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ICT Awareness among Mathematics Lecturers in Malaysian Higher Education: Evidence from Kuala Lumpur

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Abstract

The rapid integration of information and communication technology (ICT) has transformed higher education and increased expectations for academic staff to understand and respond to technological change. This issue is particularly relevant in the context of Industry 4.0 (IR4.0), where universities are expected to prepare graduates and educators for increasingly technology-oriented environments. This study examines the level and pattern of ICT awareness among mathematics lecturers in Malaysian higher education, focusing on lecturers in Kuala Lumpur. A quantitative descriptive design was used. Data were collected fully online in 2022 from 121 mathematics lecturers using a questionnaire adapted from Sidin, Alias and Tahir (2020), with 14 indicators originally grouped under lecturer ICT awareness. Because the indicators include awareness-related perceptions as well as self-reported skills, technology use, professional learning and course participation, they are interpreted in this study as a broader indicator of self-reported ICT/IR4.0 awareness and readiness. The 14-item measure demonstrated strong internal consistency in the pilot study (Cronbach's alpha = .930). Descriptive statistics, including frequencies, percentages, means and standard deviations, were used. The overall self-reported ICT/IR4.0 awareness and readiness score was moderate (M = 3.72, SD = 0.47). The strongest indicator was optimism towards teaching and learning in the IR4.0 era (M = 4.15, SD = 0.61), followed by responsibility for learning about IR4.0 developments (M = 4.10, SD = 0.65). The lowest-rated indicator was regular attendance at IR4.0-related courses (M = 3.32, SD = 0.88). The findings show a descriptive difference between positive orientation towards technological transformation and reported participation in formal professional development. The study contributes context-specific evidence from Malaysian higher education and suggests that digital transformation requires sustained, discipline-sensitive professional development alongside technological infrastructure.

Keywords

ICT Awareness, Mathematics Lecturers, Higher Education, Industry 4.0, Digital Transformation, Professional Development, Malaysia

1. Introduction

Information and Communication Technology (ICT) has become increasingly embedded in contemporary higher education, influencing how lecturers communicate with students, develop learning materials, deliver instruction, assess learning and access academic resources. The expansion of digital and blended learning has consequently broadened expectations of university lecturers beyond disciplinary expertise to include technological and pedagogical awareness. Systematic research on university teachers' digital competence indicates that digital capability involves knowledge, skills and attitudes and that professional development remains an important requirement for effective digital teaching (Basilotta-Gómez-Pablos et al., 2022).

The emergence of Industry 4.0 (IR4.0) intensified these expectations by placing greater emphasis on technological change, adaptability and continuous learning in education. In Malaysia, the digital transformation agenda has continued to develop from the IR4.0 period towards broader institutional digitalisation. The Ministry of Higher Education's Digitalisation of Higher Education Policy 2025-2030 and associated Action Plan demonstrate that digital transformation remains a strategic priority, but policy direction alone does not guarantee consistent lecturer capability or adoption (Ministry of Higher Education Malaysia, 2025a, 2025b). This policy context reinforces the importance of academic staff capability alongside infrastructure and institutional systems.

However, technology availability should not be equated with lecturers' awareness, competence or actual use. A lecturer may recognise that a technology exists, understand that it is relevant, and hold a positive orientation towards technological change without necessarily possessing the skills, experience or institutional opportunity required to integrate it effectively. This distinction is central to the present study. ICT awareness is examined as a specific construct rather than as a synonym for digital competence or technology adoption. At the same time, the questionnaire used in the present study contains indicators that extend beyond narrow awareness, including self-reported technology-related skills, technology use, professional learning and participation in IR4.0-related courses. Accordingly, the study retains ICT awareness as its central conceptual focus but interprets the resulting 14-item score more cautiously as a broader indicator of self-reported ICT/IR4.0 awareness and readiness.

The issue is particularly relevant to mathematics education. Digital technologies can support mathematical representation, visualisation, problem solving, modelling, communication and assessment. Malaysian research has nevertheless identified continuing challenges involving resources, expertise, student engagement, communication, feedback, mathematical demonstration and visualisation in technology-mediated mathematics teaching (Manimaran & Nasir, 2024; Zin & Mahmud, 2024). Recent Malaysian literature also points to persistent institutional, infrastructural and professional-development issues alongside the emergence of AI and other technologies (Rais et al., 2025; Pitchan & Azmi, 2025).

Against this background, the present study focuses on mathematics lecturers in Kuala Lumpur. The empirical data were collected within an IR4.0-oriented context. The study therefore provides a historical empirical baseline of lecturers' ICT/IR4.0 awareness rather than a direct measure of contemporary generative-AI awareness.

2. Research Problem and Research Gap

2.1. Research Problem

The problem addressed in this study is not simply whether higher education institutions possess ICT infrastructure. The more specific problem is whether lecturers recognise technological developments and understand their relevance to teaching and learning. Existing higher education research has examined digital competence, digital literacy, technology acceptance and ICT integration extensively, but these constructs are broader than the specific awareness focus of the present study.

The problem is therefore not simply whether lecturers are "aware" or "unaware", but how awareness and related self-reported indicators are expressed across different aspects of technological change. Understanding lecturers' recognition of technological developments, orientation towards IR4.0, professional learning, technology-related skills and pedagogical application can provide a more nuanced picture of their reported preparedness for technological transformation. Such evidence may also help identify areas that warrant further attention in professional development.

The problem is therefore one of understanding the character of awareness rather than simply determining whether lecturers are "aware" or "unaware". Identifying the overall level and the stronger and weaker awareness indicators can provide a more useful basis for interpreting professional-development needs.

2.2. Research Gap

Three related gaps motivate the study. First, a conceptual gap exists because the higher education literature has focused strongly on digital competence, digital literacy, technology acceptance and technology integration, while ICT awareness is less consistently isolated as a distinct empirical construct. Second, a contextual gap exists because much of the systematic literature on university teachers' digital competence has emerged from international settings, whereas context-specific evidence concerning ICT awareness among academic staff in Malaysian higher education remains comparatively limited. Third, a disciplinary and empirical gap exists because Malaysian research on mathematics and technology has often examined school teachers, technology integration, distance learning or implementation challenges rather than the specific ICT-awareness pattern of mathematics lecturers in higher education (Manimaran & Nasir, 2024; Zin & Mahmud, 2024; Foong, 2024).

The present study addresses these gaps by examining the overall level and item-level pattern of ICT awareness among 121 mathematics lecturers in Kuala Lumpur. The study does not claim national representativeness, does not measure complete digital competence, and does not establish causal relationships between awareness and technology adoption.

3. Conceptualisation and Theoretical Position

3.1. Defining ICT Awareness

For the purposes of this study, ICT awareness refers to lecturers' recognition, understanding and perceived relevance of information and communication technologies (ICT) and Industry 4.0 (IR4.0)-related developments to teaching and learning. Awareness therefore concerns lecturers' recognition of technological developments, perceived relevance of technology to teaching and learning, orientation towards technological change, awareness of professional-learning needs, and recognition of technology-supported teaching and learning possibilities.

ICT awareness is conceptually distinct from digital competence and technology adoption. Digital competence encompasses the broader combination of knowledge, skills and attitudes required to use digital technologies effectively in professional practice (Basilotta-Gómez-Pablos et al., 2022; Basantes-Andrade et al., 2022; Redecker, 2017). Technology adoption refers more directly to the implementation and use of technologies in practice. Awareness, in contrast, concerns what lecturers recognise, understand and perceive as relevant.

The distinction is important because the questionnaire used in this study was adapted from an instrument originally developed to examine lecturers' knowledge and readiness in relation to IR4.0. Although the present study retained the 14 items from the original lecturer-awareness component, several items address dimensions that extend beyond narrow awareness. These include self-reported technology-related skills, reported technology use, professional learning and participation in IR4.0-related courses. Accordingly, the 14-item score is operationalised in this study as a broader indicator of self-reported ICT/IR4.0 awareness and readiness, rather than as a pure or objective measure of ICT awareness.

The term ICT awareness is retained as the central conceptual focus because awareness is the construct underlying the research problem and the original questionnaire component from which the 14 indicators were selected. However, throughout the reporting of the overall score, the more precise term self-reported ICT/IR4.0

awareness and readiness is used to reflect the actual content of the instrument. This distinction prevents the findings from being interpreted as evidence of objectively assessed digital competence, technological proficiency or actual technology adoption.

This operational distinction is consistent with previous empirical research involving higher-education teaching staff. Nannim et al. (2018) examined lecturers' awareness of ICT facilities available for teaching purposes, representing a relatively narrow awareness-focused operationalisation. Saravanaraj and Vijayakumar (2019) similarly examined ICT awareness among faculty members using questionnaire-based indicators concerning ICT and Internet resources. Emelogu et al. (2022), in a study of university ESL lecturers, explicitly examined awareness and proficiency as separate dimensions, further demonstrating that awareness can be distinguished conceptually from practical technological proficiency.

Taken together, these studies support the treatment of awareness as a distinct conceptual dimension while also highlighting that awareness measures may differ in scope. The present study therefore interprets its findings cautiously as self-reported ICT/IR4.0 awareness and readiness, based on the 14 retained indicators, rather than claiming to provide a comprehensive measure of lecturers' digital competence or technology adoption (Table 1).

Table 1. Conceptual distinction among related constructs.

Construct	Central concern	Status in this study
ICT awareness	Recognition, understanding and perceived relevance of ICT/IR4.0 developments	Central conceptual focus
Self-reported ICT/IR4.0 awareness and readiness	Self-reported awareness, orientation, professional learning, technology-related skills, technology use and pedagogical application	Operational interpretation of the 14 indicators
Digital competence	Knowledge, skills and attitudes enabling effective digital practice	Related construct; not objectively assessed
Technology adoption/use	Implementation and reported use of ICT for teaching and learning	Reflected in selected self-report indicators; not independently measured as an adoption construct

3.2. Theoretical and Framework Position

The study is informed by established digital-competence and technology-pedagogy frameworks rather than by a technology-adoption model. The European Framework for the Digital Competence of Educators (DigCompEdu) emphasises educators' professional engagement, digital resources, teaching and learning, assessment, empowering learners and facilitating learners' digital competence (Redecker, 2017). The TPACK framework similarly highlights the interaction between technological, pedagogical and content knowledge (Koehler & Mishra, 2009). These frameworks provide a useful theoretical backdrop for distinguishing awareness from competence and for interpreting why mathematics lecturers' awareness must be considered in relation to pedagogy and disciplinary practice.

The questionnaire used in this study should not, however, be described as a direct operationalisation of DigCompEdu or TPACK unless the instrument-development evidence establishes that relationship. In this study, the frameworks are used to position the construct conceptually, while the 14 questionnaire indicators provide the empirical basis for describing self-reported ICT/IR4.0 awareness and readiness. The indicators are retained under the broader ICT-awareness orientation of the original questionnaire, but their content is recognised as extending beyond narrow awareness.

3.3. Conceptual Relationship

Conceptually, ICT awareness may be understood as part of lecturers' engagement with technological transformation: recognition of technological relevance can coexist with an orientation towards continued learning and may create conditions for subsequent competence development. This is a conceptual interpretation only. The present descriptive, cross-sectional analysis does not test whether awareness causes professional development, competence or technology adoption.

4. Literature Review

4.1. ICT and Digital Transformation in Higher Education

Digital transformation has moved technology from a supplementary role towards a more embedded role in teaching, learning, research and institutional processes. University teachers increasingly need to select digital resources, communicate through online systems, develop digital learning materials and design technology-supported learning activities. Systematic reviews show that university teachers' digital competence remains uneven and that professional development continues to be necessary (Basilotta-Gómez-Pablos et al., 2022).

Recent Malaysian evidence reinforces the importance of institutional context. Research on blended learning, technology integration and university teaching identifies continuing issues involving leadership, infrastructure, resources, expertise and institutional support (Rais et al., 2025; Foong, 2024). The updated literature also indicates that digital transformation now includes AI, while ethical, policy and technical concerns remain relevant (Pitchan & Azmi, 2025). These developments strengthen the case for examining the human capability dimension of digitalisation.

4.2. ICT Awareness, Digital Competence and Professional Development

Digital competence provides an important broader context for understanding ICT awareness. Digital competence is multidimensional and includes knowledge, skills and attitudes required for effective digital practice. It is therefore inappropriate to infer lecturers' overall digital competence solely from self-reported awareness responses (Basilotta-Gómez-Pablos et al., 2022; Basantes-Andrade et al., 2022; Redecker, 2017). The present study instead focuses on lecturers' recognition of technological developments, perceived relevance of ICT and IR4.0 to teaching and learning, orientation towards technological change, and selected self-reported indicators of learning and technology-related practice.

Previous empirical studies have demonstrated that ICT awareness can be examined as a distinct dimension among higher-education teaching staff. Nannim et al. (2018) investigated lecturers' awareness of ICT facilities available for teaching purposes among university academic staff in Nigeria. Their questionnaire focused specifically on lecturers' awareness of the availability of ICT facilities for teaching, providing an example of a relatively narrow awareness-oriented operationalisation.

Similarly, Saravanaraj and Vijayakumar (2019) examined ICT awareness among faculty members of government Siddha colleges in Tamil Nadu using questionnaire-based indicators related to ICT and Internet resources. Their study demonstrates that awareness may concern lecturers' familiarity with and recognition of available technological resources rather than their demonstrated proficiency in using those resources. The study was published in the Indian Journal of Information Sources and Services, a double-blind peer-reviewed journal.

More recently, Emelogu et al. (2022) examined awareness and proficiency in the use of emerging technologies among university ESL lecturers. Importantly, the study treated awareness and proficiency as separate dimensions, with awareness referring to recognition or acknowledgement of emerging technologies and proficiency referring to the practical skills required to use them. This distinction provides direct support for separating awareness from technological competence in the present study.

These studies indicate that ICT awareness among higher-education lecturers can be operationalised in different ways depending on the research purpose. Narrower measures may focus on recognition of available ICT facilities or familiarity with technological resources, whereas broader measures may combine awareness with related orientations and self-reported preparedness. The present study adopts the latter approach because the adapted 14-item instrument contains indicators covering technological updating, professional learning, positive orientation, curriculum connection, pedagogical application, self-reported technology-related skills and technology use.

Accordingly, the present study does not treat the 14 items as statistically validated subscales or as a comprehensive measure of digital competence. Instead, the items are interpreted individually and collectively as indicators of self-reported ICT/IR4.0 awareness and readiness. This approach preserves the central focus on ICT awareness while acknowledging the broader operational content of the adapted instrument.

Professional development is particularly relevant to this distinction. Awareness of technological change does not necessarily imply proficiency in using technology effectively, and neither necessarily guarantees sustained technology adoption. Lecturers may recognise the relevance of emerging technologies while requiring further opportunities to develop practical skills and integrate those technologies with pedagogy and disciplinary practice. The present study therefore treats professional learning and reported course participation as related indicators of readiness rather than as direct measures of awareness or digital competence.

4.3. Industry 4.0 and Education 4.0

IR4.0 intensified attention to digitally enabled systems and the capabilities required by educators and graduates. Malaysian research has examined IR4.0 knowledge, learning application, university policy, commitment and motivation in relation to educational assimilation (Chik et al., 2024). Recent literature further describes Education 4.0 in relation to 4C skills, blended learning and technology-supported pedagogies (Noor Nasran & Zakaria, 2025; Rais et al., 2025).

At the same time, the terminology of digital transformation has evolved. Contemporary higher education increasingly includes generative AI and other emerging technologies. Because the present data were collected in an IR4.0-oriented context, the findings should be interpreted as evidence of awareness during that period and not as a direct measure of current AI awareness. This temporal qualification is essential for accurate interpretation.

4.4. ICT and Mathematics Education

Mathematics is a particularly relevant disciplinary context because technology can influence mathematical representation, visualisation, modelling, problem solving, communication and assessment. Malaysian evidence indicates that technology integration in mathematics continues to involve challenges related to resources, expertise and pedagogical practice (Manimaran & Nasir, 2024).

Among Malaysian university mathematics instructors, Zin and Mahmud (2024) reported challenges involving student engagement, communication, immediate feedback, mathematical demonstration and visualisation, preparation of learning materials and internet connectivity. These findings indicate that technology use in mathematics is not merely a question of access to tools; it involves the interaction between technological resources, mathematical content and pedagogy.

4.5. Malaysian Higher Education Context

Malaysia provides a relevant setting because digitalisation has become a national higher education priority. The Ministry of Higher Education's Digitalisation of Higher Education Policy 2025-2030 and Action Plan provide a current policy context in which ICT awareness is increasingly relevant to institutional digital transformation (Ministry of Higher Education Malaysia, 2025a, 2025b). However, policy documents establish strategic direction rather than evidence of lecturers' actual awareness. Empirical studies are therefore required to understand how academic staff recognise and respond to technological change.

Recent Malaysian literature identifies continuing institutional and contextual barriers, including resource scarcity, leadership, infrastructure and limited expertise. The updated literature also highlights emerging AI-related concerns, including ethics, plagiarism, technical expertise and the need for clearer institutional guidance (Pitchan & Azmi, 2025). These issues provide context for interpreting the present finding that positive orientation towards IR4.0 coexists with weaker formal course participation.

4.6. Literature Synthesis

The literature establishes four points relevant to this study. First, ICT is increasingly embedded in higher education, raising expectations for lecturers' technological and pedagogical capabilities. Second, ICT awareness should be distinguished from broader digital competence because awareness concerns recognition, understanding and perceived relevance rather than demonstrated proficiency. Third, mathematics education presents discipline-specific technology requirements and challenges. Fourth, Malaysian higher education is undergoing continued digitalisation, making academic staff development an important part of sustainable transformation.

Taken together, the literature suggests that the relevant question is not simply whether technology is available. It is whether lecturers recognise technological developments, understand their relevance to teaching and learning, and engage with continuing professional learning. This provides the rationale for examining both the overall level and the item-level pattern of self-reported ICT/IR4.0 awareness and readiness, while retaining ICT awareness as the central conceptual focus of the study.

5. Research Objective and Research Questions

RO1: To determine the overall level of self-reported ICT/IR4.0 awareness and readiness among mathematics lecturers in Kuala Lumpur.

RO2: To identify the item-level pattern of self-reported ICT/IR4.0 awareness and readiness among mathematics lecturers in Kuala Lumpur.

RQ1: What is the overall level of self-reported ICT/IR4.0 awareness and readiness among mathematics lecturers in Kuala Lumpur?

RQ2: What are the item-level patterns of self-reported ICT/IR4.0 awareness and readiness among mathematics lecturers in Kuala Lumpur?

6. Methodology

6.1. Research Design

This study employed a quantitative descriptive research design to examine the level and pattern of ICT awareness among mathematics lecturers in higher education institutions in Kuala Lumpur, Malaysia. The data were collected by the researcher in 2022 as part of a broader master's research project. The present article focuses on the descriptive analysis of ICT awareness and does not report correlational or predictive relationships with other constructs from the broader research project.

6.2. Participants and Context

The study involved 121 mathematics lecturers from higher education institutions in Kuala Lumpur, Malaysia. The eligibility criterion was that participants had to be lecturers who taught mathematics-related subjects, regardless of their years of teaching experience or academic seniority. Both newly appointed and experienced lecturers were eligible to participate, provided that they were teaching mathematics subjects.

A convenience sampling technique was used to recruit participants based on their accessibility and willingness to participate. The study approached 25 higher education institutions in Kuala Lumpur, comprising both public and private institutions. Potential participants were approached through email, social media platforms, LinkedIn, and the researcher's professional and personal contacts. A total of 350 invitations were distributed to eligible lecturers. Of these, 121 completed responses were obtained, representing a 34.6% completed-response rate.

Data collection was conducted fully online in 2022 because face-to-face data collection was constrained by the COVID-19 pandemic. Participation was voluntary, and participants were informed of the purpose of the study before completing the questionnaire. Informed consent was obtained from all participants prior to participation.

The final sample comprised 83 female respondents (68.6%) and 38 male respondents (31.4%). In terms of age, 64 respondents (52.9%) were aged 30 - 39 years. Regarding academic qualification, 71 respondents (58.7%) possessed a Master's degree. For teaching experience, 49 respondents (40.5%) had between one and five years of teaching experience. In terms of institutional type, 96 respondents (79.3%) worked in private higher education institutions, while 25 (20.7%) worked in public institutions. Because convenience sampling was used, the findings should be interpreted within the context of the participating respondents and the Kuala Lumpur setting and should not be generalised to all mathematics lecturers in Malaysian higher education (**Table 2**).

Table 2. Participant profile.

Profile characteristic	n	%
Female	83	68.6
Male	38	31.4
Age 30 - 39	64	52.9
Master's degree	71	58.7
1 - 5 years teaching experience	49	40.5
Private institution	96	79.3
Public institution	25	20.7

6.3. Instrument

The study used a 34-item questionnaire adapted from Sidin, Alias, and Tahir (2020), entitled Kesediaan Pengetahuan Revolusi Industri 4.0 Dalam Kalangan Pensyarah Politeknik Kota Kinabalu. The original questionnaire comprised four components: lecturer awareness (14 items), learning factor (7 items), knowledge management (7 items), and innovation (6 items). For the present study, only the 14 items originally grouped under the lecturer-awareness component were retained for analysis.

The 14 items were used in the present study without substantive changes to their original wording or meaning. The questionnaire was administered in English and responses were recorded using a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree.

Prior to the main data collection, a pilot study involving 30 lecturers from different academic and professional backgrounds was conducted. The pilot study was undertaken to assess the internal consistency of the 14 retained items before the main survey. The pilot results produced a Cronbach's alpha coefficient of .930, indicating strong internal consistency among the items. No formal expert-panel review was conducted during the adaptation process. The pilot reliability result is therefore reported as evidence from the pilot administration and not as evidence of expert-validated content validity.

6.4. Reliability

A pilot study was conducted to assess the reliability of the adapted questionnaire. The 14-item measure produced a Cronbach's alpha coefficient of .930, indicating strong internal consistency among the items during the pilot administration. The .930 coefficient is reported as the pilot-study reliability estimate and is not presented as the reliability coefficient of the final sample of 121 respondents because a separate final-sample reliability analysis is not reported in this article.

6.5. Data Analysis

The collected data were analysed using descriptive statistics. Frequencies and percentages were used to summarise the demographic characteristics of the respondents and the distribution of responses. Means and standard deviations were calculated to determine the overall level and item-level pattern of self-reported ICT/IR4.0 awareness and readiness. RQ1 was addressed using the overall self-reported ICT/IR4.0 awareness and readiness mean and standard deviation, while RQ2 was addressed using item-level means, standard deviations and comparative ranking. No causal or predictive inference was made from these analyses.

6.6. Operationalisation of ICT Awareness

The 14 retained questionnaire indicators cover several aspects of lecturers' reported engagement with ICT and IR4.0, including professional learning, technological updating, positive orientation, curriculum connection, pedagogical application, self-reported technology-related skills and technology use. Because these indicators extend beyond narrow awareness, they were operationalised collectively as a self-reported ICT/IR4.0 awareness and readiness measure.

The operationalisation does not assume that all 14 indicators represent a single statistically validated dimension of ICT awareness. Instead, the items are treated as descriptive indicators of different aspects of lecturers' reported awareness and preparedness. No factor analysis was conducted in the present study; therefore, no statistically validated subscales are claimed.

This approach allows the study to retain ICT awareness as its central conceptual focus while avoiding the stronger claim that the 14-item score represents objectively assessed awareness, digital competence, technological proficiency or technology adoption (Table 3).

Table 3. Indicators used to describe self-reported ICT/IR4.0 awareness and readiness.

No.	ICT-awareness indicator	M	SD
1	Regularly attend courses related to IR4.0	3.32	0.88
2	Regularly improve technology skills related to IR4.0	3.69	0.74
3	Continuously update knowledge of IR4.0	3.70	0.69
4	Regularly follow developments in IR4.0	3.63	0.79
5	Be optimistic about teaching and learning in IR4.0	4.15	0.61
6	Take responsibility for learning about IR4.0 developments	4.10	0.65
7	Become familiar with teaching and learning approaches aligned with IR4.0	3.59	0.77
8	Connect IR4.0 with curriculum content	3.79	0.62
9	Select teaching resources appropriate for IR4.0	3.74	0.68
10	Have strategies to manage changes brought by IR4.0	3.64	0.72
11	Have teaching and learning approaches appropriate for IR4.0	3.64	0.59
12	Be able to improve performance when using IR4.0 technology	3.77	0.69
13	Use application software for teaching and learning	3.67	0.76
14	Be able to use technology for teaching and learning in the 4.0 era	3.65	0.79

7. Results

7.1. Overall Self-Reported ICT/IR4.0 Awareness and Readiness

The overall self-reported ICT/IR4.0 awareness and readiness score was M = 3.72 (SD = 0.47). Following the mean-score interpretation reported by Sidin et al. (2020), scores of 1.00 - 1.99 are classified as weak, 2.00 - 2.99 as low, 3.00 - 3.99 as moderate, and 4.00 - 5.00 as high. These categories are used as descriptive reporting conventions based on the adapted source instrument and should not be interpreted as substantively validated thresholds. Based on this descriptive classification, the overall mean score of 3.72 falls within the moderate range.

The result indicates that respondents generally reported agreement with statements relating to ICT/IR4.0 awareness, orientation towards technological change, professional learning, technology-related skills, technology use, and technology-supported teaching practices. However, because the 14 indicators encompass several dimensions beyond narrow ICT awareness, the overall score is interpreted specifically as a self-reported ICT/IR4.0 awareness and readiness measure, rather than as a pure measure of ICT awareness, objectively assessed digital competence, technological proficiency, or actual technology adoption.

This interpretation is consistent with the operationalisation adopted in this study, in which the 14 indicators are treated as descriptive indicators of different aspects of lecturers' reported awareness and preparedness rather than as statistically validated subscales (Table 4).

Table 4. Overall self-reported ICT/IR4.0 awareness and readiness.

Variable	M	SD	Descriptive Level
Self-reported ICT/IR4.0 awareness and readiness	3.72	0.47	Moderate

7.2. Item-Level Pattern

The 14 indicators varied descriptively, with item means ranging from 3.32 to 4.15. The highest mean was recorded for optimism towards teaching and learning in the IR4.0 era (M = 4.15, SD = 0.61), followed by responsibility for learning about IR4.0 developments (M = 4.10, SD = 0.65). The lowest mean was regular attendance at IR4.0-related courses (M = 3.32, SD = 0.88). The remaining items ranged from M = 3.59 to M = 3.79 (Table 5).

Table 5. Ranked indicators of self-reported ICT/IR4.0 awareness and readiness.

Rank	Indicator	M	SD
1	Optimistic about IR4.0 teaching and learning	4.15	0.61
2	Responsible for learning about IR4.0	4.10	0.65
3	Connect IR4.0 with curriculum	3.79	0.62
4	Improve performance using IR4.0 technology	3.77	0.69
5	Select appropriate teaching resources	3.74	0.68
6	Update IR4.0 knowledge	3.70	0.69
7	Improve technology skills	3.69	0.74
8	Use application software	3.67	0.76
9	Use technology for teaching and learning	3.65	0.79
10	Strategies to manage IR4.0 changes	3.64	0.72
11	Appropriate IR4.0 teaching approaches	3.64	0.59
12	Follow IR4.0 developments	3.63	0.79
13	Familiar with IR4.0 teaching approaches	3.59	0.77
14	Attend IR4.0-related courses regularly	3.32	0.88

7.3. Professional Development

Regular participation in IR4.0-related courses was the lowest-rated indicator (M = 3.32, SD = 0.88), indicating comparatively lower self-reported participation in formal IR4.0-related courses than the other indicators. In contrast, 88.4% of respondents agreed that they were responsible for learning and developing knowledge about IR4.0. This descriptive pattern suggests that respondents reported strong personal responsibility for continued learning while reporting comparatively lower participation in formal IR4.0-related courses. However, the finding should not be interpreted as evidence of limited access to professional-development opportunities because institutional access, availability and participation barriers were not directly measured.

7.4. Curriculum and Pedagogical Awareness

Respondents reported relatively positive awareness concerning curriculum and pedagogical application. The mean for connecting IR4.0 with curriculum content was 3.79 (SD = 0.62), while selecting appropriate teaching resources was 3.74 (SD = 0.68). The mean for familiarity with IR4.0-aligned teaching and learning approaches was lower at 3.59 (SD = 0.77), suggesting greater variability in lecturers' perceived familiarity with specific approaches than in their general orientation towards curriculum integration.

7.5. Positive Orientation

Optimism towards teaching and learning in the IR4.0 era was the strongest indicator (M = 4.15, SD = 0.61). The data show that 106 lecturers (87.6%) expressed positive attitudes, while 15 (12.4%) were uncertain. This finding indicates a relatively positive self-reported orientation towards technological transformation among the respondents.

8. Discussion

The overall self-reported ICT/IR4.0 awareness and readiness score was M = 3.72 (SD = 0.47), which falls within the moderate category according to the descriptive classification used by Sidin et al. (2020). However, the result should not be interpreted as a pure measure of ICT awareness. The 14 indicators include awareness-related perceptions and orientations towards technological transformation as well as self-reported skills, technology use, professional learning and participation in IR4.0-related courses. The findings therefore provide a descriptive indication of respondents' reported awareness and preparedness rather than an objective assessment of digital competence or actual technology adoption.

One notable descriptive pattern is the difference between positive orientation towards technological transformation and reported participation in formal professional development. Optimism towards IR4.0 teaching and learning was the highest-rated indicator (M = 4.15), followed by responsibility for learning about IR4.0 (M = 4.10), whereas regular attendance at IR4.0-related courses was the lowest-rated indicator (M = 3.32). This pattern suggests that respondents reported strong personal orientation towards continued learning while reporting comparatively lower participation in formal IR4.0-related courses. However, the present data do not establish why this difference exists, and no conclusions can be drawn regarding institutional access, course availability or barriers to participation.

The finding should not be interpreted as evidence that lecturers lack motivation. On the contrary, the high responsibility score suggests that respondents recognise the importance of continuing learning. The weaker course-attendance score may instead point to a difference between personal orientation and access to, participation in, or frequency of formal professional-development opportunities. Because the present study did not directly measure institutional barriers, this interpretation remains cautious.

The findings concerning curriculum and pedagogy are also relevant. Connecting IR4.0 with curriculum content received a relatively high mean (M = 3.79), whereas familiarity with IR4.0-aligned teaching approaches was lower (M = 3.59). This pattern suggests that lecturers may be more confident in recognising the relevance of technological transformation to curriculum than in identifying or applying specific technology-oriented pedagogical approaches. This interpretation is compatible with research emphasising that effective digital teaching requires the integration of technology with pedagogy and disciplinary content rather than tool familiarity alone (Koehler & Mishra, 2009; Redecker, 2017).

For mathematics education, the result is particularly significant because digital technology can support visualisation, modelling, problem solving and mathematical communication, but technology-mediated mathematics teaching can also create challenges involving demonstration, feedback, engagement, materials and connectivity (Zin & Mahmud, 2024). Awareness development should therefore be linked to discipline-specific pedagogy rather than delivered only as generic technical training.

9. Practical Implications

9.1. Implications for Universities

Universities should consider continuous professional development as a central component of digital transformation. Programmes should be practical, sustained and linked to actual teaching practice rather than limited to one-off technical workshops. Institutions may consider reviewing the accessibility, relevance, timing and discipline-specific nature of IR4.0-related professional-development opportunities. Such initiatives could provide additional opportunities for lecturers who report strong personal responsibility for continued learning but comparatively lower participation in formal courses.

9.2. Implications for Mathematics Education

For mathematics lecturers, professional learning should connect ICT with mathematical representation, visualisation, modelling, problem solving, communication, collaboration and assessment. Generic ICT training may therefore be insufficient. Discipline-sensitive digital pedagogy can help lecturers move from recognising that technology is important to understanding how particular technologies can support specific mathematical learning goals.

9.3. Implications for Policy and Institutional Leadership

Malaysia's digitalisation agenda should be supported by investment in human capability as well as infrastructure. Institutional leaders can strengthen digital transformation by aligning policy, professional development, leadership support, infrastructure and pedagogical assistance. Recent Malaysian literature similarly identifies leadership, resources and institutional guidance as important conditions for technology integration (Foong, 2024; Rais et al., 2025).

10. Limitations

First, the sample comprised 121 mathematics lecturers in Kuala Lumpur; therefore, the findings should not be generalised directly to all Malaysian higher education lecturers. Second, the study relies entirely on self-reported responses. Because the 14 indicators include awareness-related perceptions, orientation, self-reported technology-related skills, technology use, professional learning and course participation, the resulting measure should not be interpreted as an objective assessment of digital competence, technological proficiency or actual technology behaviour. Third, the questionnaire was developed in an IR4.0 context, and technologies that became prominent later, particularly generative AI, were not directly measured. Fourth, the reported Cronbach's $\alpha = .930$ is based on the pilot study and should not be interpreted as final-sample reliability without additional evidence. Finally, the descriptive design does not establish causal relationships between awareness, professional development, competence or technology adoption.

A further limitation concerns the adaptation of the questionnaire. Although the instrument was adapted from Sidin et al. (2020) and applied to mathematics lecturers in higher education, the present study does not provide factor-analytic evidence establishing a distinct multidimensional structure for the adapted 14-item measure. The findings should therefore be interpreted at the item and overall descriptive level rather than as evidence of validated subscales.

11. Future Research

Future studies should examine whether ICT awareness is associated with actual digital competence and technology adoption using validated measures. Comparative research could examine differences across disciplines, institution types and geographical regions in Malaysia. Longitudinal research could investigate whether structured professional-development programmes change lecturers' awareness and competence over time. Given the rapid development of AI, future Malaysian research should also examine lecturers' awareness and readiness concerning generative AI, AI-supported teaching, academic integrity and responsible AI use.

A particularly useful next step would be to develop and validate a contemporary ICT/IR4.0 awareness and readiness instrument that clearly distinguishes awareness of emerging technologies from digital competence, actual technology use, professional-development participation and institutional support. Such an instrument could include separate dimensions for awareness, perceived readiness, competence and adoption, supported by appropriate content-validation and factor-analytic procedures.

12. Conclusion

This study examined self-reported ICT/IR4.0 awareness and readiness among 121 mathematics lecturers in Kuala Lumpur. The overall mean score was 3.72 (SD = 0.47), which falls within the moderate range according to the descriptive mean-score classification reported by Sidin et al. (2020). The strongest indicators concerned optimism towards teaching and learning in the IR4.0 era and responsibility for continued learning, whereas regular participation in IR4.0-related courses was comparatively lower.

The findings provide a descriptive picture of lecturers' reported recognition and orientation towards technological transformation, together with related indicators of professional learning, technology-related skills, technology use and pedagogical application. The findings should therefore not be interpreted as evidence of objectively assessed digital competence, technological proficiency or actual technology adoption.

The study also demonstrates the importance of distinguishing the conceptual construct of ICT awareness from the broader operational measure of self-reported ICT/IR4.0 awareness and readiness. This distinction is necessary because the adapted 14-item instrument contains indicators that extend beyond narrow awareness. The results should consequently be understood as descriptive evidence of lecturers' reported awareness and preparedness within the IR4.0 context in which the data were collected.

The findings suggest that positive orientation towards technological transformation coexists with comparatively lower reported participation in formal IR4.0-related professional development. This pattern should be interpreted descriptively rather than as evidence of inadequate institutional access or insufficient motivation, since those factors were not directly measured. Future research should employ validated multidimensional instruments that separately assess ICT awareness, perceived readiness, digital competence, technology use and professional-development participation.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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