

A Conceptual Framework for the Individual Factors Fostering the Innovative Work Behaviour of STEM Teachers

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Abstract: This article explores the factors influencing innovative work behavior (IWB) among academics in the field of education, with a specific focus on STEM teachers. The inquiry adopts the conceptual framework of self-determination theory. A literature review methodology is employed, encompassing an examination of journals, conference papers, theses, and a conceptual approach. Variables in this analysis are delineated and measured in accordance with previous research and recommendations. The findings of this study highlight the significance of intrinsic motivation, self-efficacy, and job engagement as pivotal characteristics contributing to the cultivation of innovative work behavior among employees. The study's limitations stem from its reliance on a literature review and the analysis of prior research findings to construct a conceptual framework concerning STEM teachers' innovative work behavior. Future empirical research is recommended to comprehensively elucidate additional factors fostering innovative work behavior. The research findings corroborate earlier studies, suggesting that to bolster Malaysia's standing in the Global Innovation Index (GII) and, indirectly, to advance the goals of the NSTIP 2021-2030 aimed at cultivating a technologically proficient society, educational administrators in Malaysia should actively foster teachers' engagement in innovative work behavior activities, leveraging their competencies and strengths. This study provides valuable insights into the individual factors influencing teachers' propensity for innovative work behavior and their potential to enhance Malaysia's education system.

Keywords: *Innovative Work Behaviour, Individual Factors, Self-Determination Theory, STEM Teachers, Teachers, Education.*

1. Introduction

In tandem with technological advancements, Malaysia is intensifying its efforts to remain aligned to adopt the Fourth Industrial Revolution, often referred to as IR 4.0. The National Science, Technology, and Innovation Policy (NSTIP) 2021-2030 has introduced the concept of Science, Technology, Innovation, and Economics (STIE) to highlight the significance of Science, Technology, and Innovation (STI) in driving economic growth and achieving the objective of becoming a high-tech nation. STIE aims to establish and enhance the foundation for innovation and the utilization of science and technology for the benefit of diverse segments of society. Malaysia should transition from being a mere consumer of technology to becoming a nation that actively innovates, creates, and advances technology. Hence, this policy outlines the plan for enhancing the advancement of indigenous technology and fostering a culture of science, technology, and innovation to establish a society proficient in the application of scientific and technological knowledge (NSTIP 2021-2030, mosty.gov.my). Moreover, the advancement of Science, Technology, Engineering, and Mathematics (STEM) necessitates a shift in emphasis and direction to provide education that aligns with the objectives of IR 4.0. Currently, there is significant discourse on the advancements in the domains of STEM, which are closely linked to the concept of IR 4.0.

Therefore, the country's educational system is faced with the challenge of producing human resources equipped with the necessary abilities to successfully adapt to the ongoing shift. Education is widely recognized as a vital element in the development of human talents and attitudes, serving as a primary means of acquiring knowledge (Mohd et al., 2018). Its relevance lies in its capacity to promote the growth of knowledge workers. Hence, scholars play a crucial role in the creation and advancement of innovative knowledge, theories, models, practices, systems, technologies, tools, and approaches (Ibus et al., 2020). These advancements are particularly achieved through innovative work behavior (IWB) (Ibus et al., 2020). Furthermore, education experts have acknowledged the significant influence that various technological advancements in information and communication technology (ICT) have had on education in recent years (Haseeb, 2018). Therefore, it is widely accepted that Education 4.0 will be influenced by these advancements and will require equipping students with

the skills to generate innovations (Mirzajani et al., 2016). Recognizing and addressing the crucial impact of innovation in the context of education is essential, as highlighted by Kundu & Roy (2016). Specific acts of innovation have the potential to generate substantial improvements in the education system.

Within the field of education, innovation has the potential to enhance the learning environment, thereby boosting students' achievement and success. Teachers who introduce innovative approaches can promote creativity in learning, improve the implementation of teaching methods, and facilitate the use of new tools and technology. This can lead to significant benefits for students and the education system as a whole (Zainal & Mohd Matore, 2019). STEM education prioritizes equipping students with the essential skills necessary to address real-world problems. Furthermore, it fosters the development of students' critical thinking abilities, collaborative proficiency, innovative thinking, and effective communication skills (Dare et al., 2021). The urgent need for enhanced STEM education globally can be attributed to the environmental and social challenges of the twenty-first century, which have significant implications for global security and economic stability (Kelley & Knowles, 2016). The active engagement of teachers is crucial in achieving the objectives set by the Ministry of Education (MoE).

Before implementing STEM education, it is essential for teachers, who will serve as mentors, to have a comprehensive understanding of the subject matter (Hasim et al., 2022) and possess the necessary pedagogical skills to effectively impart knowledge. Additionally, teachers should be cognizant of the challenges and difficulties that students may encounter (Abdullah et al., 2015). Parthasarathy & Premalatha (2017) argue that there is insufficient emphasis on research studies examining innovative work behavior within the field of education. Meanwhile, Messmann et al. (2018) observed a scarcity of research on the extent to which teachers engage in innovative work behaviors and how their proactive initiatives might be encouraged and nurtured. This research aims to address a knowledge gap concerning innovative work behavior in educational institutions, focusing particularly on the role of educational institutions, especially STEM teachers, in imparting valuable and practical knowledge to students. Therefore, the objective of this study was to examine the factors influencing the IWB of STEM teachers. This study is expected to provide relevant insights into innovative work behavior, which can assist the government in formulating effective educational reforms for the betterment of its citizens.

Recent Issues: STEM education, derived from the initials of Science, Technology, Engineering, and Mathematics (STEM), encompasses disciplines such as science, mathematics, design and technology, basic computer science, biology, physics, and chemistry (Amelia & Lilia, 2019). STEM Education involves the teaching and learning process, incorporating all aspects of STEM and potentially more (Becker & Park, 2011). STEM education focuses on equipping students with the essential skills needed to tackle practical difficulties encountered in the real world. Furthermore, it fosters the growth of students' critical thinking abilities, collaborative capacity, innovative thinking, and proficient communication skills (Dare et al., 2021). The urgent need for improved STEM education worldwide can be attributed to the environmental and social challenges of the twenty-first century, which have significant consequences for global security and economic stability (Kelley & Knowles, 2016). Rifandi & Rahmi (2019) argue that integrating STEM into education can provide the next generation with the essential skills and knowledge to effectively tackle the challenges of the twenty-first century. In Malaysia, the implementation of a core science and technology policy was initiated in early 1967 to cater to the need for graduates with a science-oriented background (Ong et al., 2021).

As part of this policy, a ratio of 60:40 for Science and Arts was introduced to prioritize the advancement of science and technology (Academy of Science Malaysia, 2017). However, as stated by Thomas & Watters (2015), there has been a decrease or lack of growth in the enthusiasm displayed by students when it comes to pursuing professions in STEM subjects. Caprile et al. (2015) found that there is now an imbalance between the need for workers in STEM sectors and the quantity of students joining the workforce. The scarcity of trained and professional people, as emphasized by Kearney et al. (2015), presents development issues for countries. Additionally, according to data published by the Ministry of Education (MoE) in 2022, there has been a decrease in the percentage of upper secondary students participating in the STEM stream from 2017 to 2022, with a decline from 45.2% to 40.94%. Therefore, this study focuses on the influence of teacher behavior in persuading students to engage in STEM fields. The active involvement of teachers is crucial in attaining the objectives established by the MoE. Before implementing STEM education, it is crucial for teachers, who will act as mentors,

to have a thorough grasp of the subject matter (Hasim et al., 2022) and possess the requisite pedagogical abilities to effectively convey knowledge. Additionally, teachers should be aware of the challenges and hardships that students may face (Abdullah et al., 2015).

2. Methodology

This study involves a literature review that investigates the relationship between individual perspectives and innovative work behavior (IWB). To achieve this purpose, a thorough review of pertinent literature and past research is carried out, gathering information from credible scholarly journals, books, conference proceedings, reports, websites, and numerous commentaries. The following sections offer an overview of relevant studies organized by individual perspectives (intrinsic motivation, self-efficacy, and job engagement) and the correlation between these components and innovative behavior. The research findings are summarised and discussed in the final remarks.

3. Literature Review

This section explores several variables proposed by researchers, including innovative work behavior, intrinsic motivation, self-efficacy, and job engagement.

Innovative Work Behaviour: Innovative work behavior (IWB) refers to an individual's deliberate and purposeful actions aimed at introducing new and advantageous ideas, processes, products, or procedures within a work function, group, or organization (de Jong & Hartog, 2007). According to Scott & Bruce (1994), IWB encompasses a range of actions aimed at identifying, creating, altering, adapting, and executing ideas. Organizations address internal challenges by formulating solutions (Widodo & Mawarto, 2020) and employing non-traditional methods (Ma Prieto & Pérez-Santana, 2014). Employees are encouraged to participate in IWB as a means of fostering creativity in response to the evolving corporate landscape (Hong et al., 2016). A study conducted by Lukes and Stephen (2017) showed that the implementation of IWB has positive effects benefiting both the organization and its employees. These effects include improved working conditions, increased job satisfaction, and enhanced well-being. Innovative work behavior is considered an integral component of IWB, characterized by its dynamic and diversified nature. Within the current professional setting, the adoption of IWB is a crucial determinant for the advancement and progress of organizations, whether they belong to the private or public sectors (Abdullatif et al., 2016). Hakimian et al. (2016) argue that IWB can serve as a competitive advantage for a firm. The presence of IWB in education is essential for propelling operations and improving the quality and outcome of the learning process (Zammit et al., 2023). To fulfill educational goals effectively, teachers and education professionals must exhibit IWB.

This behavior can be influenced by a variety of circumstances (W., & Kusmaryani, 2022). Within the field of education, innovation enables the tailoring of the educational process (Brodhag, 2013), and scholars unanimously agree on the positive impacts of education on communities, families, and individual well-being. Advocating for innovation in education is crucial to optimize the return on public investment. Based on past studies, there are reasons why it is necessary to have teachers with innovative work behavior in schools. To stay updated with the rapid evolution of society, it is crucial to exhibit IWB. The requirements in our knowledge-based society are undeniably escalating for both students and teachers (Klaeijnsen et al., 2017). Furthermore, the continuous emergence of new developments and information in the field of education necessitates the adoption of novel teaching practices. This is because teachers, and their instructional approaches in particular, have the most significant influence on students' self-determination and drive to study (Awang-Hashim et al., 2017). Furthermore, schools should serve as a prominent model and serve as a catalyst for fostering more cutting-edge work ethics among individuals, thus ensuring the continued competitiveness of society. Innovation, as stated by Orindah (2014), is a crucial catalyst for both economic and social advancement. Moreover, innovation is considered a method to enhance an organization's ability to adapt to evolving circumstances (Singh & Sarkar, 2012). Education plays a pivotal role in nurturing students' creative and inventive thinking (Usma & Frodden, 2003). In essence, innovative work behavior is vital for the continual advancement of educational professionals, school organizations, and the fostering of a knowledge-based society.

Individual Factors Fostering Innovative Work Behaviour: Individual factors play a crucial role in influencing the innovative work behavior of STEM teachers. These factors can impact the level of motivation, creativity, and propensity to take risks when introducing novel teaching practices and incorporating technology into their classrooms (Zhao et al., 2002). The IWB of STEM teachers is influenced by several individual elements, including intrinsic motivation, self-efficacy beliefs, perceived rewards, perceived challenges, and barriers. Gkontelos (2023) found that crucial individual factors influencing the IWB of STEM teachers encompass self-efficacy, burnout, irrational beliefs, competence, motivation, and organizational commitment. These elements are essential in enhancing teachers' capacity to produce, adapt, and implement novel ideas within the school environment, ultimately resulting in communal advantages (Avsec & Savec, 2021). By comprehending and resolving these specific problems, educational institutions can establish a conducive environment that promotes and sustains teachers' innovative behaviors, thus improving the caliber of education in STEM subjects.

Intrinsic Motivation pertains to the inherent drive and enthusiasm that STEM teachers possess toward their work, which can foster their creativity and inclination to innovate (Stein & Wang, 1988). According to Deci and Ryan (2011), intrinsic motivation refers to the desire that is within an individual that compels them to participate in a specific activity because they find it both challenging and pleasant. Turabik & Baskan (2015) have provided support for the notion that motivation theories can shed light on the factors that drive individuals to perform at a higher level in their jobs. Numerous studies have indicated that people who are motivated by the desire to assist others and the need for personal accomplishment place great value on internal rewards (Dur & Zoutenbier, 2015; Georgellis et al., 2010). It is supported by findings from Shumow & Schmidt (2013) that found the ability to employ scientific knowledge in important decision-making processes is driven by motivation in the scientific field.

Self-efficacy beliefs contribute to the confidence of STEM teachers in their capacity to effectively apply innovative practices, hence impacting their inclination to venture outside their comfort zone and experiment with novel techniques. It pertains to the internal convictions of teachers regarding their capacity to proficiently execute actions that enhance their teaching performance. Prior research by Nemeržitski et al. (2013) has extensively employed it in the educational setting to examine teacher or student behavior. The notion has a substantial impact on the innovative behavior of mathematics teachers (Nemeržitski et al., 2013; Klaijnsen et al., 2018). According to Siregar et al. (2019), self-efficacy pertains to the confidence that teachers have in their capacity to effectively carry out novel tasks. Other than that, self-efficacy is connected to the feelings of workers, which in turn shape their attitudes and beliefs towards their workplaces (Ozer & Akgun, 2015; Warren & Gerler, 2013). In addition, Baharin et al. (2019) and Tims et al. (2014) suggest that self-efficacy can boost an individual's capability and uniqueness, leading to enhanced performance and professionalism. Schunk and DiBenedetto (2016) reported evidence indicating that high self-efficacy can also adversely affect individuals. Individuals with strong self-efficacy may tend to become overconfident and approach tasks with less effort. These diverging viewpoints have made this component a valuable subject of study due to its potential for producing dual impacts.

Additionally, previous research has extensively employed the concept of **job engagement** to examine professionalism and performance in the field of teaching (Hosseini & Haghghi, 2021; Docherty et al., 2018; Ng & Park, 2021). The term can be understood as the personal level of dedication and commitment towards work-related matters. According to the research conducted by Sari et al. (2021), job engagement can be described as the level of motivation and enthusiasm that employees have towards their work. An engaged employee actively participates and endeavors to make valuable contributions to the organization by increasing productivity, efficiency, and fostering innovation. Job Engagement can be separated into three distinct dimensions: energy, dedication, and absorption (Schaufeli, 2006). Energy encompasses a heightened degree of vitality and cognitive stamina in the workplace. Dedication is the state of being fully committed and deeply involved in one's work, resulting in a strong sense of engagement. Feelings of importance, passion, motivation, satisfaction, and difficulties related to one's job. Absorption pertains to employees who have high levels of job satisfaction, derive enjoyment from their work, are fully engaged in their tasks and often perceive time to pass quickly while working. Multiple studies have demonstrated that the level of involvement exhibited by teachers has a substantial impact on their job performance, job satisfaction, and commitment. Additionally, it has been found

to enhance creativity and innovation in teaching approaches, hence influencing teaching performance (Hosseini & Haghghi, 2021).

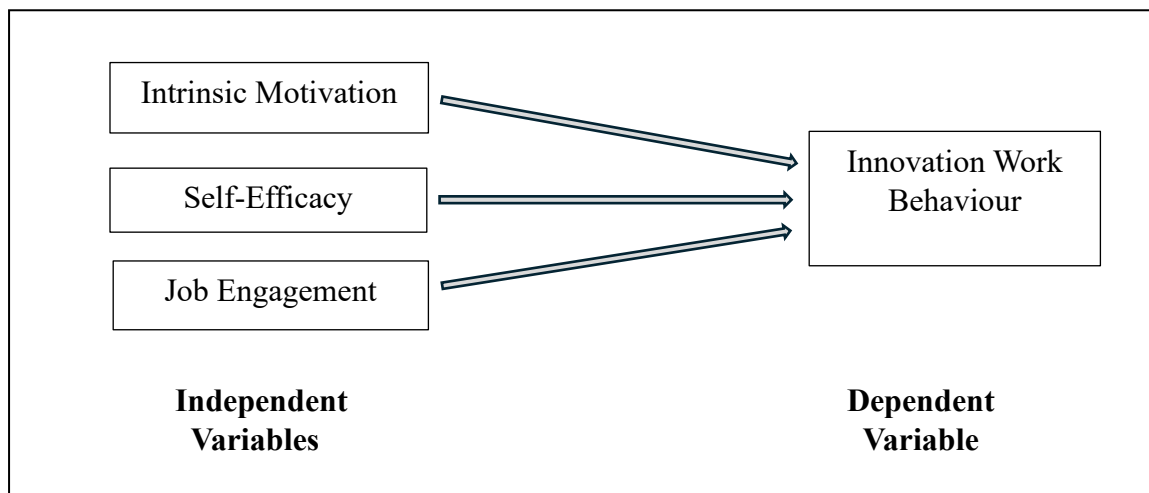
The gap in the Literature: Despite the considerable amount of research dedicated to identifying the antecedent factors that may impact STEM teachers' IWB, there remains a literature gap regarding variables and innovative work behavior due to industry differences (Zainal & Lata, 2021), fragmented and inconsistent findings (Bos-nehles, 2017), and the necessity to reexamine several variables associated with innovative work behavior (Namono et al., 2021). In Malaysia, other significant stakeholders in the education system, including administrators and instructors, are excluded from the narrow focus. Given the concerning performance of Malaysia on the Global Innovation Index (GII), there is an imperative need for, and emphasis should be placed on research about IWB in Malaysia. Aside from that, innovations will shape Education 4.0, and teachers will need to be prepared to construct creative learning environments that support student creativity (Johari et al., 2021). Furthermore, innovations can fill the void discovered by Caprile et al. (2015) between the number of students entering the workforce and the demand for workers in the STEM sector.

Underpinning Theory: A theory has been applied to the factors that underpin IWB based on the study. This theory has been employed in this investigation. Consequently, the purpose of this study is to evaluate the proposed theoretical framework by utilizing this theory.

Self-Determination Theory: The origins of self-determination theory can be traced back to the research conducted by psychologists Edward Deci and Richard Ryan. They initially presented their concepts in their 1985 publication titled "Self-Determination and Intrinsic Motivation in Human Behaviour." They formulated a motivation theory positing that individuals are primarily motivated by a desire for personal growth and fulfillment. The theory of self-determination has been extended to several domains, encompassing education, employment, child-rearing, physical activity, and well-being. Studies indicate that possessing a strong sense of self-determination can promote achievement in all aspects of one's life (Cherry, 2022). The primary focus of self-determination theory lies on internal sources of motivation, specifically the desire to acquire knowledge or attain independence. Furthermore, cultivating a cohesive sense of self necessitates the presence of employees who possess job satisfaction and derive pleasure from executing duties and embracing novel challenges and experiences. Therefore, Self-Determination Theory can and has been utilized to explain how individual factors foster employees' innovative work behavior.

Proposed Research Framework

Figure 1: Conceptual Framework



This study establishes a research framework as a foundation for the study's objective. The study's conceptual framework encompasses three independent variables, namely intrinsic motivation, self-efficacy, and job engagement, with innovative work behavior serving as the dependent variable. The independent variables and

dependent variables exhibit a direct correlation within the model. The study will adopt the Self-Determination Theory as its conceptual framework. Figure 1 presents a visual representation of the conceptual framework, showcasing the independent and dependent variables of the study at hand. The independent variables in this study include intrinsic motivation, self-efficacy, and job engagement, while the dependent variable is innovative work behavior. Moreover, the arrows signify that the present study seeks to evaluate the degree to which the preceding elements impact innovative work behavior. Several studies have investigated IWB as an outcome variable, although there remains a significant amount of research to be conducted on different aspects of this idea.

4. Discussion

The findings of this study, derived from a comprehensive evaluation of the relevant literature, indicate numerous elements that have the potential to influence the IWB of STEM teachers, either directly or indirectly. Intrinsically motivated employees tend to be more creative because this type of motivation enhances their curiosity, cognitive flexibility, and willingness to take risks, all of which are conducive to generating creative ideas (Deci & Ryan, 1985; Grant & Berry, 2011; Rego et al., 2012). This finding is supported by Kong et al. (2017), who identified that employees possessing intrinsic motivation are more likely to approach their work with diligence and embrace novel approaches that foster innovation and creativity. In addition, intrinsic motivators are associated with the work itself (Saeed et al., 2019), enabling teachers to focus better on tasks and strive for excellence in all their endeavors, including being more creative and innovative. This aligns with the findings of studies by Anzarwati (2021), Bawuro et al. (2019), and Arasli & Alphon (2019), collectively establishing that IWB is significantly and positively influenced by intrinsic motivation. However, intrinsic motivation also plays an intermediate role between leadership and innovative work behavior, as it boosts the creativity of employees (Kaur & Rahmadani, 2023).

This suggests that intrinsic motivation is one of the elements that can trigger IWB among teachers in schools. Although intrinsic motivation has been found to play a significant role in various elements of employee performance, it does not seem to be an effective component in driving innovative behaviors on its own (Karadeniz et al., 2021). If teachers are intrinsically motivated in the way they carry out their work, then it can be argued that they are more innovative. In their study, Klaijnsen et al. (2018) discovered a positive correlation between teachers' innovative behavior and their levels of intrinsic motivation and self-efficacy. Motivation and self-efficacy are recognized as key elements that influence employees' IWB (Siregar et al., 2019), and just as self-efficacy has a direct positive impact on teachers' IWB (Susanti & Ardi, 2022; Gkontelos et al., 2023; Li et al., 2024). Bandura suggested that self-efficacy affects individual performance, which is thought to affect an individual's behavior, particularly in terms of effort, resilience in facing challenges (Thurlings et al., 2015), and openness to change (Shamsudin & Majid, 2018). However, studies have discovered that the connection between self-efficacy and innovative work behavior is influenced by other factors.

A favorable school climate may enhance the impact of self-efficacy on a teacher's innovative behavior, as indicated by factors like school climate (Kundu & Roy, 2023). Thus, considering the impact of self-efficacy on IWB is crucial since it plays a significant role in shaping teachers' behavior within the innovation process. While Li et al. (2024) found that facilitating conditions, self-efficacy, and job engagement have significant direct effects on elementary mathematics teachers' IWB. Findings by Kaur and Rahmadani (2023) also confirm that job engagement directly affects IWB. Additionally, job engagement mediates the relationship between job crafting and innovative work behavior (Bhattarai & Budhathoki, 2023). Job engagement also mediates the relationship between organizational identification and innovative work behavior (Charli et al., 2023) and moderates the relationship between job crafting and IWB, with higher levels of job engagement leading to increased innovative behavior (Lee & Park, 2023). However, research findings by Sari et al. (2021) suggest that job engagement does not play a prominent role in shaping employees' IWB. Nevertheless, these findings contradict the research findings that self-efficacy and employee engagement mediate the relationship between the learning support environment and innovative work behavior (Bhattarai & Budhathoki, 2023).

5. Conclusion

In summary, the findings of this study highlight the significance of intrinsic motivation, self-efficacy, and job engagement as critical factors contributing to the development of innovative work behavior among employees. These factors have the potential to empower teachers, particularly those in STEM fields, to adapt to technological advancements and environmental changes, thereby indirectly fostering creative thinking among their students. By recognizing the relevance of self-efficacy, intrinsic motivation, and job engagement to teachers' innovative behavior, this study offers valuable insights into the educational system. It is envisaged that these findings will aid school administrators in continually supporting teachers to enhance their creativity and innovation in their work, particularly in delivering knowledge to students. This, in turn, may spark students' interest in exploring the STEM field, thus bridging the gap between the demand for STEM sector employment and the growth of employment prospects in high-tech skills-based economic and industrial sectors, which align with the nation's progress in automation and technological advancements (Astro Awani, 2023). Moreover, it is hoped that this study will inspire further research, particularly regarding STEM education in Malaysia.

Additionally, it is anticipated that this research will provide insights into the determinants of innovative behavior among educators, especially teachers, offering stakeholders guidance on efforts to enhance such behavior. In the current landscape of education and educational reform, where progress is rapid, the development of innovative conduct among teachers is imperative for the continued relevance of education in achieving its objectives. Future research endeavors should aim to explore deeper into this topic, examining the extent to which the factors identified in this study exert influence. To contribute to the body of knowledge and understand whether these variables act directly, as mediators, or as moderators of innovative behavior among educators, comprehensive research is necessary. Additionally, further empirical evidence is needed to explore the impact of various motivational factors on teachers' innovative work behavior. Such research would be instrumental in guiding future studies on teachers' innovative behavior, benefiting all stakeholders involved in the educational process.

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