



Lecturer's pedagogical attributes and teaching quality for construction and engineering education in UK universities: mediating effect of research informed teaching.

Journal:	<i>Journal of Applied Research in Higher Education</i>
Manuscript ID	JARHE-05-2023-0216.R2
Manuscript Type:	Research Paper
Keywords:	Pedagogy, lecturers, teaching quality, structural equation modelling, students, universities

SCHOLARONE™
Manuscripts

Lecturer's pedagogical attributes and teaching quality for construction and engineering education in UK universities: mediating effect of research informed teaching

Abstract

Purpose - Researchers have opined that the quality of commitment to pedagogical approaches by lecturers is one of the most important factors in determining student academic success. The purpose of this paper is to analyse the mediating effect of research informed teaching on the relationship between lecturer commitment to use of pedagogical approaches and teaching quality, with a view towards enabling delivery of high quality teaching and learning in HEIs.

Design/methodology/approach – The research is based on an online survey of the perception of 186 undergraduate and postgraduate students in four major UK universities. Covariance-based structural equation modelling (SEM) methodology was used to quantify and clarify the influence of lecturers' pedagogical attributes on teaching quality, mediated by research-informed teaching.

Findings – Findings reveal that: lecturers' pedagogical attributes have significant positive effect on teaching quality, research-informed teaching have significant positive effect on teaching quality, lecturers' pedagogical attributes have weak positive effect on research-informed teaching, and research-informed teaching partially mediates (indirect effect) the relationship between lecturers' pedagogical attributes and teaching quality.

Practical implications – Structural equation models are useful for clarifying concepts in pedagogy and have implications for education managers on how to improve teaching and learning in HEIs.

Originality/value – The paper presents a unique quantitative model for measuring the degree of teaching quality in universities.

Key words: Pedagogy, lecturers, teaching quality, students, structural equation modelling, universities,

Introduction

Researchers have opined that the quality of commitment to pedagogical approaches by lecturers is one of the most important factors in determining student academic success. Pedagogy is a set of teaching methodologies whose primary aim is to build on student's prior learning and stimulate their interest towards learning. Arguably, stimulating student's interest towards learning enhances student engagement. This has been widely considered as the "Holy Grail" of learning and research have indicated a positive connection between engaging students and positive learning outcomes (Fredricks and Mccolskey, 2012). Inquiry based learning and problem-based learning are two of such pedagogical models that have actively engaged students. These approaches have led to better student experience, higher student achievement, accelerated levels of program completion and high prospects of immediate employment (Randles et al., 2022) especially for construction and engineering students who require such pedagogical delivery methods that use problem (project tasks) as triggers to solve real world problems in a student-centred practical setting. What this implies is that a good delivery of these approaches by lecturers has the potential of improving teaching quality which ultimately leads to better academic performance. Expectedly, there are consequences of poor or inadequate delivery of these approaches. For instance, students can become disillusioned, while classes become uninteresting and boring (Bridgeland et al., 2006); leading to what researchers describe as quiet and passive form of student resistance, low morale, wastage of resources and negative situation for all stakeholders (Virtanen et al., 2016; Zaccone and Pedrini, 2019). Research informed teaching which

1 links teaching with research is known to help students among other benefits, gain deep learning
2 experience of real-world problems, develop their critical thinking mentality, improve their confidence
3 and employability (Bentley et al., 2012; Bubou et al., 2017; Birmingham City University, 2022). On
4 the other hand, it helps lecturers to share enthusiasm about conducting research to stir students'
5 interest in critical thinking and conduct of research, while also enabling them to see preparation of
6 teaching modules from different points of view rather than relying on single point of view of solely
7 depending on text books. That said, it is noteworthy to point out that integrating research informed
8 teaching into teaching pedagogies has the potential of moderating the influence of teaching pedagogy
9 on teaching quality. That has not been tested empirically.

14 The theoretical framework proposed by Hills et al. (2003) to assess teaching quality, focuses on
15 quality of lecturer (mastery of subject knowledge, feedback mechanism, good facilitator), student
16 engagement with learning (flexible curriculum that relates to their worlds and broadens their
17 horizons), social/emotional support systems, and resources of library/IT. The framework among
18 others, demonstrates how students value their lecturers' influence on their educational experience in
19 the university. Apparently, students have continued to become more aware of how they are taught,
20 what and how they learn and therefore become more selective and interactive in their educational
21 choices how they participate in the education process (Petruzzellis et al., 2006 cited in Xiao and
22 Wilkins, 2015). In the wake of the covid19 pandemic and the national lockdown that followed across
23 UK, technology has come to influence how students perceive teaching quality. As such, online
24 teaching methodologies have come under spotlight resulting in lecturers having to race up to the
25 challenge in order to meet the aspiration of students. It is therefore safe to say that perception of
26 teaching quality by students will continue to be a yardstick for measuring educational performance
27 and academic excellence by universities in the ever competitive HE environment.

34 Structural Equation Modelling (SEM) is a multivariate technique for analysing causal relationships
35 among latent variables (variables that cannot be measured directly); and between latent variables and
36 manifest variables (indicators in form of questions in a questionnaire). Basically, SEM consists of
37 two parts. *Measurement model* describes the link between latent variables and their manifest variables
38 (Byrne, 2010; Hui and Zheng, 2010). The *structural model* describes the relationships among the
39 latent variables. Although SEM has been widely used across many disciplines including construction
40 management, its application in construction education has been relatively sparse. In a study to explore
41 the mediating role of entertainment on the relationship between social media information and student
42 performance, Dzogbenuku et al. (2021) used the PLS-SEM to discover that social media
43 entertainment is indispensable in creating social media content to achieve optimal performance
44 among university students. Additionally, Hameed et al. (2021) used SEM to examine the role of social
45 media on academic performance of university students. The study observed that social media usage
46 for non-academic purposes harm students, while social media control failure moderates the
47 relationship between social media usage for non-academic purpose and student academic
48 performance. Earlier, Xiao and Wilkins (2015) examined the effects of lecturer commitment on
49 teaching quality and student satisfaction using SEM. The study discovered that lecturer commitment
50 to students' academic achievement and lecturer commitment to the social integration of students are
51 both positively related to student satisfaction while lecturer commitment to the social integration of
52 students has no effect on teaching quality. The central conclusion of these studies is that SEM is
53 highly effective and appropriate for analysing direct and relative impacts of latent factors on the
54 measured phenomenon as it relates to teaching and learning. This research builds on these previous

1 studies on teaching and learning in higher education by using SEM to analyse the mediating effect of
2 research informed teaching on the relationship between lecturer commitment to use of pedagogical
3 approaches and teaching quality. The pedagogical approach is delimited to *problem based learning*
4 and *inquiry based learning* while *teaching quality* is adapted from the five dimensions of
5 SERVQUAL by Parasuraman et al. (1988) and Hills et al. (2003) model of teaching quality in higher
6 education.
7
8
9

10 **Literature Review**

11 Pedagogical approaches to teaching have received wide coverage in the research domain over the
12 past decade on account of the increasing desire by stakeholders to explore new innovative ways of
13 making students and lecturers as well enjoy the art of teaching and learning. An extensive body of
14 knowledge on this subject exists. This section starts with a conceptual review of problem-based and
15 inquiry-based learning, research informed teaching and teaching quality. It is followed by a
16 summarised review of few studies for the purpose of situating the research problem for this study.
17
18
19
20

21 **Problem based learning (PBL) and Inquiry based learning (IBL) pedagogies.**

22 *Problem based learning (PBL)* also referred to as project based learning by some schools of thought
23 is the pedagogy that uses problem to stimulate student interest in developing solutions in a student
24 centred practical or task based environment (Klegeris and Hurren, 2011). According to Barge (2010),
25 the PBL is governed by six principles encapsulated in the Aalborg model and they are problem
26 orientation, project organisation, integration of theory and practice, participant direction, team-based
27 approach and collaborative feedback. It is the pedagogy mostly common in the civil engineering and
28 construction management domains where consideration is given to practical engineering and
29 construction capabilities of students (Zhang et al., 2019). Thus, its effectiveness and efficiency can
30 be understood and analysed from the perspective of its quantifying influence on teaching quality in
31 HEIs. *Inquiry based learning (IBL)* on the other hand, is the pedagogy in which students are directly
32 involved in cognitive development and active participation to learn, understand, and master the
33 knowledge and skills related to a subject area (Asif et al., 2021). Thus, it is anchored on active learning
34 that allows students to explore their ideas, while the lecturer who acts as the “facilitator”, provides
35 guidance and feedback that builds a culture of confidence in them to become creative thinkers. It is
36 more of an abstract trigger but takes similar inductive approach as the PBL. PBL and IBL are two
37 pedagogies commonly used in the Construction and Engineering Management (CEM) education for
38 both undergraduate and postgraduate taught programmes. Apparently, critical thinking and self-
39 directing are essential features of the two pedagogical approaches and are widely used in the teaching
40 of undergraduate and postgraduate taught programmes across HEIs in UK. They bring out skills and
41 capabilities from students and is attributable to their ability to facilitate development of content-
42 specific knowledge base and transferable project-specific skills for direct professional application in
43 a team-focused problem solving workplace environment (Corvers et al., 2016), common to the
44 construction industry. Additionally, they provide veritable platform for exploring the rich complexity
45 and challenges of the construction industry through critical thinking and deep understanding of the
46 real world problems. We therefore submit that lecturer’s use of both approaches in the classroom has
47 the capability of affecting teaching quality which ultimately and potentially will produce resilient
48 practitioners from students who will drive the fourth industrial revolution while allowing them to
49 have the best teaching and learning experience.
50
51
52
53
54
55
56
57
58
59
60

Research informed teaching.

Several researchers have defined research informed teaching based on their discipline orientation. For instance, this has led to it being called such names as research-teaching, research-led teaching, research based practices in teaching (Brown et al., 2022; Abanda, 2022). However, this study aligns with the definition commonly used by universities which is; “a term used to describe the different ways in which students are exposed to research content and activity during their time in the university (Birmingham City University, 2022; University of Plymouth, 2022). Thus, in applying PBL or IBL for teaching in the classroom by lecturers, students can be encouraged to engage in simple research exercise related to what they are taught in the classroom. **Across several universities in UK, students at advanced stages of undergraduate and postgraduate taught programmes undertake research and knowledge exchange activities as part of teaching and learning that generate new knowledge base. Moreso, this feeds into journal articles, patents, books and PhD theses which feeds into undergraduate and postgraduate curriculum thereby keeping taught contents current, innovative and challenging. This can underpin personal knowledge and skills development, develop new career opportunities, support enhanced employability, and increase overall student satisfaction with their educational experience (Liverpool John Moore University, 2023). Furthermore,** their intellectual skills through critical analysis of real world problems are triggered which can influence the relationship between use of these pedagogies and teaching quality. That is the intent of this research.

Teaching quality

Several indicators have been developed in the literature for measuring service delivery. Most of these have revolved around SERVQUAL model developed by Parasuraman et al. (1988). This comprises a five-dimensional index of tangibles, reliability, responsiveness, assurance, and empathy. *Tangibles* explains the look of the facility, tools, people, and information exchange materials. *Reliability* is the capability to achieve the expected service reliably and precisely. *Responsiveness* shows the readiness to assist users and the provision of prompt services. *Assurance* is the expertise and politeness of workforce and their capability to transmit trust and confidence. *Empathy* is the considerate, personal devotion provided by organisations to customers. Majority of teaching quality measurements in universities and other HEIs however rely on students’ satisfaction of teaching, competence, attitude, content and academic quality resources (Owlia and Aspinwall, 1996; Xiao and Wilkins, 2015). Meanwhile, Hill et al. (2003) empirically developed 4 themes for measuring teaching quality in universities. These include lecturer (mastery of subject knowledge, feedback mechanism, and good facilitator), student engagement with learning (flexible curriculum that relates to their worlds and broadens their horizons), social/emotional support systems, and resources of library/IT. The common theme in these studies is that the lecturer is at the centre stage of ensuring teaching quality in universities provided all the necessary resources needed are in place.

Review of past empirical studies

Asif et al. (2021) developed a framework of heterogeneous pedagogical approaches for promoting student engagement in a university undergrad classroom in Saudi Arabia using action research. These approaches include think-pair-share approach, flipped learning, pictorial presentation, and virtual learning environment among others. The study concluded by arguing that there is a growing pressure on universities to develop quality assurance systems and methodologies that transcend current realities and increase student learning. Although the study provides a scientific data based approach to improving academic performance, it however did not investigate the influence of these approaches on academic performance which can be measured by student perception of teaching quality. Randles

1 et al. (2022) conducted a deductive research to investigate the proposition that enquiry and problem
2 based learning pedagogies are appropriate for developing mission-oriented innovation policy (MIP)
3 environments. The study, which comprised four levels of research discovered that there is no “one
4 fits all” in the application of the pedagogies. Rather, their application to different sustainability
5 challenges and learner groups justifies their versatility and creativity of the sustainability teachers. In
6 another study, Astuty (2015) examined the influence of four pedagogical competences (pedagogy,
7 personality, professionalism, and attitude) on student academic achievement in a university in
8 Indonesia. Using questionnaire survey and regression analysis, the study observed that if applied
9 separately, personality, professionalism, and attitude influence student academic achievement; while
10 when applied simultaneously, all the four competences display a significant influence on student
11 academic achievement. This study affirms the relevance and influence of pedagogy on teaching and
12 learning in universities but however falls short of quantifying the relative influence on teaching
13 quality demonstrated by academic achievement of students, making it inconclusive in the context of
14 this study. Although these and other past studies have provided useful insights into the concepts of
15 pedagogy and teaching quality, most of the previous studies relied on analyses based on traditional
16 approaches such as factor analysis, multiple regression analysis, qualitative analysis and descriptive
17 statistics. However, these methodologies are not appropriate for mutual relationships between latent
18 variables in such a way that both direct and indirect effects can be measured. For instance, multiple
19 regression analysis requires that independent variables must not be correlated (multi-collinearity)
20 while SEM permits correlation of latent variables which is likely to exist in this research; factor
21 analysis does not examine inter-relationships among latent variables but only provide information
22 about underlying relationships (factor loadings) between latent constructs and their observable
23 attributes; and standard regression models allow modelling of direct effects only while SEM allows
24 for direct, indirect and correlative effects (Ikediashi and Mbamali, 2014).

25
26
27
28
29
30
31
32
33
34
35 Several other studies have however been carried out using SEM. In one of them, Giner and Rillo
36 (2015) empirically used SEM to measure the impact of co-creation on marketing outcome of student
37 satisfaction and loyalty among PG students at Spanish universities. The study also analysed the
38 mediating effect of satisfaction on the link between co-creation and loyalty. The study discovered
39 that co-creation has a high positive effect on student satisfaction, but a moderate positive effect on
40 student loyalty. However, according to the study, satisfaction moderately affects student loyalty but
41 partially mediates the relationship between co-creation and student loyalty. Thus, within the context
42 of our study, student satisfaction and student perception can be empirically measured both directly
43 and indirectly (mediating effect) using SEM. Osman et al. (2018) investigated the mediating role of
44 institutional image in the relationship between student satisfaction, programme quality and service
45 quality in the context of HE among fourth year students at a university in Bangladesh. The study
46 found out that image of the university had a full mediating influence on student satisfaction and
47 service quality, while the direct effect of student satisfaction on service quality was not statistically
48 significant. Thus, the study affirms the relevance of SERVQUAL for measuring service quality and
49 SEM for investigating phenomenon in the teaching and learning in HEIs.

50
51
52
53
54
55
56 From the review above, it is clear that in most studies, efforts have been made to identify and appraise
57 lecturer’s commitment, teaching quality and academic performance of students based on perception
58 of students and lecturers in HEIs. However, quantification of lecturers’ commitment to pedagogical
59 approaches and their relative impacts on teaching quality, mediated by research-informed teaching
60 have not been investigated in many previous studies. This research extends that body of knowledge

1 by using SEM to clarify the direct effect of lecturer pedagogical attributes on teaching quality in UK
2 universities and the indirect effect (mediating role) of research informed teaching on the relationship
3 between lecturer pedagogical attributes and teaching quality.
4
5

6 **Theoretical framework and conceptual model**

7 Table 1 indicates the latent factors and their measured attributes in the hypothetical construct of the
8 research as well as the supporting references.
9
10

11 *Position of table 1*

12 The relationship between the latent variables and the manifest variables is shown in Figure 1.
13
14

15 *Position of figure 1*

16 The conceptual model comprises manifest variables shown in rectangles and unobservable latent
17 variables shown in eclipses. The arrows represent the direction of the hypothesised influence. For
18 instance, the influence of PBL attributes is presumed to be reflected in the observed measures of six
19 constructs Q1 to Q6 as depicted in the directional arrows. We therefore hypothesise that antecedents
20 of lecturer's pedagogical attributes (LPA) collectively influence teaching quality (TQ). More
21 specifically, PBL attributes influence TQ while IBL attributes also influence TQ. However, the direct
22 relationship between LPA and TQ would be mediated by research informed teaching (RIT) derived
23 from the observable variables of Q12, Q13, Q14 and Q15. We therefore also hypothesise that RIT
24 mediates the relationship between LPA and TQ. Accordingly, the study sets out the following
25 hypotheses:
26
27
28
29
30
31
32
33

34 *H1*: LPA will have a direct positive effect on TQ.

35 *H2*: LPA will have a direct positive effect on RIT.

36 *H3*: RIT will have a direct positive effect on TQ.
37
38
39

40 It is important to state that the review of the literature in the previous section provided the theoretical
41 foundation for the research thereby validating the conceptual consistency of the model.
42
43

44 **Research Methodology**

45 A quantitative questionnaire survey was adopted to test the conceptual model in UK universities. The
46 sample frame was drawn from part three and final year (undergraduate) and postgraduate taught
47 students of the Schools of Engineering and Built Environment in four universities namely Edinburgh
48 Napier University, Heriot Watt University, University of Salford and University of Westminster all
49 in UK. This set of students were selected for this study because they have face-to-face classroom
50 interaction with lecturers and are able to provide reliable data about teaching delivery of lectures in
51 their respective universities. The students were recruited through an online survey in which
52 anonymity of responses was maintained through sending of the survey link to dedicated emails
53 retrieved from the universities' servers in line with the ethical protocol set by the respective
54 universities. However, the structured questionnaire was first pilot tested through personal interview
55 and group discussion with students and lecturers to verify the validity of the questions being used and
56 to sample likely feedbacks from respondents. Before undertaking the survey, the questionnaire was
57 refined to reflect the feedback received from the pilot study.
58
59
60

1 The questionnaire was in four parts. Part one requested for respondents' demographics such as
2 gender, year of study and programme of study; the other four parts sourced for respondents'
3 perception of the influence of the measured attributes/indicators of pedagogy (problem-based
4 learning and inquiry-based learning), research-informed teaching and teaching quality. A five point
5 Likert scale of (1 = strongly agree, 2 = agree, 3 = neither agree nor disagree, 4 = agree and 5 = strongly
6 agree) was adopted to guide the respondents in making their decisions. The survey was conducted
7 between November, 2022 and April, 2023.
8
9
10

11
12 One hundred and eighty six (186) respondents validly completed the online questionnaire. Results of
13 the demographic profile of the respondents are shown in figure 2. It indicates that 38% of responses
14 were from Edinburgh Napier University, 31% were from University of Salford, 20% were from
15 University of Westminster, while 11% participated from Heriot Watt University. A total of 74% were
16 postgraduate students while the remaining 26% were undergraduate students. In terms of programme
17 of study, 72% were studying Built Environment related programmes while 26% were studying
18 Engineering related programmes. The remaining 2% were studying programmes unrelated to either
19 of Built Environment or Engineering.
20
21
22

23
24 *Position of figure 2.*
25

26
27 Descriptive statistics was used to analyse the sample characteristics while the AMOS module of SPSS
28 version 29 was used to estimate the specific SEM in this study; and the estimations were covariance
29 based. Covariance-based SEM makes use of the maximum likelihood estimate approach with
30 standard errors and based on multivariate normality. As stated earlier, structural equation models
31 comprise two components namely measurement model and structural model. For this study,
32 measurement model determined how well observable variables otherwise called manifest variables
33 shown in Table 1 measured the latent variables while incorporating estimates of errors of
34 measurement of the manifest variables and their latent variables. On the other hand, structural model
35 which is akin to simultaneous regression models analysed the relationship between the latent variables
36 while taking into account the mechanisms within a process (Please see Doloi et al., 2012).
37
38
39
40

41 **Results and findings**

42
43

44 **Measurement model**

45 In order to establish confidence in the measurement model, four preliminary checks were conducted.
46 This was to ensure that a feasible model fit for SEM analysis is selected. First, exploratory factor
47 analysis (EFA) was carried out on the 20 manifest variables to confirm the factor structure of the
48 latent variables (Doloi et al., 2012; Ikediashi and Mbamali, 2014). The EFA was carried out in three
49 trials to refine the model. After two trials, Q05 and Q11 were deleted having failed to meet the
50 required threshold of 0.5 (Byrne, 2010). The third and final trial produced four components that
51 explained 71.03% of the total variance explained (Table 2). Results also indicate that the Eigen value
52 for each of the extracted components was greater than 1 (Kaiser, 1960) while % of total variance
53 explained was greater than 5% (King, 1969). This confirmed validity of the EFA procedure.
54
55
56
57

58 *Position of table 2*
59
60

Several other measures were used to establish confidence and confirm the level of reliability and validity of the constructs before running the structural model. Reliability checks using Cronbach's alpha was conducted on the attributes. Results from Table 2 indicates a range of 0.843 and 0.932, which is above the required threshold of 0.7 (Hair, et al., 2013) and therefore within acceptable levels. Additionally, Average Variance Explained (AVE) for the 4-construct model satisfied the minimum values suggested by Hair et al. (2016) indicating a satisfactory convergent validity. To measure the discriminate validity, the square root of AVE of two constructs in a model must be greater than the correlation between them (Fornell and Larcker, 1981; Giner and Rillo, 2016). The result of Pearson correlation analysis is shown in Table 3. A cursory check on Tables 2 and 3 indicate that the square root of AVE for PBL and IBL are 0.879 and 0.897 respectively and are more than correlation of 0.645 between them. This is replica of all the other 3 constructs in the model and demonstrates that there is adequate discriminate validity.

Position of table 3

Confirmatory Factor Analysis (CFA) was used to confirm strength of the measurement model. It was established using recommended benchmark of "Goodness of fit" measures suggested by Schermelleh-Engel et al. (2003), Hui and Zheng (2010) and Bagozzi and Yi, 2012. The result is presented in Table 4. Overall, the model was adjudged to be good fit with the data as all the parameters were within the recommended thresholds. For instance, the RMSEA value for the model was 0.018, lower than 0.08 as suggested by (Tabachnick and Fidell, 2017) meaning that the final model cannot be rejected at a higher level of confidence.

Position of table 4

Structural model

The structural component of the SEM model was analysed using AMOS of SPSS version 22 software. The standardised path estimates and standard errors of the hypothesised model is presented in Table 5. This is further confirmed in figure 3 where the path coefficients are shown to be statically significant at the 0.1 percent level. It shows that all the three hypotheses are strongly supported by the empirical data. More specifically, the hypothesis that a higher use of lecturer's pedagogical attributes leads to a higher level of teaching quality is confirmed by the structural model with a high positive parameter estimate (path coefficient 0.882). However, the relationship between lecturer's pedagogical attributes and research informed teaching was positive but weak (path coefficient 0.391) while the relationship between research informed teaching and teaching quality was positive and strong with path coefficient 0.620 (please see table 6).

Position of table 5

Position of table 6

Position of figure 3

Mediation effect

In order to test for mediation, Baron and Kenny (1986) suggested that for mediation to take place, the effect of the independent variable (LPA in this case) on the dependent variable (TQ in this instance) must decrease in both significance and magnitude when the mediator (RIT) is introduced to the model. Put differently, Nitzl et al. (2016) is of the view that, if the indirect effect of an exogenous variable on an endogenous variable through a mediator is significant, there is mediation; otherwise

there is no mediation. Result in Table 7 shows that RIT partially mediates the link between LPA and TQ. Apparently, the high proportion of mediation (72.6%) is an indication that the use of research informed teaching is a significant mediator on the relationship between LPA and TQ, thereby affirming the postulated hypothesis.

Position of table 7.

Discussion of findings

The results support the three hypotheses postulated for the study. Specifically, it shows that lecturers' pedagogical commitments in the classroom in terms of problem-based and inquiry-based approaches significantly impact teaching quality. This tallies with previous studies (Astuty, 2015; Hills et al., 2003; Asif et al., 2021; Randles et al., 2022) which reported that lecturers' pedagogical commitments lead to improved teaching quality which ultimately affects academic performance of students. Theoretically, it confirms the relevance and influence of pedagogy on teaching and learning in universities. The implication is that the use of PBL and IBL for teaching CEM programmes engender teaching quality and provide that unique platform for exploring the rich complexity and challenges of the construction and engineering industry through critical thinking and deep understanding of the real world problems. The result also confirms a strong and positive relationship between research informed teaching and teaching quality. It affirms the findings from previous studies (Bentley et al., 2012; Bubou et al., 2017; Birmingham City University, 2022) that RIT which describes the numerous ways lecturers expose students to research contents and activities during their time in the university significantly impacts teaching quality. By implication, students are therefore able to develop deep learning experience, build a sense of confidence among themselves and develop critical thinking mentality for solving real world problems. The relationship between lecturers' pedagogical attributes and research informed teaching was also tested using SEM and discovered to be positive but weak.

The result also indicates that research informed teaching mediates between lecturers' pedagogical attributes and teaching quality. The 72.6% proportion of mediation is a confirmation that the use of research informed teaching for teaching subject areas particularly in CEM education is absolutely essential if lecturers' pedagogical commitments are to make meaningful impact on teaching quality in universities. Arguably, intellectual skills through critical analysis of real world problems are triggered if the concept is adequately incorporated into teaching pedagogies which can influence the relationship between use of these pedagogies and teaching quality. A study conducted by Mali and Lim (2022) revealed that students who participated in research-informed teaching exhibited significant academic performance when compared to students in another group who did not participate in research-informed teaching. By implication, every modern teaching establishment such as universities is left with no better choice that to introduce research-informed teaching into their curriculum.

Conclusion and recommendations

This study investigated the effect of lecturers' pedagogical attributes (LPA) operationalised as 5 attributes of problem-based learning and 4 attributes of inquiry-based learning on teaching quality (TQ), as well as how research informed teaching mediates LPA and TQ in UK universities. We demonstrated the use of SEM as a powerful tool to clarify the causal relationships between the latent and observed variables using data from 186 respondents spread across 4 UK universities. The study concludes by strongly confirming the three hypotheses set up for the study as follows:

- 1
- 2
- 3 1. Lecturers' pedagogical attributes have a direct positive effect on teaching quality,
- 4 2. Lecturers' pedagogical attributes have a direct positive effect on research-informed teaching,
- 5 and
- 6
- 7 3. Research-informed teaching have a direct positive effect on teaching quality.
- 8

9 More precisely, findings suggest that lecturers' commitment to pedagogy is critical to effective
10 teaching in universities and has an indirect influence on teaching quality when mediated by research
11 informed teaching comprising 3 related attributes, including encouraging students to publish outcome
12 of their UG/PG dissertations, getting students involved in research activities linked to the subject
13 knowledge areas and encouraging students to initiate research topics. Therefore, universities and
14 HEIs should scale up efforts in conjunction with the HEA to prepare university workforce especially
15 lecturers with the requisite skills, knowledge and competencies needed to make significant impact
16 within the context of research-informed teaching embedded in IBL and PBL pedagogical innovations.
17 This can facilitate students' learning experience in a way that traditional, didactic teaching and
18 learning cannot (Randles et al., 2022). Evidence has shown that students value their lecturers and the
19 quality of their educational experience is influenced by lecturers' expertise in the classroom (Hill et
20 al., 2003).

21 This outcome has significant theoretical implications. As acknowledged by Olanrewaju et al. (2021),
22 adding new knowledge through the feeling in of key research gaps constitute significant contribution
23 to knowledge. Accordingly, the study provides more insights about the body of knowledge on
24 pedagogy by exploring nature of influence of pedagogical attributes on teaching quality in UK
25 universities. Additionally, it has for the first time validated the mediating role of research-informed
26 teaching in teaching quality and affirmed the continued relevance of SERVQUAL model for teaching
27 quality research by validating some components of the model. The study also produced profound
28 practical implications. For instance, one of the goals of CEM education is to continue to improve the
29 curriculum that reflects the global and national manpower needs of the industry. The outcome of this
30 research has provided an impetus for education stakeholders to integrate the use of research-informed
31 teaching for curriculum development. Plausibly, the use of problem-solving and inquiry-based skills
32 by lecturers, supported by research-informed teaching skills have profound effect on the success of
33 projects and professional career paths of products (students) of our universities. Therefore,
34 Universities and industrial stakeholders should explore the inherent creativity in the concept by
35 overhauling the CEM curriculum to fully incorporate research-informed teaching to enhance learning
36 experience of students.

37 The study has some obvious limitations. It was conducted using one strand of inquiry (quantitative
38 questionnaire survey). Further research could be carried out using interview and group discussion
39 methods to further explore and develop more insights about the concept of research-informed
40 teaching. Besides, students from four UK universities (two each from England and Scotland)
41 participated in the survey. A countrywide investigation involving more universities could be
42 conducted to triangulate outcome of this research.

References

- Abanda, F.H. (2022). "Research-informed teaching for assessing BIM courses during COVID-19 and beyond". *Journal of Applied Research in Higher Education*, DOI 10.1108/JARHE-08-2021-0306.
- Astuty, E. (2015). "Implementation analysis of lecturer's pedagogical competence on student's academic achievement". *Journal of Management Research*, Vo. 7 No. 2, pp. 152-158
- Asif, M., Thomas, G., Awan, M.U. and Dun, A.M. (2021). "Enhancing student engagement through heterogeneous pedagogical approaches: action research in a university level course in Saudi Arabia". *International Journal of Education Management*, Vol. 35 No.1, pp. 1-28
- Bagozzi, R.P. and Yi, Y. (2012), "Specification, evaluation, and interpretation of structural equation models", *Journal of the Academy of Marketing Science*, Vol. 40 No.1, pp.8–34.
- Barge, S. (2010), "Principles of problem and project based learning of the Aalborg model", available at: www.aau.dk/digitalAssets/62/62747_pbl_aalborg_modellen.pdf
- Baron, R.M. and Kenny, D.A. (1986), "The moderator-mediator variable distinction in social psychological research: conceptual, strategic and statistical considerations", *Journal of Personal Social Psychology*, Vol. 51 No. 6, 1173
- Birmingham University (2022), "Bringing our research into teaching", available at: <https://www.birmingham.ac.uk/university/hefi/funding-opportunities/projects/eefp288fs.aspx> [Accessed 20 September 2022].
- Bridgeland, J.M., Diiulio, J.J. Jr and Morison, K.B. (2006). *The Silent Epidemic: Perspectives of High School Dropouts*, Civic Enterprises, Washington, DC.
- Brown, C., Flood, J. and MacGregor, S. (Eds) (2022). *The Research-Informed Teaching Revolution –North America: A Handbook for the 21st Century Teacher*, John Catt Educational.
- Bubou, G.M., Offor, I.T. and Bappa, A.S. (2017). "Why research-informed teaching in engineering education? A review of the evidence". *European Journal of Engineering Education*, Vol. 42 No. 3, pp. 323-335.
- Byrne, B.M. (2010). *Structural Equation Modelling with AMOS: Basic Concepts, Applications and Programming*, 3rd edition, Rutledge, Taylor and Francis, New York, NY
- Corvers, R., Weik, A., de Kraker, J., Lang, D. and Martens, P. (2016). "Problem-based and project-based learning for sustainable 'development", in Heinrichs, H., Martens, P., Michelsen, G., Weik, A., (Eds), *Sustainability Science*, Springer, Chapter 29.
- Doloi, H., Sawhney, A. and Iyer, K.C. (2012). "Structural equation model for investigating factors affecting delay in Indian construction projects", *Construction Management and Economics*, Vol. 30 No. 10, 869–84.
- Dzogbenuku, R.K., Doe, J.K. and Amoako, G.K. (2022). "Social media information and student performance: the mediating role of hedonic value (entertainment)". *Journal of Research in Innovative Teaching*, Vol. 15 No.1, pp.132-146.
- Fornell, C. and Larcker, D.F. (1981), "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error", *Journal of Marketing Research*, Vol. 18, No. 1, pp. 39-50.
- Fredricks, J.A. and Mccolskey, W. (2012), "The measurement of student engagement: a comparative analysis of various methods and student self-report instruments", in *Handbook of Research on Student Engagement*, Springer, Boston, MA.

- 1 Giner, G.R. and Rillo, A.P. (2015). "Structural equation modelling of co-creation and its influence
2 on the student's satisfaction and loyalty towards university", *Journal of Computational*
3 *and Applied Mathematics*, Vol. 291, pp. 257-263
- 4
5 Hair, J.F., Ringle, C.M. and Sarstedt, M. (2013), "Partial least squares structural equation modelling:
6 rigorous applications, better results and higher acceptance", *Long Range Planning*, Vol.
7 46 Nos 1-2, pp. 1-12.
- 8
9 Hair, J.F. Jr, Sarstedt, M., Matthews, L.M. and Ringle, C.M. (2016), "Identifying and treating
10 unobserved heterogeneity with FIMIX-PLS: part I – method", *European Business*
11 *Review*, Vol. 28 No. 1, pp. 63-76, doi: 10.1108/EBR-09-2015-0094.
- 12
13 Hameed, I., Haq, M.A., Khan, N. and Bibi, Z. (2001). "Social media usage and academic performance
14 from a cognitive loading perspective". *The International Journal of Learning Futures*,
15 Vol. 30 No.1, pp. 12-27.
- 16
17 Hill, Y., Lomas, L. and MacGregor, J. (2003). "Students' perceptions of quality in higher education".
18 *Quality Assurance in Education*", Vol. 11 No.1, pp. 15–20.
- 19
20 Hui, E.C.M. and Zheng, X. (2010). "Measuring customer satisfaction of FM service in housing sector:
21 a structural equation model approach", *Facilities*, Vol. 28 Nos. 5/6, 306-320.
- 22
23 Ikediashi, D.I., and Mbamali, I. (2014), "Modelling the impact of outsourcing decisions on facilities
24 management (FM) service-level performance: a case of Nigeria's public hospitals",
25 *Construction Management and Economics*, Vol. 32 No. 11, 1130-1147
- 26
27 Kaiser, H.F. (1960) The application of electronic computers to factor analysis. *Education and*
28 *Psychology Measurements*, Vol. 20, pp.141–57.
- 29
30 King, L.J. (1969). *Statistical Analysis in Geography*, Prentice Hall, Englewood Cliffs, NJ.
- 31
32 Klegeris, A. and Hurren, H. (2011). "Impact of problem-based learning in a large classroom setting:
33 Student perception and problem-solving skills". *Advances in Physiology Education*, Vol.
34 35 No.4, pp. 408-415.
- 35
36 **Liverpool John Moore University, (2023). "Research Impact: World leading research across LJMU",**
37 **available at <https://www.ljmu.ac.uk/research/impact-hub/research-informed-teaching>**
38 **[Accessed 29/7/2023]**
- 39
40 Mali, D. and Lim, H. (2022), "Can the introduction of a research-informed teaching intervention
41 enhance student performance and influence perceptions?", *Accounting Education*. doi:
42 10.1080/09639284.2021.2014914.
- 43
44 Nitzl, C., Roldan, J.L. and Cepeda, G. (2016), "Mediation analysis in partial least squares path
45 modelling: helping researchers discuss more sophisticated models", *Industrial*
46 *Management and Data Systems*, Vol. 116 No. 9, pp. 1849-1864.
- 47
48 Olanrewaju, O.I., Chileshe, N., Babarinde, S.A. and Sandanayake, M. (2021). "Investigating the
49 barriers to building information modelling (BIM) implementation within the Nigerian
50 construction industry", *Engineering, Construction and Architectural Management*, Vol. 27
51 No. 10, pp. 2931-2968
- 52
53 Osman, A., Saputra, R. and Luis, M. (2018). "Exploring mediating role of institutional image through
54 a Complete Structural Equation Modelling (SEM): A Perspective of Higher Education",
55 *International Journal for Quality Research*, Vol. 12 No. 2, pp.517–536.
- 56
57 Owlia, M.S. and Aspinwall, E.M. (1996). "A framework for the dimensions of quality in higher
58 education". *Quality Assurance in Education*, Vol. 4 No.2, pp.12–20.
- 59
60 Petruzzellis, L., D'Uggento, A.M., Romanazzi, S. and Sigala, M. (2006). "Student satisfaction and
quality of service in Italian universities". *Managing Service Quality*, Vol. 16 No.4, pp.
349–364.

- 1 Parasuraman, A., Zeithaml Valerie A, and Berry Leonard L (1988), “SERVQUAL: A multi-item
2 scale for measuring consumer perceptions of the service quality”, *Journal of Retailing*, Vol.
3 64 No. 1, pp. 12-40.
- 4
5 Randles, S., Dewick, P., Hannan, E., Nicholson, D.T., Rietbergen, M., Taylor, C., Vargas, V.R.,
6 Wadham, H. and Keeler, L.W. (2022). “Applying enquiry and problem based learning to
7 mission-oriented innovation policy: from policy to pedagogy to teaching and learning
8 practice”. *Journal of International Education in Business*, Vol. 15 No.1, pp. 52-73.
- 9
10 Tabachnick, B.G. and Fidell, L.S. (2007) *Using Multivariate Statistics*, 5th edn, Pearson Education,
11 Upper Saddle River, NJ.
- 12
13 University of Plymouth (2022). “Research-informed teaching”, available at:
14 [https://www.plymouth.ac.uk/about-us/teaching-and-learning/guidance-and-](https://www.plymouth.ac.uk/about-us/teaching-and-learning/guidance-and-resources/research-informed-teaching)
15 [resources/research-informed-teaching](https://www.plymouth.ac.uk/about-us/teaching-and-learning/guidance-and-resources/research-informed-teaching) (Accessed 20 September 2022).
- 16
17 Virtanen, T., Lerkkanen, M.-K., Poikkeus, A.M. and Kuorelahti, M. (2016), “Student engagement
18 and school burnout in Finnish lower-secondary schools: latent profile analysis”,
19 *Scandinavian Journal of Educational Research*, Vol. 62, pp. 519-537.
- 20
21 Xiao, J. and Wilkins, S. (2015). “The effects of lecturer commitment on student perceptions of
22 teaching quality and student satisfaction in Chinese higher education”. *Journal of higher*
23 *Education Policy and Management*, Vol. 37 No. 1, pp. 98-110.
- 24
25 The Quality Assurance Agency for Higher Education. (2018). UK Quality code for Higher Education:
26 Assuring and Enhancing Academic quality. Chapter B7: External Examining.
27 https://www.qaa.ac.uk/docs/qaa/quality-code/chapter-b7_-externalexamining.pdf
- 28
29 Zaccone, M.C. and Pedrini, M. (2019), “The effects of intrinsic and extrinsic motivation on students
30 learning effectiveness. Exploring the moderating role of gender”, *International Journal*
31 *of Educational Management*, Vol. 33, pp. 1381-1394.
- 32
33 Zhang, J., Xie, H. and Li, H. (2019). “Improvement of students’ problem-solving skills through
34 project execution planning in civil engineering and construction management education”.
35 *Engineering, Construction and Architectural Management*, Vol. 26 No. 7, pp. 1437-1454.
- 36
37 Zheng, X. and Hui, E.C.M. (2010). “Measuring customer satisfaction of FM service in housing sector:
38 a structural equation modelling approach”. *Facilities*, Vol. 28 Nos. 5/6, pp. 306-320.
- 39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Table 1: Latent and manifest variables and their supporting references

Latent variables	Manifest (observable) variables	Source(s)		
Lecturer pedagogical attributes (LPA)				
Problem-based learning (PBL)	Q01 Students allowed to divide project/problem into parts	Pilot study, group discussion, Barge (2010); Klegeris and Hurren (2011); Zhang et al. (2019).		
	Q02 Students allowed to stimulate tasks			
	Q03 Students encouraged to act in different project management roles			
	Q04 Site visits on real-world projects provided to observe technical and managerial activities			
	Q05 Constructive feedback provided			
	Q06 Students allowed to choose project tools and distribute tasks			
	Inquiry-based learning (IBL)		Q07 Students enabled to work independently	Pilot study; Corvers et al. (2016); Asif et al. (2021);
			Q08 Students allowed to set up goals and objectives	
			Q09 Challenging and enriching experience created	
			Q10 Constructive feedback provided	
			Q11 Students allowed to choose tools and tasks	
Research informed teaching (RIT)	Q12 My lecturers share enthusiasm about their research during lectures	Pilot study; Abanda (2022); BCU (2022); UP (2022).		
	Q13 Lecturers encourage students to publish outcome of their UG/PG dissertations			
	Q14 Lecturers get students involved in research activities linked to the subject knowledge areas.			
	Q15 Lecturers encourage students to initiate research topics			
Teaching Quality (TQ)	Q16 Lecturers demonstrate responsiveness by being prompt and responsive to students' queries	Pilot study; Parasuraman et al. (1988); Hill et al. (2013); Xiao and Wilkins (2015); Osman et al. (2018).		
	Q17 Lecturers demonstrate assurance by always instilling confidence in teaching and learning process			
	Q18 Lecturers show empathy by always giving individualised attention during lectures			
	Q19 Lecturers demonstrate tangibles by always appearing professionally dressed during lectures			
	Q20 Lecturers demonstrate reliability by being dependable in the delivery of their subject knowledge areas			

Note: BCU = Birmingham City University; UP = University of Plymouth

Table 2: Factor loadings, reliability and validity test results

Measured attributes	Extrated factors after 3 trials			
	PBL	IBL	RIT	TQ
Q01	0.891			
Q02	0.902			
Q03	0.811			
Q04	0.759			
Q06	0.741			
Q07		0.722		
Q08		0.785		
Q10		0.811		
Q12		0.842		
Q13			0.801	
Q14			0.767	
Q15			0.778	
Q16				0.744
Q17				0.802
Q18				0.891
Q19				0.784
Q20				0.822
Eigen values	4.67	3.82	3.25	2.04
% of variance	27.34	20.319	14.28	9.22
Cumulative %	27.34	47.53	61.81	71.03
Cronbach's alpha	0.911	0.843	0.904	0.932
AVE	0.772	0.804	0.714	0.881
Square root of AVE	0.879	0.897	0.845	0.939

Note: PBL = problem-based learning; IBL = Inquiry-based learning; RIT = research informed teaching; TQ = teaching quality; Details of measured attributes are shown in Table 1.

Extraction method: Principal Component Analysis

Table 3: Pearson correlation coefficient result

Constructs	Mean	SD	PBL	IBL	RIT	TQ
PBL	4.211	0.911	1	0.645	0.659	0.741
IBL	3.899	0.824	0.645	1	0.738	0.637
RIT	4.013	1.025	0.659	0.738	1	0.798
TQ	4.228	1.208	0.741	0.637	0.798	1

Table 4: GOF evaluation results of final SEM Model

Goodness of fit (GOF) measure	Recommended Good fit	Empirical results
$X^2/\text{degree of freedom}$	≤ 2	1.791
Incremental fit index (IFI)	Closer to 1, the stronger	0.983
Goodness-of-fit index (GFI)	Closer to 1, the stronger	0.922
Normal fit index (NFI)	$0.95 < \text{NFI} \leq 1$	0.978
Comparative fit index (CFI)	$0.97 < \text{CFI} \leq 1$	0.991
Tucker-Lewis index (TLI)	≥ 0.9	1.133
Root mean square error of approx.. (RMSEA)	< 0.08	0.018

Note: Adapted from Schermelleh-Engel et al. (2003), Hui and Zheng (2010), Bagozzi and Yi (2012).

Table 5: Structural path estimates for the final SEM model.

Hypothesis	Structural path	Path estimate	Standard error	t-value	p-value	Remark
H1	LPA>TQ	0.882	0.116	2.157	0.001*	Supported
H2	LPA>RIT	0.391	0.091	2.804	0.003*	Supported
H3	RIT>TQ	0.620	0.215	3.041	0.001*	Supported

Note: *Significant at $p < 0.05$

Table 6: Summary of hypotheses results

Hypothesis	Direction and magnitude	Mediation	Remark
H1	Positive and strong		Supported
H2	Positive and weak		Supported
H3	Positive and strong	Measured by RIT	Supported

Note: RIT = research informed teaching

Table 7: Mediation of research informed teaching (RIT) between lecturer pedagogical attributes (LPA) ad teaching quality (TQ)

Mediation path	Direct effect without mediator (a)	Direct effect with mediator (b)	Indirect effect (a*b)	Mediation type	Proportion of mediation
LPA>RIT>TQ	0.825**	0.663**	0.547*	Partial	0.726

Note: **Significant at p < 0.01; *Significant at p < 0.05

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

Journal of Applied Research in Higher Education

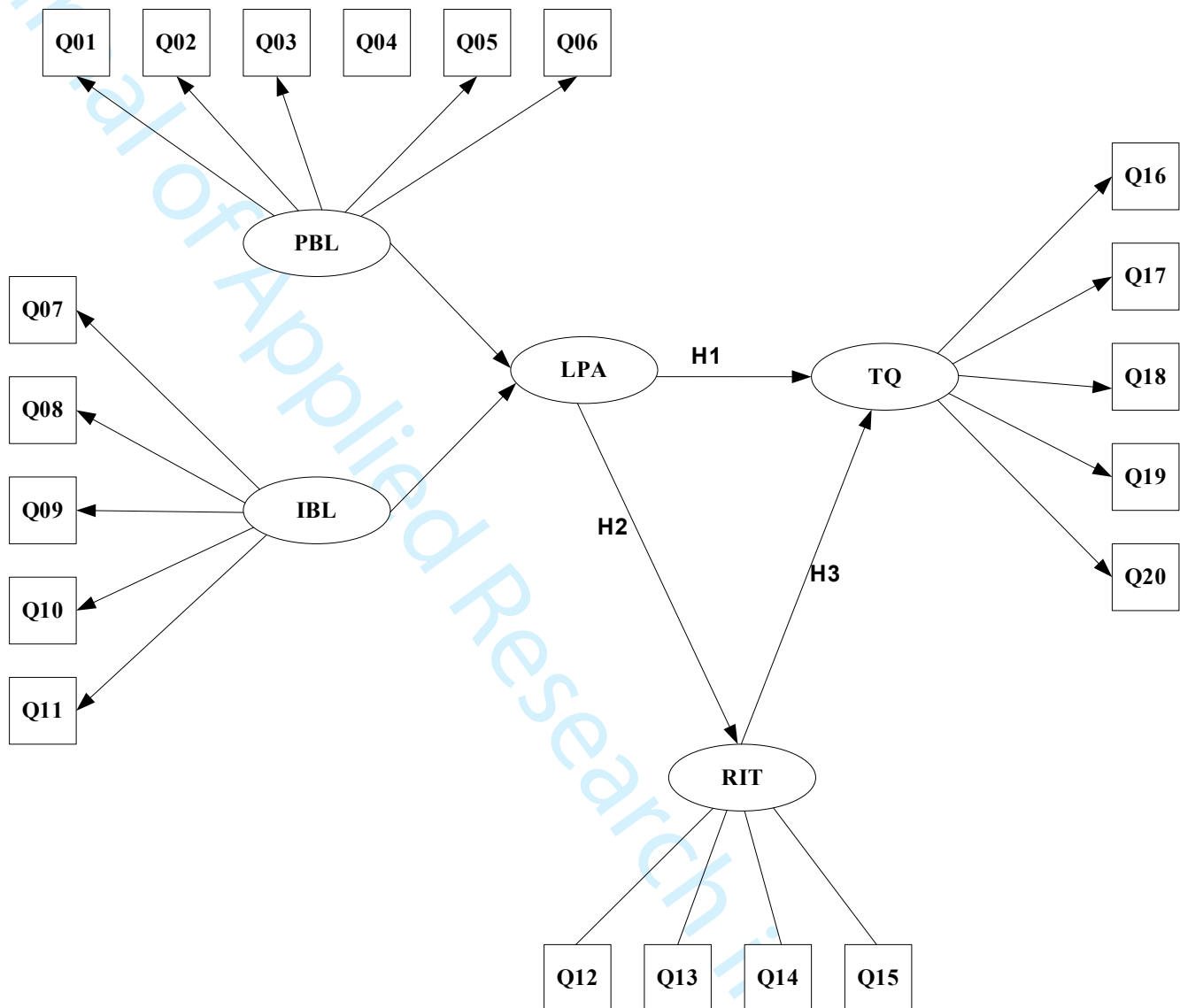


Figure 1: Hypothetical SEM model of pedagogy and teaching quality mediated by research-informed teaching.

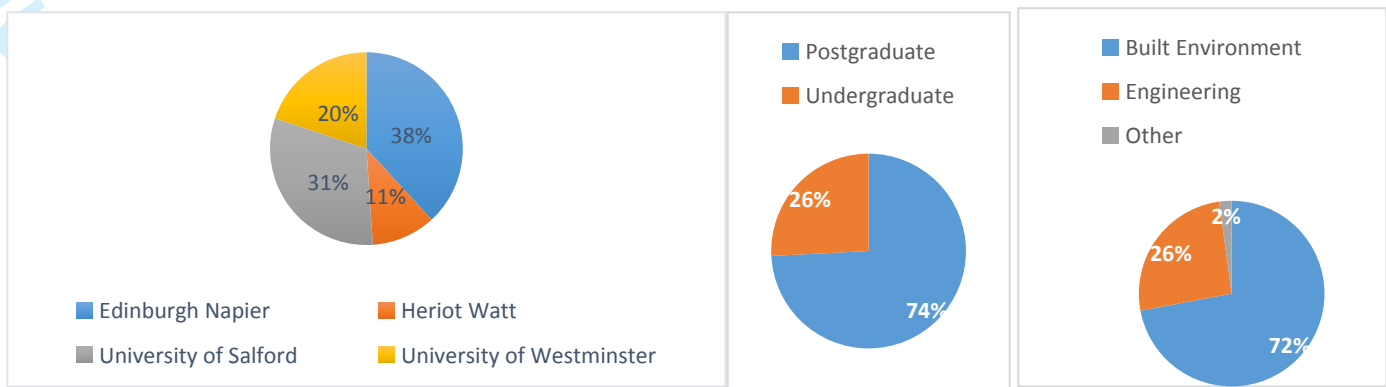


Figure 2: Demographic profile of respondents

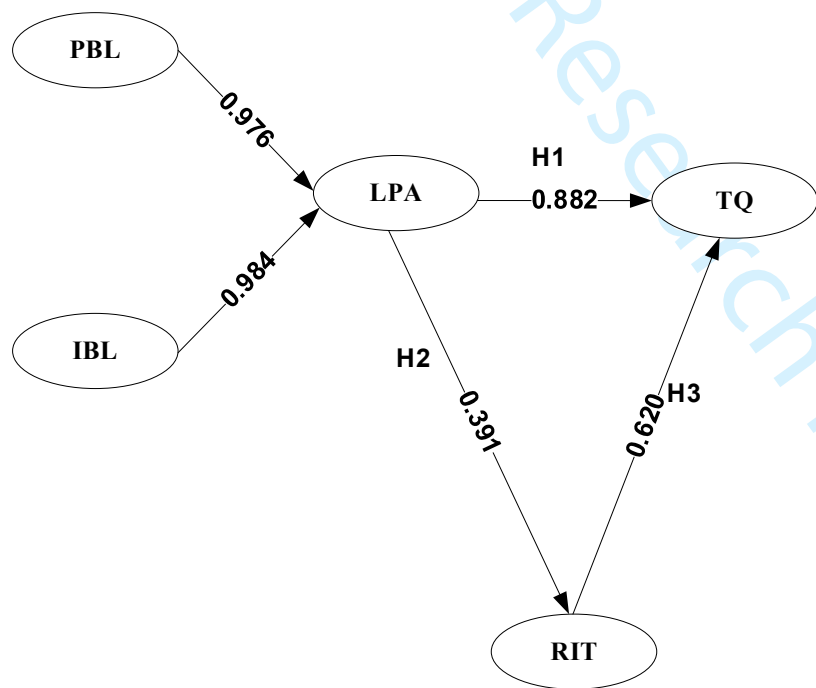


Figure 3: Final SEM model showing structural path results.