**Collaboration, Morality, and Teacher Readiness for the Challenges of the Industrial Revolution: A Quantitative Study**

*Hutkemri Zulnaidi 1\*, Nofouz Mafarja 1,* *Enny Oktavika2, Nur Nabihah Mohamad Nizar 4, & Umi Kalsum Mohd Salleh3*

*1 Department of Mathematics and Science Education, Faculty of Education, University of Malaya, 50603 Kuala Lumpur, Malaysia*

*2 MTsN 2 Rokan Hulu, Riau, Indonesia*

*3 Department of Curriculum and Instructional Technology, Faculty of Education, University of Malaya, 50603 Kuala Lumpur, Malaysia*

*4Department of Educational Foundation and Humanities, Faculty of Education, University of Malaya, 50603 Kuala Lumpur, Malaysia*

*\*Corresponding author:* [*hutkemri@um.edu.my*](mailto:hutkemri@um.edu.my)

# **Abstract**

This research aims to explore the correlation between collaboration and the preparedness of mathematics teachers for the Industrial Revolution, with morality playing a role as a mediator. Data on collaboration, preparedness, and moral values will be collected through a survey questionnaire, and the data will be analyzed using structural equation modeling (SEM). The study involved a total of 231 mathematics teachers from Indonesia and 384 mathematics teachers from Malaysia. The findings reveal that morality significantly mediates the relationship between collaboration and the readiness of mathematics teachers for IR4.0 in both Indonesia and Malaysia. The study highlights the importance of morality in influencing the connection between collaboration and teachers' preparedness for the Industrial Revolution. Furthermore, it contributes to the understanding of factors influencing the effectiveness of teacher training programs designed to prepare educators for the Industrial Revolution. The study suggests that when designing teacher training programs, moral values should be taken into consideration as they can impact how collaboration influences teachers' readiness.

**Keywords:** Collaboration, Industrial Revolution, Mathematics Teachers, Morality, Readiness

# **1. Introduction**

Teaching Mathematics holds immense significance in the realm of school education, with increasing emphasis on its moral value. It is crucial for educators to actively integrate moral education into their subject instruction, thereby fulfilling the fundamental mission of nurturing individuals with strong ethical values. While moral education remains an important aspect of disciplinary teaching, it should not overshadow the primary objective. Teachers must focus on employing effective methods and strategies to seamlessly integrate moral education into Mathematics lessons, ensuring a balanced approach. Rather than prioritizing moral education at the expense of essential mathematical concepts, educators should strive to enhance their awareness of integration, maintain practicality, and emphasize the consistent incorporation of moral values (Song & Wen, 2020). The era of industrial revolution is characterized by rapid technological advancements and changes in the economy, society, and culture. This has led to a shift in the skills and knowledge required for success in the workforce, with a greater emphasis on (science, technology, engineering, and mathematics) skills. Mathematics teachers play a critical role in preparing students for the challenges of the Industrial Revolution (Sima et al., 2020)

The fourth industrial revolution (IR4.0) is reshaping society and impacting the education sector, including mathematics teaching. The emergence of new technologies and digital platforms is transforming teaching and learning methods, presenting both challenges and opportunities for mathematics teachers (Schwab, 2017). To effectively respond to these changes, mathematics teachers must be equipped to adapt to new teaching approaches, technologies, and educational practices. However, the integration of IR4.0 is hindered by the lack of professional ethics and understanding among some teachers, which poses significant barriers to successful implementation (Zulnaidi et al., 2020). Therefore, the aim of this study is to explore the influence of professional identity and ethics on teachers' preparedness for IR4.0. The research collected data from 203 technical and vocational education lecturers in Malaysia using two assessment tools to measure professional ethics, understanding of IR4.0, and readiness for IR4.0. The findings indicate that teachers' comprehension of the intelligence age significantly affects their readiness to embrace IR4.0, although professional ethics did not act as a mediator in the relationship between understanding of IR4.0 and readiness. To enhance teachers' preparedness for IR4.0, it is recommended that the Ministry provide relevant courses and training programs while ensuring access to up-to-date teaching and learning technology (Zulnaidi et al., 2020).

Collaboration has been identified as an important factor in promoting effective teaching practices and enhancing student learning outcomes. However, the relationship between Collaboration and the readiness of mathematics teachers to face the challenges of IR4.0 has not been extensively studied. Moreover, it is unclear whether the relationship between Collaboration and IR4.0 readiness is mediated by other factors, such as teacher morale (Layco, 2022).

Moral Development Theory, which has been widely recognized and influential, is a prominent framework explaining the progression of moral reasoning in individuals. This theory suggests that individuals pass through six sequential stages of moral development, which can be categorized into three levels: pre-conventional, conventional, and post-conventional. Developed by Kohlberg, this theory highlights the significance of cognitive development in shaping moral reasoning. As individuals encounter more intricate moral dilemmas and engage in perspective-taking, they are believed to advance to higher stages of moral reasoning. The theory has found broad application in educational and clinical settings as a means to comprehend and facilitate moral development (Vozzola, 2014). As well as, Social learning theory emphasizes the role of observation in learning. Teachers and students can learn collaborative behaviors and moral values by observing others who exhibit these behaviors. For example, teachers who consistently demonstrate collaborative practices in their classrooms can serve as role models for other teachers to learn from. Similarly, students who observe their peers engaging in positive collaborative behaviors are more likely to adopt and exhibit those behaviors themselves (Koutroubas & Galanakis, 2022).

Understanding the interplay between collaboration, morale, and readiness for IR4.0 among mathematics teachers holds significant importance for policymakers and educators aiming to improve mathematics education in Indonesia and Malaysia. The findings of this study can provide valuable insights for the development of policies and practices that foster effective teaching approaches and enhance student learning outcomes in the context of IR4.0. Investigating the connection between collaboration, morality, and teacher readiness within the challenges posed by the industrial revolution carries immense significance in addressing educational obstacles, promoting collaboration, recognizing the influence of morality, cultivating teacher preparedness, and ensuring global relevance. By delving into these areas, this research can contribute to the formulation of effective strategies, interventions, and policies aimed at preparing teachers and students for the complexities of the industrial revolution. The primary aims of this study are: (1) to explore the mediating role of morality in the link between collaboration among mathematics teachers and their preparedness for the Industrial Revolution era, (2) to investigate the direct and indirect impacts of morality on the relationship between teacher collaboration and readiness for the Industrial Revolution in Indonesia, and (3) to assess the direct and indirect effects of morality on the relationship between teacher collaboration and readiness for the Industrial Revolution in Malaysia. This study seeks to address the following research questions:

Research Question 1: Does morality serve as a mediator in the relationship between collaboration among mathematics teachers and their readiness to tackle the challenges of the Industrial Revolution?

Research Question 2: What are the direct and indirect effects of morality on the relationship between collaboration among mathematics teachers and their readiness to face the Industrial Revolution era in Indonesia?

Research Question 3: What are the direct and indirect influences of morality on the relationship between collaboration among mathematics teachers and their readiness to meet the demands of the Industrial Revolution in Malaysia?

# **2. Literature Review**

## **2.1 Morality in Mathematics Education**

Moral education is a structured and systematic process wherein educators adhere to the principles of cultivating moral character, tailored to the specific needs of a given society. Through internalization and externalization, moral education aims to instil in individuals the values and qualities encompassing ideology, politics, legal systems, and morality. Effective methods, such as speech teaching and personal guidance, are employed to facilitate this process (Lu & Wang, 1994; Wang, 2012). Moral education covers various domains, including social moral education, community moral education, school moral education, and family moral education. Specifically, in a narrower sense, moral education pertains to the ethical instruction within educational institutions. School moral education encompasses purposeful, planned, and systematic educational activities, wherein educators consciously influence students in accordance with societal or class expectations. The goal is to shape the moral character required by a particular society and class, fostering positive understanding, experiential learning, and practical application (Abtahi & Barwell, 2019).

Morality intersects with mathematics education in many areas, such as access and opportunity, the way mathematical concepts are presented and taught, and the ethical implications of mathematical research and applications. To address these issues, educators must foster a classroom environment that values diversity and inclusivity, and by addressing issues of access, equity, and social justice (Wang, Li & Jiang, 2015). This can be done by addressing disparities in funding and resources for schools, as well as working to provide support and accommodations for students with diverse learning needs. Additionally, educators must be aware of the cultural and social contexts in which mathematics is used, and to be sensitive to the ways in which different students may approach mathematical ideas. By addressing issues of access, equity, and social justice, and by fostering a classroom environment that values diversity and inclusivity, mathematics educators can help students to develop a more nuanced and thoughtful understanding of the role of mathematics in society (Wu, 2016).

## **2.2 Mathematics Teachers Collaboration**

Cooperative learning is a teaching approach that caters to students with diverse abilities, considering their varying levels of comprehension, learning styles, and sociological backgrounds. Its purpose is to enhance students' academic achievements and skills while fostering social harmony among individuals from different ethnic backgrounds. In addition to academic success, the development of process skills and values is vital in promoting social cohesion within today's multicultural schools. Consequently, educators are tasked with seeking pedagogical methods that enable students to acquire academic knowledge and professional skills necessary to confront the challenges they encounter in their daily lives (Hossain et al., 2012). Mathematics teachers can collaborate to create a supportive and productive learning environment for students. This can be done through curriculum planning, professional development, data analysis, classroom observations, and collaboration with other subject areas. Curriculum planning can involve sharing materials, discussing teaching strategies, and creating assessments that accurately measure student understanding (Capar & Tarim, 2015). Professional development can involve attending professional development opportunities together to learn new teaching strategies and stay up-to-date on current research and best practices in mathematics education. Data analysis can involve sharing student work samples, discussing assessment results, and brainstorming strategies for addressing student misconceptions. Classroom observations can provide new insights into teaching strategies and student learning. Collaboration with other subject areas can help students see the relevance of mathematics to their lives and prepare them for real-world problem-solving. Overall, collaboration among mathematics teachers is essential for creating a dynamic and engaging learning environment for students (Bores-Garcia et al., 2021).

## **2.3 Mathematics Teachers Readiness**

Mathematics teachers need to be well-prepared and equipped to provide effective instruction that helps students develop strong mathematical skills and understanding. This includes having a deep understanding of the mathematical concepts they are teaching, as well as the ability to effectively communicate these concepts to students. Additionally, teachers must have a strong understanding of how students learn mathematics, and be able to apply this knowledge in their teaching practice. Finally, teachers must be able to effectively manage their classrooms and create a positive learning environment that promotes student engagement and success. Finally, teachers must be skilled in designing and administering assessments that accurately measure student understanding and progress, as well as analyzing and interpreting assessment data to inform their instruction and identify areas of strength and weakness in student learning (Petko et al., 2018). By focusing on content and pedagogical knowledge, classroom management, assessment and data analysis, technology integration, and professional learning, mathematics teachers can ensure that they are ready to meet the needs of their students and provide high-quality mathematics education (Sun et al., 2017).

## **2.4 Mathematics Education in the IR4 Era**

The Industrial Revolution had a significant impact on mathematics education, shaping both the content of instruction and the ways in which it was taught. Key ways in which mathematics education changed during the Industrial Revolution include practical applications, standardization, vocational education, technology, efficiency, and public education. With the rise of industry and manufacturing, there was an increased demand for workers with strong mathematical skills, leading to the emphasis on practical applications of mathematics (Ayanwale, 2023). Standardization led to the development of standardized curricula, textbooks, and assessments that were used in schools across the industrializing world. Vocational education was also seen as essential for success in many industrial occupations, due to the increased focus on vocational education and training programs (Zulnaidi et al., 2020). Technology, such as the steam engine and the telegraph, required new mathematical skills and knowledge, and mathematics education began to incorporate the use of technology into instruction (Hajeniati & Kaharuddin, 2022). Finally, the focus on efficiency and productivity led to the emphasis on speed and accuracy, as well as the ability to apply mathematical concepts to real-world problems in an efficient and practical way (Hajeniati & Kaharuddin, 2022). Several researchers mentioned that Industrial Revolution had a lasting impact on mathematics education that can still be seen today (Schwab, 2017; Howson & Rogers, 2014; Doucet et al., 2018).

## **2.5 Relationship between Collaboration and the Readiness among of Mathematics Teachers**

Collaboration and readiness are closely related concepts in mathematics education. When teachers work collaboratively and cooperatively, they are more likely to be prepared and ready to deliver effective instruction (Mokher & Jacobson, 2021). Collaboration can help teachers to create a supportive and collaborative learning environment that promotes teacher readiness, build their pedagogical knowledge and skills, and build a culture of continuous learning and professional development. For example, when teachers work together to plan and develop a cohesive mathematics curriculum, they can use their combined expertise and knowledge to create a curriculum that is both rigorous and accessible to all students. Finally, Collaboration among mathematics teachers can help to stay up-to-date on current research and best practices in mathematics education, and to continually improve their instructional practice (Slavíčková & Novotná, 2022).

# **3. Methodology**

## **3.1 Research design**

To assess the preparedness of mathematics teachers in addressing the challenges of the Industrial Revolution, a survey was conducted. This survey followed a quantitative research approach as outlined by Creswell (2012), utilizing questionnaires to gather data from a sample of the population. By analyzing the characteristics and attributes of the sample, the findings can be generalized to the broader population. In this study, questionnaires were used to collect data from the entire population of mathematics teachers in Malaysia and Indonesia. Random sampling was employed to select an appropriate number of participants from each country.

## **3.2 Participant**

The study involved a total of 231 mathematics teachers from Indonesia and 384 from Malaysia, selected through random sampling. Among the Indonesian teachers, 59 (25.5%) were male and 172 (74.5%) were female. Their teaching experience varied: 26 (11.3%) had less than 5 years, 65 (28.1%) had 5 to 10 years, 97 (42.0%) had 11 to 15 years, 19 (8.2%) had 16 to 20 years, and 24 (10.4%) had more than 20 years of experience. Regarding school type, 65 (28.1%) taught in primary schools, 71 (30.7%) in middle schools, and 95 (41.1%) in senior high schools.

For the Malaysian sample, there were 88 (22.9%) male teachers and 296 (77.1%) female teachers. The teaching experience among these teachers was as follows: 27 (7.0%) had less than 5 years, 66 (17.2%) had 5 to 10 years, 104 (27.1%) had 11 to 15 years, 85 (22.1%) had 16 to 20 years, and 102 (26.6%) had more than 20 years of experience. Regarding school type, 260 (67.7%) were from primary schools, 41 (10.7%) from middle schools, and 83 (21.6%) from senior high schools.

## **3.3 Instrument**

In this study, the researchers developed instruments to measure readiness for the era of the Industrial Revolution, mathematics teacher collaboration, and morality. These instruments were designed to utilize a 5-point Likert scale, where 1 represents "strongly disagree" and 5 represents "strongly agree." The instruments were sent to five experts for validation, and all of the experts agreed with the items. The measurement of intelligence era readiness will assess teachers' preparedness in facing the challenges of the intelligence era. This readiness encompasses two key aspects: knowledge for the era of the Industrial Revolution and attitude in facing the era of the Industrial Revolution. The instruments developed aim to capture these dimensions and provide insights into teachers' readiness to adapt and thrive in the changing landscape of the intelligence era. Aspects of technological readiness include technological knowledge, technological skills and attitudes towards technology. The aspect of working together is enough to exchange ideas, get involved in activities and support friends. Work morale in this study also includes teachers' attitudes and behaviors in shaping work motivation and ethical aspects in this study include carrying out responsibilities to students, students' parents, colleagues and society and the country.

To ensure the reliability and validity of the study instrument, the researchers took several steps. They sought input from experts in relevant fields, such as content and language experts, to gather their professional opinions and make necessary improvements to the instrument. Additionally, a pilot study was conducted involving 150 mathematics teachers. The purpose of the pilot study was to evaluate the reliability of the items and constructs developed for the study. The reliability of the items and constructs was assessed through an exploratory factor analysis (EFA) test. This analysis helps identify the underlying factor structure and examine the relationships between variables. By conducting the EFA, the researchers aimed to ensure that the items in the instrument were measuring the intended constructs reliably. Furthermore, a confirmatory factor analysis (CFA) test was performed using a separate sample of 150 teachers. The goal of the CFA was to confirm and validate the items generated in the instrument and assess their compatibility with the proposed model. Through the CFA, the researchers sought to determine if the observed data fit well with the hypothesized model, providing evidence for the construct validity of the instrument. Overall, these steps, including input from experts, pilot testing, and factor analyses, were taken to enhance the reliability and validity of the study instrument, ensuring that it accurately measures the constructs of interest in the research (Cheung et al., 2023).

The results of the exploratory factor analysis (EFA) indicate important statistical indicators. The Kaiser-Meyer-Olkin (KMO) value, which assesses the sampling adequacy, is 0.904. A KMO value of 0.9 or higher is considered excellent and suggests that the data is highly suitable for factor analysis. In this case, the KMO value of 0.904 indicates that the sample size is sufficient and the data is appropriate for factor analysis. Additionally, the significance level of less than 0.001 suggests that the results of the factor analysis are statistically significant. This indicates that the identified factors or components derived from the analysis are reliable and meaningful in explaining the relationships between variables in the study. The low significance level further supports the validity of the results obtained from the factor analysis.The communalities values, ranging from 0.559 to 0.816, exceed the threshold of 0.5. This indicates that each item shares a substantial amount of variance with the underlying factors. The eigenvalues, which represent the amount of variance explained by each factor, are 7.229 for collaboration, 1.830 for morality, and 1.105 for readiness. All of these eigenvalues surpass the minimum threshold of 1, suggesting that each factor accounts for a sufficient amount of variance. Additionally, the cumulative variance reported as 67.8% indicates that the factors identified in the analysis collectively explain a significant portion of the total variance. This percentage meets the minimum requirement of 60%, indicating a satisfactory level of variance explained by the factors identified through the EFA.

Table 1. Rotated Component Matrix

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Component | | | Eigen value | Variance |
| Collaboration | Morality | Readiness |  |  |
| F1 |  |  | .719 | 1.105 | 7.4% |
| F2 |  |  | .722 |  |  |
| F3 |  |  | .604 |  |  |
| F4 |  |  | .659 |  |  |
| F5 |  |  | .713 |  |  |
| A1 | .790 |  |  | 7.229 | 48.2% |
| A2 | .653 |  |  |  |  |
| A3 | .772 |  |  |  |  |
| A4 | .782 |  |  |  |  |
| A5 | .773 |  |  |  |  |
| C1 |  | .714 |  | 1.830 | 12.2% |
| C2 |  | .757 |  |  |  |
| C3 |  | .636 |  |  |  |
| C4 |  | .774 |  |  |  |
| C5 |  | .704 |  |  |  |

The results of the confirmatory factor analysis (CFA) provide important indicators of model fit and the relationships between variables. The loading factors for each variable, ranging from 0.63 to 0.91, indicate the strength of the relationship between each variable and its underlying factor. These values suggest that the variables are well-aligned with their respective factors. The Chi-square/degrees of freedom (df) ratio of 1.773 is within an acceptable range, indicating a reasonable fit between the observed data and the hypothesized model.

The Goodness-of-fit Index (GFI) value of 0.888 suggests a good fit between the observed data and the model. The Comparative Fit Index (CFI) value of 0.953 indicates a high level of model fit, suggesting that the model adequately represents the data. The Root Mean Squared Error of Approximation (RMSEA) value of 0.072 indicates a reasonable fit, with values below 0.08 typically considered acceptable. This suggests that the model provides a good approximation of the population covariance matrix. Furthermore, the relationships between variables, ranging from 0.52 to 0.81, indicate significant associations between the constructs measured by the variables. Taken together, these findings suggest that the generated model is of high quality and provides a good fit to the data, as supported by relevant literature (Kline, 2005; Awang, 2012).

Table 2. Confirmation Factor Analysis (CFA)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Factor | Item | Loading Factor | Cronbach alpha | CR | AVE |
| Readiness | F1 | 0.65 | 0.827 | 0.831 | 0.501 |
| F2 | 0.63 |  |
| F3 | 0.75 |  |
| F4 | 0.69 |  |
| F5 | 0.80 |  |  |  |
| Collaboration | A1 | 0.90 | 0.926 | 0.931 | 0.731 |
| A2 | 0.69 |  |  |  |
| A3 | 0.91 |  |  |  |
| A4 | 0.91 |  |  |  |
| A5 | 0.84 |  |  |  |
| Morality | C1 | 0.83 | 0.877 | 0.876 | 0.588 |
| C2 | 0.70 |  |  |  |
| C3 | 0.81 |  |  |  |
| C4 | 0.71 |  |  |  |
| C5 | 0.77 |  |  |  |

The internal validity of each variable was assessed using Cronbach's alpha values, which ranged from 0.827 to 0.938. These values indicate high internal consistency and reliability, as they exceed the minimum threshold of 0.70. This suggests that the items within each variable consistently measure the same underlying construct. Similarly, the Composite Reliability (CR) values, which measure the reliability of the latent constructs, ranged from 0.831 to 0.931. These values also surpass the required threshold of 0.70, indicating that the constructs are reliable and consistent. The Average Variance Extracted (AVE) values, ranging from 0.501 to 0.731, are above the recommended threshold of 0.50. This suggests that the constructs explain a substantial amount of variance in the observed variables, indicating good convergent validity. Higher AVE values indicate that the constructs capture a significant portion of the variability in the observed variables. Based on these results, the validation factor analysis meets the predefined criteria, indicating that the tested instrument is suitable for use in real research scenarios. The high internal validity, reliability, and convergent validity of the instrument contribute to its robustness and suggest that it can effectively measure the constructs of interest. (Awang, 2012).

## **3.4 Data analysis**

In this study, Structural Equation Modeling (SEM) analysis was conducted using AMOS software to develop a model of teacher readiness for the Industrial Revolution era. SEM is a statistical technique that combines factor analysis and path analysis to examine complex relationships between variables and test theoretical models. It allows researchers to analyze both direct and indirect effects among variables, making it ideal for investigating mediating relationships. The primary objective of the analysis was to explore the direct effects of collaboration on the readiness of mathematics teachers to face the Industrial Revolution. The researchers aimed to understand how collaboration directly influences readiness. Additionally, the study examined whether morality serves as a mediator in the relationship between mathematics teacher collaboration and readiness for the Industrial Revolution. A mediating role suggests that morality affects the relationship between collaboration and readiness. By utilizing SEM analysis with AMOS software, the study aimed to provide a comprehensive understanding of the relationships and mechanisms among mathematics teacher collaboration, morality, and their readiness to address the challenges of the Industrial Revolution era. SEM analysis allows for a more nuanced examination of these relationships, helping to uncover direct and indirect effects and providing insights into the complex dynamics at play. Overall, the use of SEM analysis in this study facilitated a thorough investigation of the relationships between collaboration, morality, and readiness among mathematics teachers, shedding light on the factors that contribute to their preparedness in the face of the industrial revolution era.

# **4. Result**

## **4.1 The Effect of** **Morality as a Contribution Mediator between the Collaboration of Mathematics Teachers in Indonesia and the Readiness to Face the Era of industrial revolution**

To analyze the impact of collaboration and morality on the readiness of mathematics teachers in Indonesia to face the challenges posed by the Industrial Revolution, the study adopts a quantitative research design. This involves using a survey questionnaire and structural equation modeling (SEM) to analyze the data. The results, depicted in Figure 1 below, illustrate how morality acts as a mediating factor in the relationship between the collaboration of mathematics teachers in Indonesia and their readiness to confront the challenges of the Industrial Revolution.

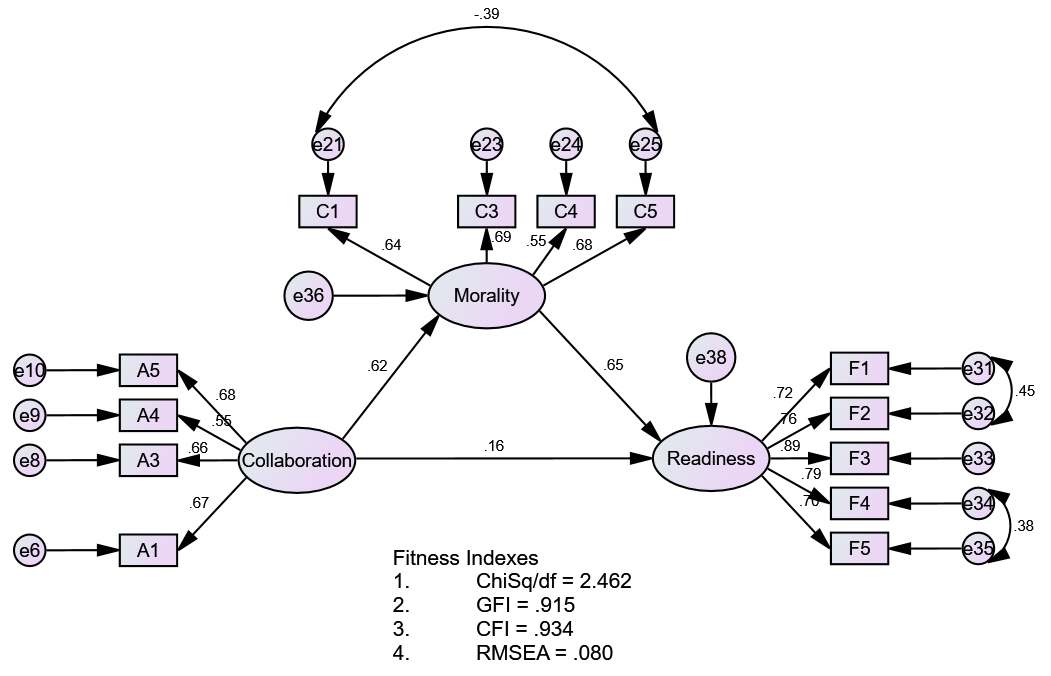


Figure 1. Moral Mediators in the Contribution between Collaboration and IR4.0 Readiness of Mathematics Teachers in Indonesia

Based on the results shown in Figure 1, the analysis indicates that collaboration does not have a significant direct effect on the readiness of mathematics teachers for the challenges of the Industrial Revolution era (β = 0.16, p > 0.05). This suggests that collaboration alone does not directly enhance the preparedness of mathematics teachers for the Industrial Revolution. However, collaboration does have a significant direct effect on morale (β = 0.62, p < 0.001), indicating that collaboration positively influences morale among mathematics teachers. Moreover, the study reveals that morale significantly mediates the relationship between collaboration and readiness for the Industrial Revolution era among mathematics teachers in Indonesia (β = 0.40, p < 0.001). This indicates that the impact of collaboration on readiness is fully mediated by morale. In other words, the effect of collaboration on readiness is channeled through its influence on morale. The model fit indices suggest that the model fits the data well, with a Chi Square/df ratio of 2.462, a Goodness-of-fit Index (GFI) of 0.915, a Comparative Fit Index (CFI) of 0.934, and a Root Mean Squared Error of Approximation (RMSEA) of 0.080. These values indicate that the model adequately represents the data and provides a reasonable fit. Overall, these findings suggest that collaboration indirectly influences the readiness of mathematics teachers to face the challenges of the Industrial Revolution era through its impact on morale. The mediating effect of morale underscores the importance of fostering positive morale among mathematics teachers to enhance their readiness for the Industrial Revolution era.

## **4.2 The Effect of Morality as a Contribution Mediator between Mathematics Teacher Collaboration in** **Malaysia and Readiness in Facing the Era of industrial revolution**

To analyze the impact of collaboration and morality on the readiness of mathematics teachers in Malaysia to face the challenges posed by the Industrial Revolution, the study adopts a quantitative research design. This design utilizes a survey questionnaire and structural equation modeling (SEM) to analyze the data. The results, illustrated in Figure 2 below, depict how morality mediates the relationship between collaboration among mathematics teachers in Malaysia and their readiness to confront the Industrial Revolution era challenges.

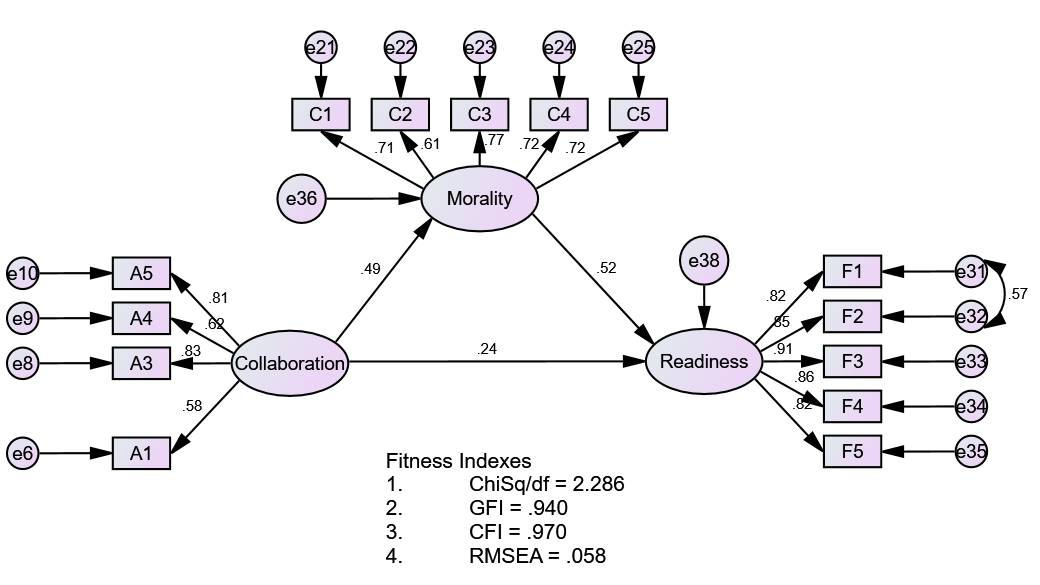
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Figure 2. Moral Mediators in the Contribution between Collaboration and IR4.0 Readiness of Mathematics Teachers in Malaysia

Based on Figure 2, the analysis findings indicate that collaboration does indeed have a significant direct effect on IR4.0 readiness (β = 0.24, p < 0.001). This suggests that collaboration positively contributes to the readiness of mathematics teachers in facing the challenges of the industrial revolution era in Malaysia. Similarly, there is a significant direct effect between collaboration and morale (β = 0.49, p < 0.001), indicating that collaboration positively influences morale among mathematics teachers. Additionally, the study reveals that morale has a significant partial mediator effect in the relationship between collaboration and readiness for IR4.0 among mathematics teachers in Malaysia (β = 0.26, p < 0.001). This suggests that while collaboration has a direct effect on readiness, a portion of its impact is transmitted through its influence on morale. The model fit indices further support the adequacy of the model, with a Chi Square/df ratio of 2.286, Goodness-of-fit Index (GFI) of 0.940, Comparative Fit Index (CFI) of 0.970, and Root Mean Squared Error of Approximation (RMSEA) of 0.058 indicating a good fit of the model to the data. In summary, the updated findings suggest that collaboration has a significant direct effect on IR4.0 readiness among mathematics teachers in Malaysia. Collaboration also directly impacts morale. Furthermore, morale plays a significant partial mediating role in the relationship between collaboration and readiness. These findings emphasize the importance of collaboration and morale in enhancing the readiness of mathematics teachers for the challenges of the industrial revolution era.

# **5. Discussion**

The purpose of the study was to examine the correlation between Collaboration, morale, and the readiness of mathematics teachers in Indonesia and Malaysia to confront the challenges brought by the Industrial Revolution 4.0 (IR4.0). The findings of the study revealed that morale acts as a significant mediator between Collaboration and IR4.0 readiness, indicating that the impact of Collaboration on IR4.0 readiness is fully explained by its influence on morale. This emphasizes the significance of creating a positive work environment and promoting teacher well-being. Previous research has also emphasized the importance of teacher morale in fostering effective teaching practices and improving student learning outcomes (Kasa et al., 2020; Bosso, 2017). Therefore, the study suggests that endeavors to enhance teacher morale can positively impact teachers' preparedness to face the challenges of IR4.0.

Collaboration in the context of mathematics education refers to the collaborative efforts of teachers working together towards a shared objective. This can involve activities such as jointly creating and implementing innovative teaching methods, sharing resources and expertise, or collaborating on research endeavors. The hypothesis proposes a positive relationship between Collaboration and the preparedness of mathematics teachers in Malaysia and Indonesia to confront the challenges posed by the industrial revolution. This suggests that teachers who engage in collaborative practices are better prepared to adapt to the transformations brought about by the industrial revolution, including the increased integration of technology in classrooms, shifts in the job market, and the demand for new skills and knowledge.

Teachers' perceptions regarding collaboration and morale are indicative of their preparedness to confront the challenges presented by the industrial revolution in a multitude of ways. Primarily, teachers' views on collaboration are influenced by the alterations made to the systems of evaluation for teachers, which have resulted in a reduction of social and decisional capital, a decrease in the instructional leadership provided by administrators, and an augmentation in teacher competition (Ismail et al., 2020). Consequently, such changes have compelled teachers to work together, albeit in a manner that may be antithetical to their preferences, with a focus on data relating to students and practices rooted in research (Rawat, 2020). Secondly, teachers' morale is affected by their perceptions of collaboration. Educators who view collaboration as effective and supportive report higher levels of morale, whereas those who feel isolated or lack support experience lower levels of morale (Jemimah & Suziyani, 2019). Therefore, an evaluation of teachers' preparedness for the challenges of the industrial revolution can be undertaken through an examination of their perceptions of collaboration and morale, as these factors are closely linked to their ability to adapt and flourish in an evolving educational landscape. As well as, there is strong positive relationship between participation in collaborative discussions and morale (Goldstein, 2015).

The findings suggest that morality plays a crucial role in shaping the relationship between Collaboration and readiness. Morality encompasses a set of principles and values that guide individuals' behavior, including teachers. It can be argued that a teacher's moral compass significantly influences their approach to work and their dedication to the teaching profession (Goldstein, 2015). For instance, teachers who prioritize collaboration and teamwork are more inclined to cooperate with their colleagues and actively work towards shared objectives. Conversely, teachers who prioritize competition and individual achievement may exhibit less cooperation and may not be adequately prepared to face the challenges presented by the industrial revolution (Jemimah & Suziyani, 2019).

However, readiness refers to the ability of mathematics teachers in Malaysia and Indonesia to adapt to the changes brought on by the industrial revolution. This could include their ability to incorporate technology into their teaching, their knowledge of new mathematical concepts and theories, or their ability to collaborate with colleagues and other professionals. The hypothesis suggests that Collaboration and morality both play a role in determining a teacher's level of readiness. As well as, the study could reveal that individuals who have reached higher stages of cognitive development, as proposed by Moral Development Theory, demonstrate more advanced levels of moral reasoning. This finding would provide support for the idea that cognitive growth and the ability to engage in perspective-taking contribute to moral development (Vozzola, 2014). The study could find that individuals who have been exposed to positive moral models and have observed and imitated their behaviors are more likely to exhibit higher levels of moral development. This finding aligns with the Social Learning Theory's emphasis on the role of observation, modeling, and imitation in learning moral behaviors (Lian et al., 2022).

The findings of the study have important implications for policy and practice in the field of mathematics education in Indonesia and Malaysia. The findings of this study can inform educational policymakers and curriculum developers about the importance of incorporating collaboration and morality into the curriculum to prepare teachers for the challenges of the Industrial Revolution. It highlights the need to prioritize these skills and values in teacher training programs and ongoing professional development, provide insights into the specific areas where teachers need support and training in relation to collaboration and morality. It can guide the development of targeted training programs and resources that enhance teachers' readiness to address the challenges posed by the Industrial Revolution. This can include strategies for fostering collaborative skills, promoting ethical decision-making, and integrating moral education into various subject areas, shed light on the potential impact of collaborative and moral education on student learning outcomes. It can demonstrate how teacher readiness in these areas positively influences students' ability to navigate the challenges of the Industrial Revolution, such as adapting to technological advancements, understanding the ethical implications of automation, and developing critical thinking skills, as well as, raise awareness about the ethical implications of the Industrial Revolution and the role of teachers in guiding students to make ethical decisions in a rapidly changing world. It can promote discussions on ethical frameworks, responsible innovation, and the potential consequences of technological advancements. These considerations can be integrated into broader conversations on the ethics of technology and its impact on society.

# **6. Conclusion**

Based on the research objectives, the study provides evidence supporting the role of morality as a mediator between mathematics teacher collaboration and readiness in facing the era of the Industrial Revolution. This indicates that morality plays a significant role in influencing the relationship between mathematics teacher collaboration and readiness in both Indonesia and Malaysia. The research findings demonstrate that mathematics teacher collaboration directly affects readiness in facing the era of the Industrial Revolution in Indonesia. Furthermore, the study reveals that morality partially mediates this relationship, indicating that morality is an important factor in explaining the indirect impact of mathematics teacher collaboration on readiness in Indonesia. Similarly, in Malaysia, the research shows that mathematics teacher collaboration has a direct effect on readiness in facing the era of the Industrial Revolution. It is also observed that morality partially mediates this relationship, emphasizing the significance of morality in explaining the indirect effect of mathematics teacher collaboration on readiness in Malaysia. Overall, the findings suggest that mathematics teacher collaboration has a direct influence on readiness in facing the era of the Industrial Revolution in both Indonesia and Malaysia. Additionally, morality serves as a significant mediator in this relationship, highlighting the importance of moral values and ethical considerations in enhancing readiness for the challenges posed by the Industrial Revolution in the field of mathematics education in both countries.

However, it’s essential to acknowledge the study's limitations, such as reliance on self-reported measures and its focus on a specific group of teachers in Indonesia and Malaysia. Future research could address these limitations by utilizing objective measures and broadening the scope to include teachers from diverse countries and educational settings. Overall, the study offers a valuable contribution to the literature on the relationship between collaboration, morale, and readiness for the Fourth Industrial Revolution (IR4.0) among mathematics teachers. It provides several recommendations, including integrating collaboration and moral values into teacher training programs, fostering teamwork among teachers, and recognizing the significance of moral values in shaping the effectiveness of such programs. Furthermore, the study emphasizes the importance of further research to explore the relationship between collaboration, morality, and readiness in other subject areas and among different groups of teachers. It also suggests investigating the long-term effects of teacher training programs on teachers' readiness to confront the challenges of the Industrial Revolution and examining the relationship between collaboration, morality, and student outcomes within the context of the Industrial Revolution. These future research avenues could enrich our understanding of how collaboration and moral values contribute to teachers' preparedness for the changing landscape of education in the era of the Industrial Revolution.

**Declarations of Competing Interest**

The authors state that they have no personal relationship(s) that might have inappropriately influenced them in writing the current paper.

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Research ethics approval was obtained by the Institutional Review Board On behalf of the University of Malaya Research Ethics Committee

**Author Contributions**

These authors contributed equally to this work.

Hutkemri Zulnaidi: The idea, data analysis, collecting data and findings

Nofouz Mafarja: Writing, finding recourses, conceptual framework and literature review

Enny Oktavika: collecting data

Umi Kalsum Mohd Salleh: literature review

**Contribution to the literature**

1.This research is essential because it helps us understand how Collaboration and morality impact teacher readiness for the challenges posed by the Industrial Revolution.

2. The study emphasizes the importance of morality as a mediator in the relationship between Collaboration and teacher readiness. This contribution is significant because it underscores the need to consider moral values when designing teacher training programs aimed at preparing teachers for the Industrial Revolution.

3. The study's findings offer valuable insights into teacher readiness for the Industrial Revolution. This contribution is essential because it helps us understand how Collaboration and morality can be leveraged to prepare teachers for the challenges of the Industrial Revolution.

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