

# Fostering Action Research Culture through Head Teacher Leadership and Management: Driving Transformative Education in the Digital Era

Azlin Moktar, Bity Salwana Alias and Nurazidawati Mohamad Arsad

**Abstract** – The Fourth Industrial Revolution (IR 4.0) has heightened the need for innovative, reflective, and technology-enabled practices in education, positioning action research (AR) as a key driver of teacher professional development and school transformation. This study investigates the culture of AR fostered by head teachers in Malaysian primary schools, with specific attention to its leadership and management dimensions. Using a quantitative, cross-sectional survey design, data were collected from 481 teachers across 50 District Education Offices through stratified proportional sampling. The structured questionnaire measured AR culture across five dimensions: visionary leadership, instructional support, resources and climate, professional collaboration, and quick wins. Data were analyzed using SPSS 29 and SmartPLS 4.1.1.2. The results indicated that the overall level of AR culture was moderately high ( $M = 3.91$ ,  $SD = 0.662$ ). Quick Wins ( $M = 4.07$ ) and Visionary Leadership ( $M = 4.04$ ) were rated highest, validating Kotter's emphasis on vision and early achievements in driving organizational change. By contrast, Instructional Support ( $M = 3.72$ ) and Resources and Climate ( $M = 3.72$ ) emerged weaker, reflecting gaps in systematic training, mentoring, and resource allocation. Reliability and validity tests confirmed robust psychometric properties, with CA and CR values exceeding 0.70 and HTMT ratios below 0.90. The findings underscore the need to institutionalize AR culture not only as a compliance mechanism but as a sustainable professional practice, evolving into digital ecosystems such as e-reflection logs, online PLCs, and cloud-based AR documentation. The study contributes theoretically by integrating Kotter's change theory, Guest's HRM framework, and Malaysian standards, while offering practical and policy insights for embedding AR in the digital education agenda.

**Keywords**—action research, head teacher leadership, teacher professional development, digital transformation, Malaysia

## I. INTRODUCTION

The transformation of education in the twenty-first century has been strongly influenced by global technological advancements, which require schools to embrace innovative, reflective, and technology-oriented practices. The Fourth Industrial Revolution (IR 4.0) has reshaped the way schools prepare learners for future competencies, emphasizing adaptability, creativity, and

critical thinking alongside traditional knowledge delivery (Santos, 2025; Mukuni, 2023; Asri et al., 2023; World Economic Forum, 2020). This shift signals the urgency for schools to strengthen reflective professional practices as a core strategy in navigating the challenges and opportunities of the digital era. In particular, teachers are increasingly expected not only to deliver content but also to act as facilitators of inquiry, innovation, and problem-solving, all of which require sustained professional learning.

Within this transformation, action research (AR) has emerged as a recognized approach to empower teachers through reflective inquiry and continuous professional development. Seminal works (Kemmis & McTaggart, 1988; Elliott, 1991; Antoci & Borozan 2024) have conceptualized AR as a cyclical process of planning, acting, observing, and reflecting, forming the foundation for evidence-based practice in education. More recent studies reaffirm its significance in fostering innovation and teacher competence, demonstrating AR's role in sustaining in professional growth and pedagogical change (Ferencova et al., 2025; Ilgaz et al., 2024; Ukowitz, 2021). In Malaysia, the Ministry of Education (MOE) has recognized AR as central to educational transformation through the *Pelan Pembangunan Pendidikan Malaysia 2013–2025 (PPPM)*, while national standards such as *Standard Kualiti Pendidikan Malaysia Gelombang 2 (SKPMg2)* and *KOMPAS 2.0* emphasize reflective practices as part of head teachers' leadership competencies (Kementerian Pendidikan Malaysia, 2017, 2019).

## II. PROBLEM STATEMENT

Despite these initiatives, the adoption of AR as a school-wide culture remains inconsistent in Malaysian schools. Many teachers perceive AR as a peripheral activity undertaken mainly for administrative or appraisal purposes. Empirical research has primarily examined AR as a pedagogical tool for classroom innovation (Weber & Harris, 2020; Pham et al., 2021), but limited studies focus on the leadership role of head teachers in institutionalizing AR as a cultural practice. This creates a significant gap in understanding how leadership and management dimensions contribute to embedding AR as a driver of school transformation in the digital era.

The objectives of this study are:

1. To identify the level of action research culture fostered by head teachers.
2. To evaluate the dimensions of leadership and management that support AR culture.

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3. To discuss the implications of AR culture for professional development and school transformation in the digital era.

Research Questions:

1. What is the level of AR culture fostered by head teachers?
2. Which dimensions of leadership and management are most and least evident in AR culture?
3. What are the theoretical, practical, and policy implications of fostering AR culture in the digital era?

Theoretically, this study integrates international frameworks (Kotter's Change Management Theory, Guest's HRM Model) with Malaysian standards (SKPMg2, KOMPAS 2.0, SGM 2.0) to provide a comprehensive model of AR culture. Practically, the findings guide head teachers in balancing visionary leadership and operational management, including leveraging digital platforms for collaboration and reflective practice. From a policy perspective, this study supports the Ministry of Education's agenda to institutionalize AR as part of digital-era school transformation.

### **III. LITERATURE REVIEW**

#### ***Action Research as Reflective Practice***

Action research (AR) has long been recognized as a systematic approach for teachers to reflect on and improve their practice. Kemmis and McTaggart (1988) describe AR as cyclical process of planning, acting, observing, and reflecting, positioning it as an evidence-based pathway to professional learning. While reflective practice remains central to this process, recent scholarship also highlights that action research is increasingly intertwined with digital assessment and innovation, reinforcing its relevance in the context of the Fourth Industrial Revolution (IR 4.0) (Ramasamy & Lee, 2022). Schon's (1983) reflective practitioner framework further strengthens this perspective by emphasizing that teachers must continually engage in both reflection-in-action and reflection-on-action to address the complexities of classroom realities. More recent contributions, such as Sharma (2022) and Talluri (2023), demonstrate AR's potential in fostering innovation, enhancing collaboration, and building professional agency among teachers. Collectively, these perspectives establish AR not only as a methodological tool but also as a cultural practice that sustains teacher learning and drives educational improvement.

#### ***Leadership and Change Management***

Leadership has a decisive influence on the extent to which AR becomes institutionalized within schools. Kotter's (1996) change management theory underscores the importance of creating urgency, mobilizing coalitions, and generating quick wins in embedding organizational change. In the educational context, (Hallinger, 2011;

Sonmez et al., 2024) emphasizes instructional leadership as a mechanism for aligning teacher learning with student outcomes, while (Raman, 2022; Aureada, 2021) highlights transformational leadership that cultivates vision and collective capacity. Together, these frameworks illustrate how head teachers serve as both instructional leaders and change agents who establish the conditions for AR to flourish. Furthermore, leadership is critical in supporting teacher preparedness and resource allocation, factors that significantly influence the successful implementation of curriculum reform and innovation (Manizabayo & Kachchhap, 2025).

#### ***HRM and Teacher Development***

From a human resource management (HRM) perspective, Guest (1997) emphasizes that training, reward, and involvement are critical in shaping organizational commitment and performance, and these dimensions translate meaningfully into the educational context. Training provides the foundation for professional development, as Nazim et al. (2024) contend that comprehensive and structured training directly enhances teachers' commitment and competence. Reward, often reflected through quick wins, reinforces achievement and recognition, with Basnet (2020) showing that acknowledgement of teacher's contributions is positively correlated with organizational commitment and improved morale. Involvement, manifested through professional collaboration, further strengthens commitment by enabling teachers to actively engage in collective learning and development processes, which ultimately lead to better educational outcomes (Mufeed & Kumar, 2018). When head teachers embed these HRM principles into their leadership practices, they not only motivate teachers but also create sustainable mechanisms for action research (AR) as a continuous and institutionalized form of professional growth aligned with school transformation goals.

#### ***Malaysian Standards***

The Malaysian education system provides a unique context for embedding action research (AR) culture through its established national standards. The Standard Kualiti Pendidikan Malaysia gelombang 2 (SKPMg2) emphasizes instructional leadership, reflective practices, and continuous improvement as central components of school quality (Ministry of Education, 2017). School principals who adopt a comprehensive leadership approach that combines instructional and transformational practices can maximize their impact on student achievement by strengthening teacher learning and effectively addressing the ever growing demands of educational reforms (Bellibas et al., 2021). Similarly, KOMPAS 2.0 outlines competencies for school leaders that include visionary, instructional leadership, and collaborative practices (Ministry of Education, 2019). Effective leaders who embody these competencies are better equipped to facilitate professional development opportunities, and encourage teachers to adopt AR as a

tool for instructional improvement (Vorobel et al., 2021). Complementing these standards, the Standard Guru Malaysia 2.0 (SGM 2.0) highlights reflective professionalism, professional responsibility, and collaborative learning as essential qualities of effective teachers (Ministry of Education, 2020). Recent studies further emphasize that SGM 2.0 positively influences teaching practices and that reflective professionalism plays a critical role in enhancing teacher effectiveness (Zainal & Husain, 2021). Collectively, these standards establish AR as a strategic instrument for advancing Malaysia's educational transformation agenda.

### ***Digital Transformation in Education***

The global discourse on digital transformation underscores the urgent need for pedagogical models that integrate technology, innovation, and reflective practice. Voogt et al. (2018) identify three core challenges to learning in a digital world: , digital literacy, and the integration of technology into pedagogy. Issues of equity have been highlighted internationally; for instance, during the International Day for Digital Learning 2025, UNESCO convened policy makers, educators, and students to examine how digital learning can promote equity in low-resource contexts. These discussions underline the persistent digital divide, particularly the need to provide equal opportunities for remote learning and access to technology (Weisberg & Dawson, 2023). In parallel, digital literacy has emerged as a pressing concern. Choudhary and Bansal (2022) argue that barriers to digital literacy training, especially for marginalized populations, must be overcome to maximize program effectiveness. Nkomo and Matli (2022) further emphasize that emergency remote learning during the pandemic revealed critical gaps in teachers' digital competence, underscoring the necessity of strengthening digital skills as schools expand digital transformation initiatives.

Equally important is the integration of technology into pedagogy, which must be approached critically to ensure that it reduces rather than reinforces inequality. Afzal et al. (2023) caution that although technology has the potential to enhance education, it may also perpetuate inequities if implemented without careful planning. Wu (2024) echoes this concern by advocating for inclusive digital strategies that position technology as an enabler rather than a barrier to learning. In line with this, the World Economic Forum (2020) underscores adaptability, creativity, and problem solving as essential twenty-first century skills for future ready learners. For schools, this means that action research (AR) culture must evolve to incorporate digital modes of reflection and collaboration, such as online professional learning communities, e-portfolios, and cloud based documentation, to remain relevant in the IR4.0 era (Ramasamy & Lee, 2022; Zuo, Krish, & Jain, 2025). Complementary to this, recent studies have also called for the establishment of mentorship programs, global digital learning communities, and equitable infrastructure to strengthen teachers' digital competence (Zuo, Krish, & Jain, 2025; Annamalai, 2021).

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### ***Research Gap***

While substantial literature affirms the value of AR, leadership, and digital transformation in education, limited empirical work has focused on how head teachers in Malaysia integrate these dimensions to institutionalize AR culture. Much of the existing research privileges teacher level inquiry, leaving the leadership and management dimensions underexplored. This study addresses this gap by examining the role of head teachers in fostering AR culture as a pathway to professional commitment and transformative education in the digital era.

#### IV. METHOD

##### Research Design

This study employed a quantitative, cross-sectional survey design, which is widely recognized as appropriate for examining relationships among leadership practices, action research (AR) culture, and teacher professional development within a large population. The survey method enabled systematic data collection from a broad sample, thereby generating findings that are both generalizable and statically robust (Mitani et al., 2021; Jauslin et al., 2021).

##### Population and Sampling

The population comprised 189,936 teachers serving in Malaysian national primary schools (Sekolah Kebangsaan) (Ministry of Education, 2024). To ensure representativeness, a stratified proportional sampling strategy was employed at three levels: district education offices (DEOs), schools, and teachers, followed by simple random sampling at each stage. Through this multistage process, a total of 481 valid teacher responses were collected across 50 DEOs nationwide. This approach enhanced representativeness, minimized sampling error, and aligned with best practices for large-scale educational survey research.

##### Instrumentation

The research instrument was a structured questionnaire designed to measure AR culture across five dimensions. These dimensions included visionary leadership, which reflects the extent to which head teachers articulate and communicate a clear vision for AR; instructional support, which captures the provision of training, mentoring, and resources to sustain AR practices; resources and climate, which refers to the allocation of operational resources and the establishment of supportive school environment; professional collaboration, which emphasizes teamwork and the sharing of knowledge among teachers; and quick wins, which recognize small, early successes that encourage sustained engagement in AR. All items were rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Content validity was ensured through expert review by specialists in educational leadership and action research. A pilot study involving 107 teachers was subsequently conducted to refine clarity, reliability, and usability.

##### Reliability and Validity

The psychometric properties of the instrument were rigorously evaluated. Rasch model analysis was employed to test item fit, unidimensionality, and rating scale functioning. Internal consistency reliability was confirmed through Cronbach's alpha, with all constructs exceeding the 0.70 threshold (Hair et al., 2019). Construct validity was assessed using confirmatory factor analysis (CFA) with Smart PLS version 4.1.1.2. Composite reliability

(CR) values exceeded 0.70, and average variance extracted (AVE) surpassed 0.50, establishing convergent validity. Discriminant validity was verified using the Fornell-Larcker criterion and HTMT ratios (Henseler et al., 2015).

##### Ethical Approval

Ethical clearance was obtained through multiple levels of approval to ensure compliance with research governance and the protection of participants. Formal approval was granted via the eRAS 2.0 system with official authorization from the Ministry of Education Malaysia (KPM), including the Educational Policy Planning and Research Division (BPPDP), State Education Departments (JPN), District Education Offices (PPD), and individual schools. Participation was voluntary, and informed consent was secured from all respondents. Confidentiality was assured by anonymizing responses and ensuring that no personal identifiers were recorded.

##### Data Analysis

Descriptive statistics (mean scores and standard deviation) were computed using SPSS version 29 to evaluate the level of AR culture across the five dimensions. The measurement model of AR culture was further assessed using CFA with SmartPLS 4.1.1.2. This process included the evaluation of internal consistency reliability (Cronbach's alpha, composite reliability), convergent validity (AVE), and discriminant validity (Fornell-Larcker and HTMT). Such rigorous procedures ensured that the five dimensions of AR culture were psychometrically sound and provided a robust foundation for subsequent descriptive analyses.

The study was guided by a conceptual framework integrating leadership and management dimensions of action research (AR) culture. As illustrated in Figure 1, AR culture is conceptualized as multidimensional construct encompassing visionary leadership, instructional support, resources and climate, professional collaboration, and quick wins. This framework provided the analytical basis for evaluating AR culture among head teachers prior to presenting descriptive results.

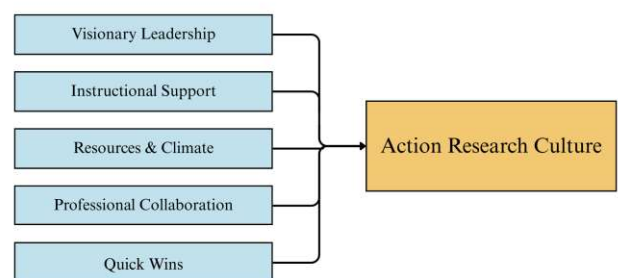


Figure 1. Conceptual Framework of AR Culture

V. FINDINGS

Internal Consistency Reliability and Convergent Validity

Internal consistency and convergent validity were assessed using Cronbach’s alpha (CA), composite reliability (CR), and average variance extracted (AVE). As reported in Table 1, all constructs exceeded the recommended threshold of CA and CR > 0.70, and AVE > 0.50 (Hair et al., 2019). Specifically, CA values ranged from 0.862 to 0.941, CR values from 0.862 to 0.946, and AVE values from 0.835 to 0.886. These results confirm that the five dimensions of AR culture are both reliable and valid in measuring the intended constructs.

TABLE I: RELIABILITY AND CONVERGENT VALIDITY OF AR CULTURE DIMENSIONS

| Construct                       | Cronbach’s Alpha (CA) | Composite Reliability (CR) | Average Variance Extracted (AVE) |
|---------------------------------|-----------------------|----------------------------|----------------------------------|
| Visionary Leadership (W)        | 0.941                 | 0.946                      | 0.849                            |
| Instructional Support (I)       | 0.926                 | 0.926                      | 0.870                            |
| Resources & Climate (SO)        | 0.862                 | 0.862                      | 0.879                            |
| Professional Collaboration (KP) | 0.872                 | 0.877                      | 0.886                            |
| Quick Wins (QW)                 | 0.934                 | 0.935                      | 0.835                            |

Discriminant Validity

Discriminant validity was evaluated using the Heterotrait Monotrait (HTMT) criterion. As shown in Table 2, all HTMT ratios were below the conservative threshold of 0.90 (Henseler et al., 2015), confirming adequate discriminant validity. This indicates that the five dimensions of AR culture are conceptually distinct, while maintaining moderate correlations with one another. The relationships are visually presented in Figure 2, which illustrates the HTMT values in the form of a heatmap.

TABLE II: DISCRIMINANT VALIDITY (HTMT)

| Construct                       | W     | I     | SO    | KP    | QW    |
|---------------------------------|-------|-------|-------|-------|-------|
| Visionary Leadership (W)        | 1.000 | 0.860 | 0.759 | 0.873 | 0.860 |
| Instructional Support (I)       | 0.860 | 1.000 | 0.813 | 0.889 | 0.813 |
| Resources & Climate (SO)        | 0.759 | 0.813 | 1.000 | 0.898 | 0.815 |
| Professional Collaboration (KP) | 0.873 | 0.889 | 0.898 | 1.000 | 0.890 |
| Quick Wins (QW)                 | 0.860 | 0.813 | 0.815 | 0.890 | 1.000 |

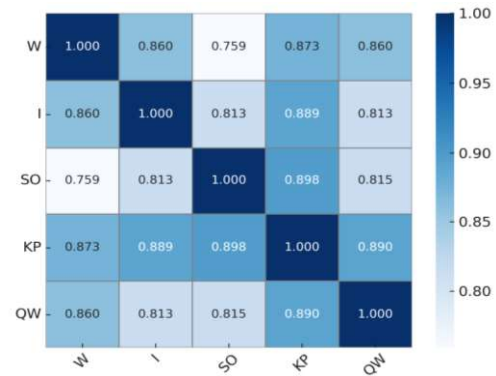


Figure 2. Heatmap of HTMT values showing discriminant validity among AR culture dimensions.

Descriptive Results

The descriptive analysis indicated that the overall level of action research (AR) culture among head teachers was moderately high (M=3.91, SD=0.662). As reported in Table 3, the highest-rated dimensions were Quick Wins (M=4.07, SD=0.683) and Visionary Leadership (M=4.04, SD=0.701), both reaching the ‘high’ category. This finding suggests that head teachers were particularly effective in articulating a clear vision for AR and in recognizing early achievements, which in turn motivated teachers to engage in AR activities. By contrast, Instructional Support (M=3.72, SD=0.768), Resources and Climate (M=3.72, SD=0.802), and Professional Collaboration (M=3.82, SD=0.762) were rated only ‘moderately high’. These results highlight persistent challenges in providing systematic instructional support, adequate resources, and sustained professional collaboration, despite the presence of strong leadership vision.

TABLE III: DESCRIPTIVE STATISTICS OF AR CULTURE DIMENSIONS

| Dimension                  | Mean        | SD           | Interpretation         |
|----------------------------|-------------|--------------|------------------------|
| Visionary Leadership       | 4.04        | 0.701        | High                   |
| Instructional Support      | 3.72        | 0.768        | Moderately High        |
| Resources & Climate        | 3.72        | 0.802        | Moderately High        |
| Professional Collaboration | 3.82        | 0.762        | Moderately High        |
| Quick Wins                 | 4.07        | 0.683        | High                   |
| <b>Overall AR Culture</b>  | <b>3.91</b> | <b>0.662</b> | <b>Moderately High</b> |

Source: Nunally & Bernstein Interpretation Scale (1994)

As summarized in Table 3, Visionary Leadership and Quick Wins emerged as the strongest dimensions of AR culture, while Instructional Support, Resources and Climate, and Professional Collaboration remained weaker. These results are visually illustrated in Figure 3, which compares mean scores across the five dimensions.

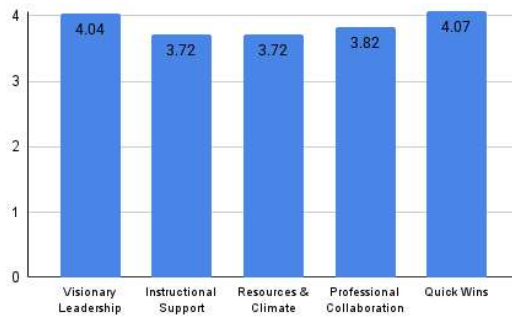


Figure 3. Mean Scores of AR Culture Dimensions

## VI. DISCUSSION

### *Validation of Kotter's Change Theory*

The findings substantiate Kotter's (1996) change management theory, particularly the centrality of vision and quick wins in institutionalizing organizational change. The high mean scores for Visionary Leadership ( $M=4.04$ ) and Quick Wins ( $M=4.07$ ) confirm that head teachers in Malaysian primary schools are effective in communicating direction and celebrating early achievements. These results echo Hallinger's (2011) assertion that instructional leaders who align teacher learning with broader school goals are more successful in shaping sustainable improvement. Similarly, Manizabayo & Kachchhap, (2025) argue that visible achievements, even if small, can accelerate momentum for reform. Within the Malaysian context, this reinforces the role of head teachers as change agents who integrate AR into the professional culture of schools, resonating with SKPMg2 emphasis on reflective practice and continuous improvement (Ministry of Education, 2017). The empirical evidence, therefore, validates Kotter's framework by demonstrating that visionary capacity and recognition of quick wins remain pivotal in driving AR culture.

### *Guest's HRM Perspective: Training and Involvement*

While vision and recognition appear strong, the comparatively lower scores for Instructional Support ( $M=3.72$ ) and Professional Collaboration ( $M=3.82$ ) highlight weaknesses in the training and involvement dimensions articulated in Guest's (1997) HRM model. These findings align with Mufeed and Kumar (2018), who argued that collaboration is fundamental to organizational commitment, yet often remains underdeveloped in practice. Similarly, Nazim et al. (2024) emphasized that structured training enhances teacher competence and commitment, but this study suggests that such training opportunities remain unevenly distributed. The measurement model results (CA, CR, and AVE all  $>0.80$ ) demonstrate that these constructs are psychometrically reliable, however, the moderate mean scores indicate challenges in practice. The gap between recognition (reward) and sustained support suggests that AR culture is celebrated symbolically but requires stronger institutional

scaffolding to become embedded. To address this imbalance, the literature advocates for digital professional learning communities (PLCs), e-reflection tools, and structured mentoring systems (Zuo, Krish, & Jain, 2025), which can strengthen teacher agency and ensure AR practices are not only initiated but sustained.

### *Alignment with Malaysian Educational Standards*

The alignment between this study's findings and Malaysian educational standards is notable. Both KOMPAS 2.0 (Ministry of Education, 2019) and SGM 2.0 (2020) stress reflective professionalism, leadership competencies, and professional collaboration as essential elements of teacher and leader effectiveness. However, the moderately high scores for Instructional Support and Professional Collaboration suggest a gap policy frameworks and school level implementation. Vorobel et al. (2021) similarly observed that effective leadership is contingent not only on visionary capacity but also on the provision of resources and structured opportunities for collaboration. The discriminant validity results (HTMT values  $<0.90$ ) indicate that the dimensions are distinct, yet the moderate intercorrelations suggest that integration is necessary for holistic practice. This discrepancy implies that while Malaysia's standards provide a robust policy framework, head teachers remain the mediators who determine whether AR is institutionalized as part of professional culture or remains a peripheral compliance exercise.

### *Implications for Digital Transformation*

The study reinforces arguments in the literature that link AR culture to the broader agenda of educational digital transformation. The IR 4.0 era requires schools to cultivate adaptability, creativity, and problem solving (World Economic Forum, 2020), competencies inherently fostered through reflective and collaborative inquiry. However, as Afzal et al. (2023) caution, the integration of technology must be critically managed to avoid reinforcing inequities. Wu (2024) similarly contends that inclusive strategies are needed to ensure technology functions as an enabler rather than a barrier. The relatively weaker findings for Instructional Support and Professional Collaboration point to the need for AR culture to evolve into digital ecosystems. This includes cloud based documentation of AR projects, digital mentoring programs, and global learning communities (Annamalai, 2021). Such practices bridge existing gaps and position head teachers as digital change leaders, consistent with both Kotter's and Guest's frameworks, while remaining contextualized within Malaysia's education policy ambitions.

## VII. CONCLUSION

This study examined the culture of action research (AR) fostered by head teachers in Malaysian primary schools within the context of digital transformation in

education. The findings revealed that the overall level of AR culture was moderately high ( $M=3.91$ ,  $SD=0.662$ ), with Quick Wins ( $M=4.07$ ) and Visionary Leadership ( $M=4.04$ ) emerging as the strongest dimensions, thus validating Kotter's (1996) emphasis on vision and early wins as drivers of change. Conversely, Instructional Support ( $M=3.72$ ) and Resources and Climate ( $M=3.72$ ) were weaker, indicating gaps in systematic training, mentoring, and resource allocation. These results underscore that AR must be institutionalized not as a compliance driven activity but as a sustainable professional culture. In the era of IR 4.0, AR culture must also evolve into digital forms of reflective practice, including e-reflection logs, cloud based AR documentation, and online professional learning communities (PLCs), to remain scalable, impactful and aligned with twenty first century educational demands.

Theoretically, this study integrates Kotter's change management model, Guest's HRM framework, and Malaysian standards (SKPMg2, KOMPAS 2.0, SGM 2.0) into a holistic conceptualization of AR culture in the digital era. This framework highlights the dual importance of leadership vision and recognition of quick wins, while also recognizing the structural need for training, collaboration, and resource allocation. Practically, the study underscores the role of head teachers as digital change leaders who leverage platforms such as online PLCs, cloud based repositories of AR projects, structured training modules, and innovation recognition schemes can reinforce AR as a driver of teacher quality, professional development, and systematic school improvement.

This study is subject to several limitations. First, it focused exclusively on national primary schools (SK), which restricts the generalizability of findings to secondary schools or other school categories. Second, the use of a cross-sectional survey design prevents the capture of longitudinal changes in AR culture over time. Third, reliance on self-reported data may introduce response bias, despite rigorous efforts to ensure validity and reliability, including CFA and HTMT analysis. Future studies could expand the scope by including secondary schools and other contexts to allow comparative insights. Longitudinal research would be valuable in examining how AR culture evolves in response to digital transformation initiatives. In addition, mixed methods design, combining large scale surveys with in depth qualitative case studies of 'digital AR champions', would provide richer insights into how head teachers and teachers institutionalize AR practices in real world school settings. Such approaches could deepen understanding of how AR contributes to teacher commitment, professional growth, and sustainable educational transformation.

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