examine the effectiveness of the proposed measures through pre-test and post-test data, rubric-based CLO attainment, and student feedback.

*Table 3. Data sources and assessment evidence used in the design process*

<b>Data source / evidence</b>	<b>Purpose in the study</b>	<b>Related CLOs</b>
Course syllabus and CLO documents	To identify expected learning outcomes and course content structure	CLO1 to CLO5
Classroom observation notes	To identify students' difficulties in translating economic situations into mathematical models	CLO1, CLO2, CLO3
Student worksheets	To examine how students formulate variables, equations and mathematical models	CLO1, CLO2, CLO3

Quizzes and tests	To assess students' understanding of matrix operations, linear equations and differential calculus	CLO1, CLO2, CLO3
Project reports	To assess modelling, calculation, interpretation and economic recommendations	CLO1, CLO2, CLO3, CLO4
Presentations	To assess communication, teamwork and explanation of modelling results	CLO4, CLO5
Learning journals	To collect evidence of self study, reflection and learning difficulties	CLO4
Rubrics	To collect structured evidence of project performance and CLO attainment	CLO1 to CLO5

The data sources listed in Table 3 were not used for statistical hypothesis testing. Instead, they served as design evidence to support the development of the proposed instructional framework. Classroom observation notes were used to identify recurring student difficulties in translating economic situations into mathematical models. Student worksheets, quizzes, project reports, presentations, and learning journals were reviewed qualitatively to identify common patterns in students' modelling, calculation, interpretation, collaboration, and self-study. Rubrics were used as structured tools to organise evidence of CLO attainment and to support course-level continuous improvement.

The research procedure comprises four stages: (1) analysing AUN-QA requirements and the programme and course learning outcomes; (2) constructing a design matrix linking course learning outcomes, learning activities, and assessment evidence; (3) designing and providing detailed descriptions of three instructional measures with illustrative examples; and (4) mapping the measures against criteria of alignment, feasibility, relevance to learning outcomes, and capacity to generate assessment evidence.

## 4. RESULTS AND DISCUSSION

### 4.1. Principles to propose measures

The proposed measures must align with the course content and learning outcomes under the AUN-QA framework; be feasible for implementation throughout the course; explicitly target the attainment of the learning outcomes; and support students in applying Advanced Mathematics to professional scenarios.

*Table 4. Design matrix linking course learning outcomes, core learning activities, and suggested assessment evidence*

Course learning outcome	Core learning activities	Suggested assessment evidence
CLO1	Experiential learning; real world problem modelling; project work	In class tasks; quizzes/tests; project report
CLO2	Experiential learning; real world problem modelling; project work	In class tasks; quizzes/tests; project report
CLO3	Experiential learning; real world problem modelling; project work	In class tasks; quizzes/tests; project report
CLO4	Lesson preparation; learning journals	Lesson summaries; short answer responses
CLO5	Role based teamwork; presentations	Project report; rubrics

### 4.2. Proposed instructional measures for AUN-QA aligned teaching of Advanced Mathematics

#### 4.2.1. Measure 1: Applying Kolb's experiential learning model to introduce new mathematical content through economic scenarios

This measure draws on Kolb's experiential learning cycle (Kolb, 1984), comprising concrete experience, reflective observation, abstract conceptualisation, and active experimentation. A key design feature is the use of an

economically meaningful opening scenario to activate students' prior knowledge and create a genuine learning need before introducing new concepts or techniques. Instruction informed by this model aligns with learner-centred principles and facilitates the ongoing collection of evidence, while also enabling students to recognise the practical relevance of mathematical knowledge from the outset of the lesson. Building on the literature on Kolb's experiential learning model and the specific characteristics of Advanced Mathematics, the author proposes a four step design procedure for teaching this course using an experiential learning approach (Tran & Nguyen, 2020).

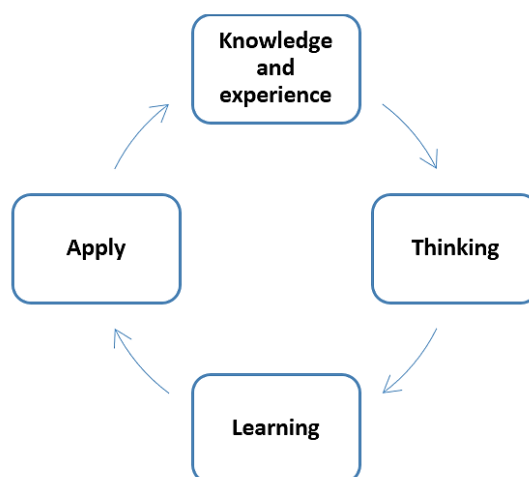


Figure 1. Experiential teaching model for the Advanced Mathematics course

Figure 1 illustrates the experiential teaching cycle, and the detailed work to be performed at each stage is presented in Table 5.

Table 5. Teachers' work during steps of the experience model

No.	Step of the model	Work to be done
1	Knowledge and experience	State the opening problem
		Ask questions that recall relevant past lessons.
		Ask questions that mobilize known knowledge
2	Thinking	Ask provocative questions
		Guide students to discuss in pairs or small groups
		Worksheets can be distributed to students to complete in small groups.
3	Studying	Summarize student answers
		Guide students to discuss and debate in groups and individually
		Guide students to present new knowledge content from the opening activity.
4	Applying	Present simple application problems.
		Introduce higher level application problems
		Summary and consolidation through applied exercises

The following passages illustrate the steps of the model in detail through the lesson "System of linear equations and its application in economics."

**Step 1: Knowledge and experience**

The teacher presents a situation pertaining to the lesson content, posing appropriate questions for students to mobilize their own knowledge and experience to complete the learning task effectively.

Firstly, the teacher presents the problem. A food processing company needs to process a type of pizza containing three types of nutrients: protein, carbohydrate, and fat. They are taken from three types of food: A, B, and C. The amount of nutrients in 1g of each type of food and the requirements of each type of nutrient needed in a pizza are illustrated in the following table:

Table 6. Nutrient content and demand in the pizza problem

Nutrients	Nutrient content (g)			Demand (g)
	A	B	C	
Protein	0.1	0.2	0.3	6
Carbohydrate	0.2	0.5	0.4	14
Fat	0	0.1	0.3	3

Find the mass of each type of food, A, B, and C, needed to make a pizza that meets the nutritional requirements (Tran & Dinh, 2024).

### Step 2: Thinking

Teachers need to divide the class into small groups, organize students to work in groups, encourage them to present their own opinions, and know how to listen, defend, and refute. The interaction between group members is considered a miniature social environment, preferably with mutual understanding and respect, thereby helping students to be more open in communication. After students finish their exchange and discussion in groups, the teacher invites a group representative to present their opinions in front of the whole class. The process of sharing and feedback among groups continues for all the groups; the teacher listens, comments, evaluates, and praises. In the lesson "Systems of linear equations applied in economics", in this thinking step, the teacher asks students open-ended questions concerning the opening problem as follows.

1. Determine the requirements of the problem.

Expected answer: The mass (g) of each food type, A, B, and C, needed to make a pizza.

The teacher suggests that students set a variable for the problem: Let  $x_1$ ,  $x_2$ ,  $x_3$  be the mass (g) of each food type A, B, C needed to make a pizza, with  $x_1, x_2, x_3 \geq 0$ .

2. What is the mass of nutrients (protein, carbohydrate, and fat) obtained from the mass of foods A, B, and C used above?

Expected answer:

Protein:  $0.1x_1 + 0.2x_2 + 0.3x_3$  (g); Carbohydrate:  $0.2x_1 + 0.5x_2 + 0.4x_3$  (g);

Fat:  $0x_1 + 0.1x_2 + 0.3x_3$  (g).

3. To meet the nutritional requirements set out in a pizza, what conditions must the mass of each nutrient satisfy?

Expected answer:

Protein:  $0.1x_1 + 0.2x_2 + 0.3x_3 = 6$ ; Carbohydrate:  $0.2x_1 + 0.5x_2 + 0.4x_3 = 14$ ;

Fat:  $0x_1 + 0.1x_2 + 0.3x_3 = 3$ .

Teacher consolidates: The problem requirement becomes to find  $x_1, x_2, x_3$  that satisfies the system of equations:

$$\begin{cases} 0.1x_1 + 0.2x_2 + 0.3x_3 = 6 \\ 0.2x_1 + 0.5x_2 + 0.4x_3 = 14 \\ 0x_1 + 0.1x_2 + 0.3x_3 = 3 \end{cases}$$

and the above system of equations is called a system of linear equations with three unknowns, three equations.

In this example,  $x_1, x_2, x_3$  denote the masses, measured in grams, of food types A, B and C used to make one pizza. Each equation is constructed by matching the total amount of one nutrient obtained from the three food types with the required amount of that nutrient. The example is intentionally simple because it is used at the introductory stage of the lesson to help students understand how tabular data can be transformed into a system of linear equations.

### **Step 3: Studying**

From the inherent experience with the lesson content, through the process of contemplation, sharing, and feedback with friends and teachers, students need a certain amount of time to interact with the textbook and reference materials and listen to lectures. As a result, students can understand the general principles of the lesson and be able to express what they have learned in words. For example, for the above problem, the teacher asks questions for students to synthesize the results from the opening problem, forming the concept of a general linear system of equations.

### **Step 4: Applying**

The basic content of the lesson has been grasped by students but needs to be applied in new situations. The role of the teacher in this stage is to set higher demand for students so that they not only understand the lesson content and have interdisciplinary knowledge through situations but also proactively and effectively apply that knowledge in professional practice. An example of a problem applying linear equations in economics could be: A factory produces three types of products: chairs, tables, and cabinets. Each product must go through three stages of cutting, assembling, and painting, with the required time (hours) for each stage listed in the following table:

*Table 7. Processing time by production stage for chairs, tables, and cabinets*

Stage	Chair	Table	Cabinet
Cut	0.6	1.0	1.5
Assemble	0.6	0.9	1.2
Paint	0.2	0.3	0.5

The cutting, assembling, and painting departments have the highest number of working hours per week: 380, 330, and 120 working hours, respectively. How many of each type of product must the factory produce each week to operate at full capacity?

This measure supports students in achieving the course learning outcomes (CLO1, CLO2, and CLO3) through lessons that directly address the corresponding outcome related content knowledge.

#### *4.2.2. Measure 2: Guiding students to use a procedure for applying Advanced Mathematics to solve economic application problems*

Drawing on research on mathematics teaching methods (Nguyen & Vu, 2001), together with modelling procedures synthesised in the literature (Le, 2014; Nguyen, 2015; Niss & Blum, 2020; Stillman et al., 2008), and in alignment with the objective of delivering Advanced Mathematics in accordance with AUN-QA oriented learning outcomes (ASEAN University Network Quality Assurance, 2020), we propose a procedure for solving real world problems within Advanced Mathematics courses. This procedure is consistent with modelling research recommendations: students require structured support when switching between natural language and mathematical language, and they should be explicitly required to validate the reasonableness of results in economic contexts (Le, 2014; Niss & Blum, 2020). The proposed procedure comprises three steps:

**Step 1. Mathematical modelling:** Students translate the real situation into a mathematical model, reformulating the problem in a form that is compatible with relevant mathematical knowledge and tools.

**Step 2. Model processing:** Students solve the mathematical problem using appropriate mathematical knowledge and techniques.

**Step 3. Result translation:** Students translate the mathematical results back to the original situation and provide a response to the real world question.

The implementation of the measure is illustrated through the following example.

*Example:* A store imports green-skinned grapefruit at an import price of 30,000 VND per fruit and sells it at a selling price of 50,000 VND per fruit. At this selling price, the store expects to sell only forty fruits. The store has

decided to reduce the selling price, knowing that if the store reduces each fruit by 5,000 VND, the number of grapefruits sold will increase by fifty fruits. Determine the selling price of grapefruit so that the store can earn the greatest profit and calculate that profit. (Tran & Dinh, 2024)

Step 1: Build a mathematical model

Let  $x$  be the new selling price of 1 grapefruit (thousand VND), with  $30 \leq x \leq 50$ , and  $P(x)$  is the profit function.

Profit: (number of grapefruits sold) · (profit per grapefruit)

Price decrease compared to the original:  $50 - x$  (thousand VND).

Number of grapefruits sold:  $10(50 - x) = 500 - 10x$  (fruits)

Total number of grapefruits sold at the new selling price:  $40 + 500 - 10x = 540 - 10x$  (fruits)

Profit function is:  $P(x) = (540 - 10x)(x - 30) = -10x^2 + 840x - 16200$  (thousand VND)

Step 2: Process the model

The problem becomes finding the maximum of the function:  $P(x) = -10x^2 + 840x - 16200$ , with  $30 \leq x \leq 50$

We have:  $P'(x) = -20x + 840$ ;  $P'(x) = 0 \Leftrightarrow -20x + 840 = 0 \Leftrightarrow x = 42 (y = 1440)$

Create a variation table:

$x$	30	42	50
$P'(x)$		+	-
$P(x)$	0	1440	800

So, the function reaches its maximum value at  $x = 42 (y = 1440)$ .

Step 3: Convert the results to answer the practical question.

The optimal selling price is 42,000 VND per grapefruit. Then, the maximum profit is 1,440,000 VND.

This example is used to illustrate the modelling procedure in a familiar pricing context. The focus is not on the complexity of the business situation, but on helping students identify variables, formulate the profit function, apply differential calculus, and translate the mathematical result into an economic decision. More complex applications can be implemented through project based tasks, in which students collect data, make assumptions, construct matrices, calculate revenue and profit, and propose practical recommendations.

This measure enables students to apply Advanced Mathematics tools to practical economic problems through the steps of the proposed real world problem solving procedure. In addition, it contributes to the development of key competencies such as mathematical modelling and problem solving. Accordingly, it serves as a core instructional measure supporting students in attaining the Advanced Mathematics course learning outcomes aligned with the AUN-QA requirements, namely CLO1, CLO2, and CLO3.

#### 4.2.3. Measure 3: Implementing project-based tasks to apply Advanced Mathematics to practical economic problems

Project-based tasks are intended to develop students' transfer competence, moving from problem identification to data collection and standardisation, modelling, solution procedures, interpretation, and decision recommendations. In higher education, project-based learning has been documented as an effective approach for fostering integrative competence while also producing tangible learning artefacts that can serve as assessment evidence (Guo et al., 2020). Evidence from a large scale meta analysis further indicates that project based learning yields a positive effect on academic achievement (Chen & Yang, 2019).

From an assessment perspective, projects align well with authentic assessment because they evaluate competence through tasks that approximate professional practice and generate diverse products (e.g., reports, spreadsheets,

presentations, and peer critiques). A systematic literature review by Vlachopoulos and Makri (2024) shows that authentic assessment supports the development of skills such as problem solving, collaboration, and communication.

Sample project: “Managing a Small Coffee Shop for Seven Days” (Tran & Dinh, 2024).

1) Real world situation:

A small coffee shop (e.g., a shop near the university) sells four common product categories:

- A: Coffee (black/milk coffee)
- B: Tea and non-coffee beverages
- C: Pastries and light snacks
- D: Bottled water and other items

The shop operates three sales channels:

- K1: Dine in sales
- K2: Takeaway
- K3: App-based delivery

Requirements:

Over a seven-day period, the shop would like to determine:

1. Sales by channel: quantities sold via each channel, total revenue and profit, inventory changes, and which items should be prioritised for replenishment.

2. Pricing scenario: if the price of category A increases by 5%, how does weekly profit change (given that sales volume remains constant, or decreases according to a rate proposed by the group with a clear justification)?

3. Procurement plan for the following week: recommend which items to increase or decrease in purchasing, based on sales quantities and profit.

Guidance on data collection and estimation

Each group selects one real coffee shop. Data should be collected from receipts, shop records, or structured observation with an explicit rationale. If exact data cannot be obtained, the group may use justified estimates and must clearly describe the estimation method and assumptions. This design emphasises translation between economic situations and mathematical representations, and the interpretation and validation of results in context.

Daily Sales Data Collection Table (Product Quantities): For each day, construct a sales quantity matrix  $Q(t)$  of size  $3 \times 4$ . Rows correspond to sales channels (K1, K2, K3), and columns correspond to product categories (A, B, C, D). An example of the Day 1 matrix is provided below.

Table 8. Day 1 sales quantity matrix  $Q(1)$  for the coffee shop project

Channel / Category	A	B	C	D
K1				
K2				
K3				

Project objectives:

Table 9. Objectives of the project “Managing a Small Coffee Shop for Seven Days”

No.	Objective domain	Description	Aligned learning outcomes
1	Knowledge	Consolidate, extend, and deepen knowledge of matrix operations and their applications in economics.	CLO1
2	Skills	Mathematical modelling; problem solving; teamwork; oral presentation.	CLO4

No.	Objective domain	Description	Aligned learning outcomes
3	Attitudes	Demonstrate proactive, active, and self directed engagement in learning; collaborate effectively in group work and take responsibility for the team and the class.	CLO5

Implementation procedure

Step 1 - Initiation: Define the project objectives.

Step 2 - Planning: The instructor forms student groups and assigns tasks and project requirements to each group.

Step 3 - Project execution: Students collect data, develop the mathematical model, carry out analyses, and prepare deliverables.

Step 4 - Product presentation: Groups present their outputs (report and presentation) to the class.

Step 5 - Project assessment: Assessment should be conducted using rubrics. To ensure explicit alignment with AUN-QA, the project rubric should be structured along key dimensions such as the accuracy of the mathematical model, the plausibility of the economic interpretation, the quality of group collaboration, and the quality of academic communication. Rubrics also enable systematic collection of evidence data across semester-wide cycles to support continuous improvement.

*Table 10. Suggested rubric for assessing project based tasks*

Criterion	Excellent	Good	Satisfactory	Needs improvement
Mathematical model	The model is correct, complete and appropriate for the economic situation.	The model is mostly correct with minor limitations.	The model is understandable but contains some errors.	The model is incomplete or inappropriate.
Data and assumptions	Data sources and assumptions are clearly described and well justified.	Data sources and assumptions are mostly clear.	Some data or assumptions are unclear.	Data sources and assumptions are weak or unjustified.
Calculation and analysis	Calculations are accurate and analysis is logically presented.	Calculations are mostly accurate.	Some calculation errors are present but do not seriously affect the conclusion.	Calculations are inaccurate or poorly organised.
Economic interpretation	Results are interpreted convincingly and linked to practical recommendations.	Interpretation is mostly appropriate.	Interpretation is limited or general.	Interpretation is unclear or disconnected from the problem.
Teamwork and presentation	The group collaborates effectively and presents ideas clearly.	Collaboration and presentation are generally good.	Collaboration or presentation is uneven.	Teamwork and presentation are weak.

The rubric can be used not only for grading but also for collecting comparable evidence of CLO attainment across semesters. Overall, this measure supports students' attainment of course learning outcomes across knowledge, skills, and attitudes, namely CLO1, CLO2, CLO3, CLO4, and CLO5.

#### **4.3. Discussion: Alignment, expected value, and policy and practice implications**

The three proposed measures share a common foundation - the principle of constructive alignment: learning outcomes are operationalised through the learning activities students are required to perform and the corresponding assessment evidence. This approach is consistent with the AUN-QA Version 4.0 requirements regarding coherence among expected learning outcomes, teaching and learning approaches, and assessment, as well as the requirement to use assessment data to inform improvement.

In terms of expected effectiveness, Measure 1 is intended to help students recognise the meaning and applicability of Advanced Mathematics in economics; Measure 2 is designed to develop modelling and interpretation competence, which is central to economic decision making; and Measure 3 aims to strengthen students' application capability, collaboration, and communication, aligning with learning outcomes related to teamwork and lifelong learning.

Regarding feasibility, the measures are designed to be integrated into the existing course structure. They do not require major changes in contact hours; however, they do require instructors to prepare contextual scenarios, data sources, and rubrics. A limitation of the present study is that it does not employ an experimental design to evaluate the effectiveness of the proposed measures. Accordingly, a key direction for future research is to implement semester-wide evaluation using pre-post data, combining quantitative analyses of achievement scores with qualitative analyses of student feedback. Such evidence would enable contextual refinement of the measures for specific classroom settings.

Therefore, the present study should be interpreted as a pedagogical design study rather than an empirical study. Its contribution lies in the development of an aligned instructional and assessment framework, while empirical verification of student learning gains remains a direction for future research.

From a policy and practice-oriented perspective, the proposed design provides a practical mechanism for connecting course-level teaching evidence with programme-level quality assurance. Programme managers can use the CLO activity evidence matrix to review whether the Advanced Mathematics course genuinely contributes to the intended outcomes of economics-related programmes, while lecturers can use the same matrix to devise formative feedback, project rubrics, and learning support. The findings also qualify the implementation of AUN-QA by showing that alignment should not be treated only as documentary compliance; it should be translated into recurring learning activities and assessment artefacts that reveal how students apply mathematical knowledge in economic contexts.

## 5. CONCLUSION

This paper proposes three instructional measures for teaching Advanced Mathematics to students in economics-related disciplines in alignment with the AUN-QA framework. The measures are mutually reinforcing: experiential learning helps students recognise the economic meaning of mathematical concepts; the modelling procedure supports translation between real situations and mathematical representations; and project based tasks generate authentic evidence of knowledge, skills, and attitudes. Together, these measures operationalise the alignment among course learning outcomes, learning activities, and assessment evidence, thereby supporting both student learning and programme-level quality assurance.

Three implementation recommendations are also offered. First, the design matrix linking course learning outcomes, learning activities, and assessment evidence should be standardised in the course syllabus. Second, shared rubrics should be developed for common task clusters, including modelling exercises, project reports, presentations, and collaborative work. Third, assessment results and student feedback should be archived across semesters so that instructors and programme managers can analyse outcome attainment and adjust course content, learning support, and assessment tasks within a continuous improvement cycle.

The study is limited by its design-based and reflective nature; it does not include an experimental or quasi experimental evaluation of student learning gains. Future research should implement the proposed measures with multiple student cohorts, collect quantitative and qualitative evidence of CLO attainment, and compare learning outcomes across instructional conditions. Such evidence would strengthen the empirical basis for integrating Advanced Mathematics into outcomes based economics education and for using course assessment data in AUN-QA aligned programme governance. Future empirical studies should apply the proposed framework to multiple cohorts and analyse students' CLO attainment through rubric scores, achievement tests and qualitative feedback.

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