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The Role of Teacher Response and Support in Fostering Smart Risk-Taking Behavior of K-12 Chemistry Students Through Learning Intention

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Abstract: The Role of Teacher Response and Support in Fostering Smart Risk-Taking Behavior of K-12 Chemistry Students Through Learning Intention. Objectives: This study explores how teacher support influences K-12 students' learning intentions and risk-taking in Indonesian chemistry education, aiming to bolster creative and critical thinking. **Methods:** A quantitative survey aligned with the positivist paradigm examines the dynamics between teacher behaviours, classroom interactions, and students' willingness for intelligent risk-taking. **Findings:** It reveals the critical role of supportive teaching methods in promoting smart risk-taking, enhancing classroom engagement, and shaping students' educational interests and attitudes. These insights suggest a profound impact on educational practices in chemistry, highlighting the importance of supportive learning environments. **Conclusion:** The research emphasizes the need for fostering robust teacher-student engagement and creating conducive learning spaces, with broad implications for teacher training, curriculum design, and educational policy. It underscores the value of dynamic, engaging, and effective learning experiences in the chemistry classroom that empower students to take intelligent risks, significantly contributing to their educational development.

Keywords: chemistry smart taking behavior; k12 students; learning intention; teacher support and response.

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INTRODUCTION

The education sector prepares students to meet these evolving demands in the current industrial landscape, where innovation and adaptability are paramount. Specifically, in chemistry education, the challenge is to impart knowledge and equip students with the skills necessary for intelligent risk-taking and problem-solving. These abilities are increasingly sought after in various industries, from pharmaceuticals to environmental science, where chemistry plays a foundational role. In this intricate landscape of K-12 education, especially within the discipline of chemistry, the dynamics of teacher-student interaction play a pivotal role in shaping students' learning experiences and outcomes. This study delves into the realm of social interaction in educational settings (Demaray & Malecki, 2002), and examines its impact on the development of smart risk-taking behaviour among students. *Smart risk-taking* is an individual's readiness to act in conditions of uncertainty and unknown consequences (Çakýr & Yaman, 2015). The role of teacher response and support (Beghetto, 2009; Beghetto et al., 2021), becomes crucial in nurturing this type of behaviour in students.

The significance of teacher support and response in the educational process extends beyond imparting knowledge; it plays a vital role in shaping students' behavioural attitudes and affective learning outcomes. Effective teacher support can foster self-motivation, creativity, responsibility, leadership, self-confidence, perseverance, and good student behaviour (Deci & Ryan, 2013). This notion is further supported by a multitude of research, indicating that teacher support is instrumental in students' emotional development and academic achievement (Langhout & Mitchell, 2008; Perry et al., 2010). The perception and interpretation of classroom events by students are crucial for their educational outcomes (Shuell, 1996). The constructivist ideas emphasized by Brok et al. (2004) suggest that the student's perception of teacher behaviour is central to the learning experience. Psychological support from educators, including perceptions of confidence, kindness, respect, and closeness, significantly influences the learning environment and students' responses to it (Langford et al., 1997; Patrick et al., 2011; Wentzel et al., 2010; Witt et al., 2011).

This study aims to explore the impact of teacher support and response on the development of smart risk-taking behaviour in chemistry education among K-12 students in Indonesia. It will examine how teacher behaviour and classroom interactions influence students' learning intentions and willingness to engage in intelligent risk-taking behaviours. The study is particularly pertinent given the challenges posed by chemistry education's abstract and complex nature, which often leads to student disengagement and passivity (Sunyono et al., 2009). By incorporating strategies like Problem-Based Learning (PBL) (Djoa et al., 2023), this research seeks to understand how psychological factors play a role in fostering smart risk-taking behaviour in the context of learning chemistry. To explore these interconnected dynamics, the study is structured around the following research questions:

RQ1: How does teacher support and response contribute to the chemistry smart risk-taking behaviour of K-12 chemistry students?

RQ2: How does teacher support and response contribute to the learning intention of K-12 chemistry students?

RQ3: How does learning intention contribute to the chemistry smart risk-taking behaviour of K-12 students?

RQ4: How does learning intention mediate the relationships between teacher support and response on chemistry smart risk-taking behaviour?

Through investigating these questions, this study aims to uncover insights into how educators can effectively foster an environment conducive to smart risk-taking in chemistry. By understanding the interplay between teacher support, student learning intentions, and risk-taking behaviour, educators can better tailor their teaching strategies to impart knowledge and develop the skills necessary for intelligent risk-taking. This research, therefore, holds significant implications for educational practices in chemistry, aiming to transform the traditional learning experience into one that is more dynamic, engaging, and conducive to developing critical thinking and problem-solving skills among K-12 students.

Chemistry Problem Based Learning (PBL)

Problem-based learning (PBL) in chemistry education is a pedagogical approach that aims to deepen students' understanding and knowledge of chemical concepts through active engagement in solving real-world problems (Barrows, 1996; Duch, 1996; Montserrat, 2009). Unlike traditional teaching methods, where the student's role is often passive, and the teacher primarily dispenses information, PBL encourages students to take an active role in their learning process. It begins with introducing theoretical concepts in the classroom, which are then applied and explored through practical problem-solving activities. The essence of PBL is not just in the application of these concepts but in fostering a deeper understanding through their utilization in practical contexts. As students navigate through complex problems, they learn to break them down into a series of simpler steps, each guided by informed decision-making that relies on the initial problem definition and insights gained from previous steps. In traditional settings where teachers directly solve problems, students may passively follow the solution path, potentially missing out on exploring alternative methods or strategies. PBL addresses this by empowering students to collaboratively engage in the problem-solving process, initially under guidance but eventually leading to autonomous problem-solving within a set timeframe. This method not only encourages active learning but also enhances students' skills in information management and selection (Hmelo-Silver, 2004; Norman & Schmidt, 1992; Yew & Goh, 2016).

The effectiveness of PBL in chemistry education has been demonstrated in various contexts, including laboratory and theoretical settings (Bellová et al., 2018; Cáceres-Jensen et al., 2021; Costantino & Barlocco, 2019; Shultz & Li, 2016; Wellhöfer & Lühken, 2022; Williams, 2017; Williams et al., 2010). It has been observed to significantly boost student motivation and improve key skills such as autonomy, collaboration, critical thinking, oral communication, and self-evaluation. The transition to online teaching models during the COVID-19 pandemic posed unique challenges to PBL, requiring significant adaptation from students and teachers as they navigated the new virtual learning environment. Despite these challenges, PBL's adaptability to online platforms has shown promising results, highlighting its effectiveness as a teaching methodology in various learning environments. In chemistry, PBL's significance is further magnified due to the subject's inherent complexity and practical nature. Students learn to apply chemical principles to real-world problems, thereby gaining a deeper understanding of the subject matter. This approach also prepares students for the practical challenges they may face in their professional careers, making PBL an essential tool in modern chemistry education. The interactive and collaborative nature of PBL, whether in physical or virtual classrooms, fosters a dynamic learning environment where students can develop not only their chemical knowledge but also essential life skills such as problem-solving, teamwork, and adaptability.

Chemical Risk Management

Tracing its origins to ancient practices, risk management first emerged as a strategic approach by the Phoenicians. Klein (2001) describes how these skilled merchants, known for their maritime prowess, minimized losses by using smaller ships near shores, effectively reducing the risk of losing cargo. This early manifestation of risk mitigation parallels modern strategies. Moreover, the Phoenicians' development of one of the first insurance systems in Genoa illustrates their innovative approach to managing and transferring risk. Although the Phoenician civilization eventually declined, their legacy in insurance, banking, trade, and commerce structures persisted in the Roman Empire and laid the foundations for modern risk management practices. In the realm of school districts, risk management focuses on preventing accidents that impact students, staff, and property. This involves identifying potential risks, such as student injuries due to negligence, inadequate training, or property damage from external factors (Gaustad, 1992; Herman, 1992). The objective is to assess the school district's vulnerability to these risks and develop strategies to minimize or eliminate their impact. This approach is crucial in managing unforeseen costs and ensuring the safety of the school community.

Applying these principles to K-12 chemistry education, the role of educators is pivotal in integrating risk management into the laboratory setting. Teachers are instrumental in adapting risk assessments, a process mandated by legislation like the Health and Safety at Work Act (1974) (Moore et al., 2023). This involves hazard identification, risk evaluation, and the implementation of control measures ranging from elimination to personal protective equipment, with a strategic preference for non-PPE measures due to their relative ineffectiveness (Chang et al., 2021; Dreier et al., 2021). Furthermore, cultivating a proactive safety culture is essential. Teachers support students in developing smart risk-taking behaviors, teaching them to make informed decisions in potentially hazardous situations, thereby instilling a sense of responsibility and awareness about laboratory safety (David & Dobreanu, 2022; Murcia et al., 2023). In conclusion, risk management in K-12 chemistry labs involves a synergy between historical risk mitigation strategies and modern safety protocols. Teachers play a crucial role in this process, adapting traditional principles to contemporary educational settings. This approach ensures not only compliance with safety norms but also empowers students with the skills and knowledge to navigate laboratory environments safely and responsibly.

Smart Risk Taking Behavior

Risk behaviour encompasses the decision-making processes in situations where outcomes are not guaranteed, ranging from success to potential failure (Reniers et al., 2016). In the context of chemistry education, this is especially pertinent, given the subject's inherent complexities and the often unpredictable nature of scientific experimentation and exploration. Zhang et al. (2017) provide a deeper understanding of risk perception, presenting it as a highly individualized concept. This individualization is pivotal, as it shapes how students perceive and react to challenges in their educational journey, with these perceptions being influenced by their past experiences, innate intuition, and the subjective interpretation of these experiences. Beghetto (2009) introduces the concept of smart risk-taking behaviour, specific to educational contexts, which is predicated on a student's desire for knowledge, their self-confidence in creative problem-solving, and, importantly, the support they receive from educators. This aspect of risk-taking is vital in educational settings (Clifford, 1991), where the learning environment plays a crucial role in either encouraging or discouraging students from engaging with academic risks. This environment, shaped by educators, can create a safe space for exploration or can act as a barrier to student engagement in risk-taking activities.

Building on this, Allmond et al. (2016) emphasize the significance of smart risk-taking as a critical skill for the 21st century, highlighting the responsibility of educators to guide and nurture this skill in their students. This is especially relevant in today's rapidly evolving world, where adaptability and the ability to navigate complex situations are invaluable. The research by Radloff et al. (2019) underscores the benefits of this approach, noting improvements in student engagement, teacher confidence, and the strengthening of teacher-student relationships. The research also accentuates the integral role of teacher support in fostering smart risk-taking behaviours, as discussed by Beghetto (2009).

The manner in which educators respond to and assist students in their academic endeavours is a determining factor in the development of these behaviours. The presence or absence of this support can significantly impact not only immediate academic outcomes but also shape students' long-term educational and career trajectories. Therefore, the role of the educator is not merely as an instructor but as a facilitator and mentor in the process of developing smart risk-taking behaviours. In summary, smart risk-taking behaviour in chemistry education is a dynamic interplay of individual risk perceptions, the educational environment created by teachers, and the crucial influence of educator support. It goes beyond merely navigating uncertainties; it involves cultivating a mindset geared towards intellectual curiosity, confidence in one's creative abilities, and leveraging the support system provided by educators. Understanding and nurturing smart risk-taking behaviours are essential for preparing students to handle the challenges of academic pursuits effectively and to equip them for the complexities of their future professional lives in an ever-changing world.

Teacher Response and Support

Psychological theories offer diverse interpretations of teacher support, with each definition and concept highlighting the significance of the interaction between teachers and students. This interaction is a cornerstone of the impact that teacher support has on the teaching and learning process, with the potential to improve student achievement substantially. This emphasizes the effectiveness of teacher support in quality education, transforming the teacher's role from merely being adept at teaching to becoming a proficient mentor (Allee-Smith et al., 2018) and a career consultant for students (Schiersmann et al., 2012). This active role involves elevating students' consciousness and engagement with the learning material (Vigny et al., 2011). Teacher competence, as a professional attribute, encompasses the ability and skills necessary to support students and to build positive interactions between students and teachers. The Tardy model of social support implies that teacher support involves using social interaction strategies effectively within the teaching and learning process (Tardy, 1985). Teacher support is also evident in students' emotional attitudes toward their teachers, recognizing support that includes physical help, clear information provision, and positive assessments of learning outcomes (Malecki & Demaray, 2002).

In the context of students' career development, teacher support is crucial, shaped by interpersonal social support that fosters strong teacher-student relationships (Zhang et al., 2018). In the educational process, teacher support is instrumental in solving students' problems, improving overall welfare, providing security, and bolstering students' determination and interest in their studies. The concepts of self-determination and social support offer bifurcated definitions of teacher support. Self-determination theory posits that students perceive support from teachers as cognitive (Skinner et al., 2008), emotional (Skinner & Belmont, 1993), or autonomy-oriented during their learning process (Wellborn & Connell, 1987). Ryan and Deci (2000) suggest that individuals engage in tasks based on their values, interests, and enthusiasms, with their environment influencing corresponding emotions and motivations. Teacher support is threefold—encompassing support for autonomy, providing structure, and facilitating participation. Autonomy support includes offering students choices and acknowledging their perspectives; structural support is about setting clear expectations; and participation involves demonstrating warmth and affection, utilizing resources, understanding students, or establishing trustworthiness (Skinner et al., 2008). Research utilizing this framework has found that such support can impact students' emotions, including anxiety, depression, hope, and others (Reddy et al., 2003; Skinner et al., 2008).

Additionally, teacher support is instrumental in fostering smart risk-taking behaviours among students. When teachers provide a secure and supportive environment that encourages autonomy and respects students' perspectives, they enable students to engage in thoughtful risk-taking. Smart risk-taking involves students engaging with complex material, attempting new problem-solving strategies, and being willing to face potential setbacks as part of the learning process. Such an environment nurtures the confidence and resilience required for students to embrace challenges and innovate within their learning journey. Social support theory provides a broad and narrow view of teacher support. According to Tardy's framework, the broad definition encompasses providing informational, instrumental, emotional, and evaluative support across various situations (Malecki & Demaray, 2002; Tardy, 1985).

The narrower perspective limits teacher support to help, trust, friendship, and concern within the classroom (Aldridge et al., 2013; Fraser, 1998). This type of support is essential for improving student-teacher relationships, where supportive teachers express concern for their students, who, in turn, respect their teachers by adhering to classroom norms (Chiu & Chow, 2011; Longobardi et al., 2016). Negative teacher behaviours, such as yelling or excessive criticism, can result in students showing less interest and cooperative behaviour (Miller et al., 2000). Given the variety of definitions and the complexity of teacher support's impact, a direct relationship between teacher support and student academic sentiment is not easily discerned, highlighting critical areas for intervention and support. To synthesize these diverse frameworks and refine our understanding, meta-analyses are essential, contributing to the advancement of the field and the enhancement of educational strategies that promote positive student outcomes and smart risk-taking behaviours. Based on this discussion, this research hypothesizes:

H1. Teacher support and response a has positive and significant influence on the learning intention of K-12 chemistry students.

Chemistry Learning Intention

The intention to learn chemistry, a pivotal element in educational psychology, is profoundly influenced by both interest and teacher support (Hidi, 2006; Krapp, 2005). Hidi (2006) emphasizes that attention, a mental state pivotal to learning, arises from interactions between the individual and the subject matter. The development of interest in chemistry, as posited by theorists, originates from the intricate relationship between students and the subject, shaped within various social and institutional contexts (Avargil, 2019). Interest in chemistry involves elements such as enthusiasm, focused attention, and emotional involvement, which are essential for sustained and in-depth learning across different contexts and complexities (Krapp & Prenzel, 2011).

When choosing careers, students often consider their interest in chemistry; however, a relatively small number opt for a science, technology, engineering, and mathematics (STEM) career based solely on interest (Dalgety & Coll, 2006; Rodrigues, 2007). This perception is influenced by their belief that science careers lack creativity and social engagement compared to other professions (Bordt et al., 2001; Masnick et al., 2010). Students recognize the societal value of chemistry but frequently do not view it as a path to a prospective career (Bordt et al., 2001; Fredricks & Eccles, 2002; Salta & Tzougraki, 2004). This is compounded by the misconception that chemistry graduates primarily become teachers, which may not be appealing to all students (Jegede, 2007; Tytler & Symington, 2006). Parental expectations, particularly in Asian cultures, also significantly influence career choices, often more than the students' interests (Woodrow, 1996). Moreover, perceived differences in cognitive abilities and societal expectations may cause male students to show more interest in science fields requiring logical reasoning (Nelson & Cheng, 2017). Female students, while recognizing the importance of chemistry for career prospects, may not favour the subject due to its perceived difficulty (Cousins, 2007).

Teacher support and response are critical in nurturing chemistry learning intentions and can directly affect the development of smart risk-taking behaviour. Educators who provide a supportive environment, show enthusiasm for the subject, offer guidance, encourage inquiry, and foster a classroom atmosphere where students can safely engage in smart risk-taking. This kind of behaviour is characterized by exploring complex concepts, engaging in experimental problem-solving, and persevering through challenging material, all of which are vital for success in chemistry and related fields. By cultivating a supportive and responsive learning environment, teachers can inspire students to pursue chemistry with interest and confidence, thereby preparing them for innovative and successful careers in STEM. Based on this discussion, this research hypothesizes:

H2. Teacher support and response a has positive and significant influence on the learning intention of K-12 chemistry students.

H3. Learning intention has a positive and significant influence on the chemistry smart risk-taking behaviour of K-12 students.

H4. Learning intention mediates the relationships between teacher support and response on chemistry smart risk-taking behaviour of K-12 Students.

METHODS

Participants

The sample size for this study consisted of 227 participants drawn from three distinct regions across Indonesia, contributing to the diversity of the data. Specifically, samples were collected from Western Indonesia, including provinces such as North Sumatra and Lampung; Central Indonesia, represented by regions such as Bali and East Kalimantan; and Eastern Indonesia, with East Nusa Tenggara being one of the contributing provinces. The participants were selected to ensure a broad geographical representation within the country.

A comprehensive questionnaire was disseminated to these students to gather data on intelligent risk-taking behaviour in the context of chemistry education. The questionnaire aimed to explore their approaches to risk-taking within their chemistry lessons. It encompassed various aspects of their behaviour in a learning environment that necessitates both analytical thought and practical application, crucial for understanding complex chemical phenomena. The distribution of the questionnaire spanned five provinces, providing a rich cross-section of educational experiences and attitudes towards chemistry education in Indonesia. This methodology allowed for an in-depth analysis of the factors influencing students' engagement and smart risk-taking behaviours in learning chemistry, which could vary significantly across different cultural and regional educational settings.

Research Design and Procedures

This investigation is structured as a quantitative survey utilizing the positivist paradigm, which is grounded in the investigation of causality among variables that can be quantitatively measured and observed (Sekaran & Bougie, 2016). The positivist approach is underpinned by the belief that phenomena should be studied through empirical observation and quantifiable data. The ambition of this study is to substantiate a theoretical model that is informed by the principles of smart risk-taking behavior in the context of chemistry education. It seeks to delineate and elaborate on the interplay between the support and responses provided by teachers, the learning intentions of students, and the manifestation of smart risk-taking behavior within chemistry learning environments. The need to distill and enhance the relationships among these constructs is paramount, as it lays the groundwork for the empirical validation of the proposed model. This enhancement requires a more comprehensive theoretical base and a thorough review of existing educational literature.

The conceptual framework of our study is depicted in Figure 1, which outlines the research model employing a notation system adapted from Putra (2022). Within this model, the latent variables are designated as follows: î1 symbolizes the construct of teacher support and response; ç1 encapsulates the learning intention of students; and ç2 captures the essence of smart risk-taking behavior. The model employs path coefficients, denoted by ã, to represent the influence of exogenous variables on endogenous variables. Observable indicators of latent variables are represented by x for exogenous variables and y for endogenous variables. The residuals, or unexplained variance in endogenous latent variables, are indicated by ò.

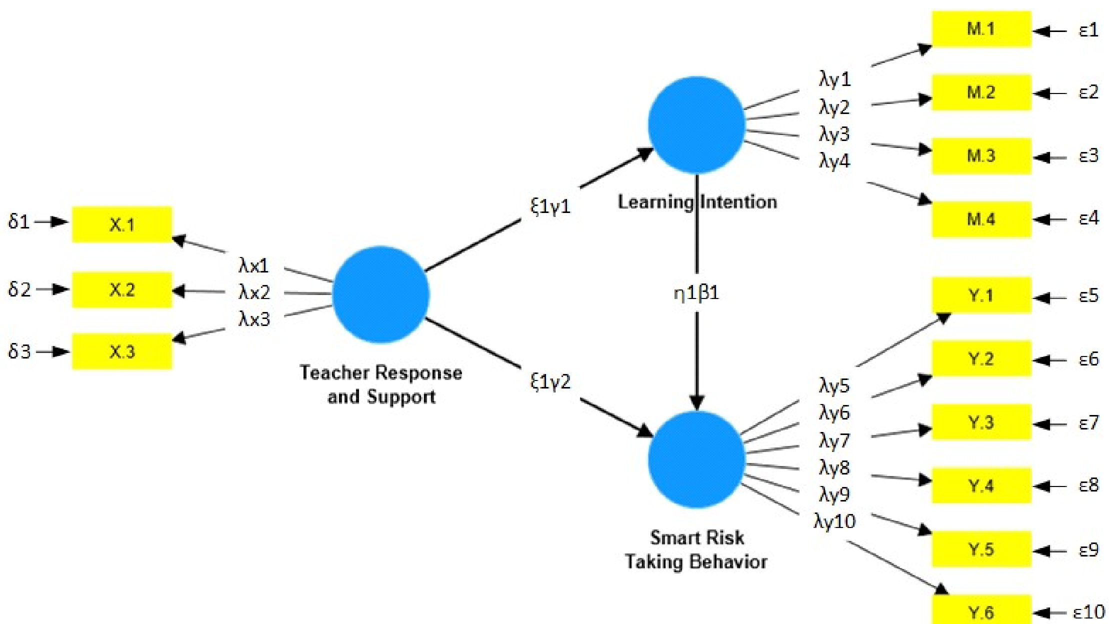

Figure 1. Conceptual research model

To articulate the relationships within the model, two structural equations are proposed. Equation 1 posits that the learning intention (ç1) is a direct consequence of the teacher support and response (î1), with ò1 accounting for the residual effects. The equation is formulated as ç1 = ã1î1 + ò1. Equation 2 predicts smart risk-taking behavior (ç2) as a function of an additional exogenous variable (î2), the previously established learning intention (ç1) influenced by its path coefficient (â1), and a residual term (ò2). Thus, it is presented as ç2 = ã1î2 + ç1â1 + ò2. These equations are integral to understanding the interconnectedness of the variables and will aid in quantifying the degree to which teacher support and responses can shape students' learning intentions and their propensity for smart risk-taking behavior within the academic of chemistry.

Instrument

The data collection for the study was meticulously conducted using the Item Response Theory - Scale (IRT-S) Questionnaire, a tool developed based on the conceptual framework provided by Beghetto (2009). This questionnaire is distinguished by its use of a four-point Likert scale, allowing for a nuanced assessment of various attitudes and behaviours in the context of chemistry education. It is carefully structured around three distinct but interrelated variables: Teacher Support and Response (î1), Learning Intention (ç1), and Chemistry Smart Risk Taking Behavior (ç2). The Teacher Support and Response variable (Djoa et al., 2023) evaluates the extent to which teachers are receptive to student ideas (X.1), their tendency to praise innovative efforts (X.2) and their recognition of students' scientific proficiency (X.3). This aspect of the questionnaire seeks to understand how teacher behaviours and attitudes can influence a conducive learning environment in chemistry (Table 1).

Table 1. Measurement items

Measurement Item(s)
Teacher Support and Response (ξ1) – Adapted from Beghetto (2009)
X.1 Teacher's receptiveness to ideas
X.2 Teacher's praise for innovation
X.3 Teacher's acknowledgment of scientific proficiency
Learning Intention (η1) – Adapted from Djoa et al. (2023)
M.1 Interest in studying chemistry
M.2 Perceived importance of chemistry lessons
M.3 Enjoyment in chemistry activities
M.4 Preference for chemistry
Chemistry Smart Risk Taking Behavior (η2) – Adapted from Djoa et al. (2023)
Y.1 Experimental attempts despite uncertainty
Y.2 Idea sharing despite doubt
Y.3 Trying new methods despite unsureness
Y.4 Innovative attempts regardless of success
Y.5 Learning through mistakes
Y.6 Questioning despite peer perception

The learning intention variable delves into the student's engagement with the subject (Djoa et al., 2023). It measures their interest in studying chemistry (M.1), gauges the perceived importance they assign to chemistry lessons (M.2), evaluates their enjoyment in participating in chemistry activities (M.3), and assesses their overall preference for chemistry as a field of study (M.4). This section aims to capture the intrinsic and extrinsic motivational factors driving student chemistry engagement. Lastly, the chemistry smart risk taking behavior variable examines the students' willingness to engage in innovative and potentially risky behaviours in a scientific context (Beghetto, 2009). This includes their readiness to attempt experiments despite facing uncertainty (Y.1), their courage to share ideas even when they have doubts (Y.2), their openness to trying new methods despite not being sure of the outcomes (Y.3), their innovative attempts regardless of the success or failure they might bring (Y.4), their capacity to learn from their mistakes (Y.5), and their boldness in questioning established norms or ideas, even when such actions might differ from peer perceptions (Y.6). These variables provide a comprehensive picture of the educational dynamics within a chemistry learning environment. They not only shed light on the role of teacher support in fostering a positive and encouraging learning space but also highlight the importance of nurturing a student's intrinsic interest and willingness to engage in smart risk-taking behaviours. This holistic approach is vital for understanding the multifaceted nature of learning and teaching in the complex field of chemistry education (Table 1).

Data Analysis

As the research endeavor is exploratory in nature, it is positioned to discover patterns and relationships within the collected data, particularly when prior theoretical constructs or empirical findings concerning the variables in question are sparse or ambiguous (Putra, 2022). The choice of an exploratory approach is justified by the aim to map out the preliminary contours of the phenomenon before confirming it through more definitive research. To this end, the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique has been selected for data analysis. PLS-SEM is particularly adept at handling complex models with multiple constructs and is favored in exploratory research for its capacity to handle small to medium sample sizes and its orientation towards prediction and theory building (Rinaldi & Putra, 2022).

The use of PLS-SEM in this study is instrumental in exploring the directional relationships and potential causal linkages between teacher support and response, learning intentions, and smart risk-taking behavior in chemistry. The model (Figure 1) anticipates that effective teacher support and positive responses will foster a learning environment that not only bolsters students' intentions to learn but also encourages them to engage in smart risk-taking behaviors. These behaviors, characterized by an openness to new experiences and a willingness to engage with complex problems, are seen as crucial for the development of innovative thinking and problem-solving skills in chemistry. By employing PLS-SEM, the study aims to provide predictive insights into how these key educational factors interact, thus offering a valuable framework for future interventions and pedagogical strategies aimed at enhancing student engagement and achievement in chemistry.

RESULTS AND DISCUSSION

Measurement Evaluation

Before examining the proposed conceptual model, the study addresses the normality of data distribution by evaluating the critical values of skewness and kurtosis. Putra (2022) states that data is normally distributed if the skewness is within ±2.00 and kurtosis does not exceed 7. The absence of any items with a skewness greater than ±2.00 or a kurtosis value above 7 indicates normal distribution. Consequently, the data meets the normality criterion, deeming it suitable for Structural Equation Modeling (SEM). Following the confirmation of data normality, the next step involves assessing the measurement model's validity and reliability, referred to as the outer model in Partial Least Squares SEM (PLS-SEM) (Sarstedt et al., 2019). This model encapsulates the relationships between indicators and latent variables. To establish convergent validity (Table 1; Figure 2), each indicator's loading factor should exceed 0.70. However, Henseler (2015) suggest that a reflective indicator's loading factor above 0.50 indicates a good measure for latent variables. This study finds all indicators' loadings surpassing 0.50 with a significant p-value, meeting the criteria.

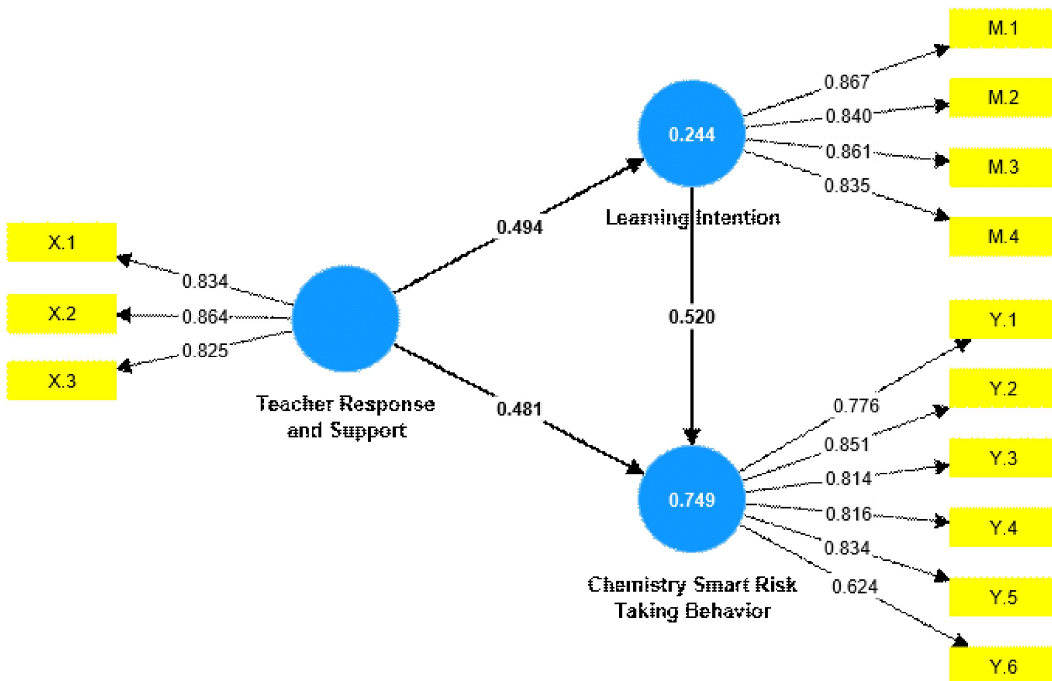

Figure 2. Measurement model evaluation output

This study then examines the Average Variance Extracted (AVE) values to further validate convergent validity, with a required cut-off value above 0.50. All variables in this study meet this requirement, confirming their validity in measuring each latent variable. Discriminant validity is tested next, using the Fornell-Larcker criterion and cross-loadings (Fahmi et al., 2022). This study satisfies the Fornell-Larcker criterion, where the AVE square root correlation with its respective construct is higher than with other constructs. The cross-loading test confirms that each intended construct's loading value is greater than that of other constructs. Finally, the reliability of each latent construct is assessed using Cronbach's Alpha (CA) and Composite Reliability (CR). To ensure the reliability of PLS construction scores, CR values must be at least 0.7, and CA values must be at least 0.6 (Hayes & Preacher, 2006; Henseler et al., 2014, 2015; Kunaifi et al., 2022).

Table 2. Validation output

Item (s)	Item Validations										
	Loadings	Cross Loadings			AVE	Fornell Larcker			CR	rho_a	rho_c
		ξ1	η1	η2		ξ1	η1	η2			
Teacher Support and Response (ξ1)											
X.1	0.834	**0.834**	0.478	0.691	0.708	**0.841**			0.795	0.802	0.879
X.2	0.864	**0.864**	0.404	0.581							
X.3	0.825	**0.825**	0.350	0.574							
Learning Intention (η1)											
M.1	0.867	0.481	**0.867**	0.671	0.724	0.494	**0.851**		0.873	0.875	0.913
M.2	0.840	0.382	**0.840**	0.600							
M.3	0.861	0.430	**0.861**	0.654							
M.4	0.835	0.381	**0.835**	0.650							

Chemistry Smart Risk Taking Behavior ($\eta 2$)											
Y.1	0.776	0.563	0.479	**0.776**	0.623	0.738	0.758	**0.790**	0.877	0.883	0.908
Y.2	0.851	0.694	0.614	**0.851**							
Y.3	0.814	0.589	0.615	**0.814**							
Y.4	0.816	0.652	0.619	**0.816**							
Y.5	0.834	0.596	0.596	**0.834**							
Y.6	0.624	0.363	0.664	**0.624**							

Structural Data Evaluation

Following the satisfactory assessment of the measurement model, the research progresses to evaluating the structural model. This phase emphasizes key metrics, including the coefficient of determination (R^2), cross-validated redundancy (Q^2), and the overall fit of the model. Initially, the process involves checking for potential collinearity between exogenous constructs within the structural model, utilizing the inner Variance Inflation Factor (VIF) as a tool. The assessment commences with the analysis of the R-Square (R^2) values for each endogenous latent variable, following the methodological approach of Tenenhaus et al., 2004. The R^2 values, which lie between zero and one, reflect how much the exogenous variables explain the variance in the endogenous variables. The R^2 value for the smart risk-taking behaviour variable (ç2) is 0.749, indicating that Teacher Support and Response (î1) and Learning Intention (ç1) explain 74.9% of its variance. In contrast, the R^2 value for Learning Intention (ç1) stands at 0.244, suggesting that Teacher Support and Response (î1) explains 24.4% of its variance.

Furthermore, the predictive relevance (Q^2) of the structural models is evaluated. According to Hair et al., 2017, a Q^2 value greater than zero for an endogenous latent variable signifies the model's predictive relevance for that construct. The Q^2 values for Chemistry Smart Risk Taking Behavior and Learning Intention are 0.541 and 0.233, respectively, both surpassing zero and thus confirming the model's predictive validity. The final aspect of the structural model assessment involves evaluating the fit of the model using the standardized root mean square residual (SRMR) and the normed fit index (NFI), as recommended by Ramayah et al., 2018. The model achieves a good fit if the SRMR value is below 0.10 and the NFI value exceeds 0.9. The findings of this study present an SRMR value of 0.091, which is within the acceptable range, and an NFI value of 0.982, well above the threshold, indicating an excellent overall fit. These results suggest that the model not only shows a reasonable residual fit but also excels in its overall fit as per conventional standards for satisfactory model fit.

Hypotesis Testing

This study aims to verify various hypotheses related to the influence of teacher support and response on the learning intentions and chemistry-smart risk-taking behaviour of K-12 students. Specifically, it investigates whether teacher support and response positively and significantly affect the learning intention of K-12 chemistry students and whether learning intention positively and significantly influences the chemistry smart risk-taking behaviour of these students. Additionally, the study examines the potential mediating role of learning intention in the relationship between teacher support and response and the chemistry-smart risk-taking behaviour of K-12 students. The validation of these hypotheses is conducted by analyzing path coefficients, T-statistic values obtained through bootstrapping procedures, and p-values (Figure 3). Hair et al. (2017) describe path coefficients as ranging from -1 to +1, with values near +1 suggesting a strong positive relationship and values near -1 indicating a strong negative relationship. The significance of the relationships between constructs is assessed using T-statistics from bootstrapping, with Hair et al. (2017) recommending a resample value of 5,000 for this procedure. The acceptance or rejection of the hypotheses hinges on a T-Statistic value threshold of ±1.96, with values within the range of -1.96 to 1.96 leading to the rejection of the hypothesis or the acceptance of the null hypothesis (H0).

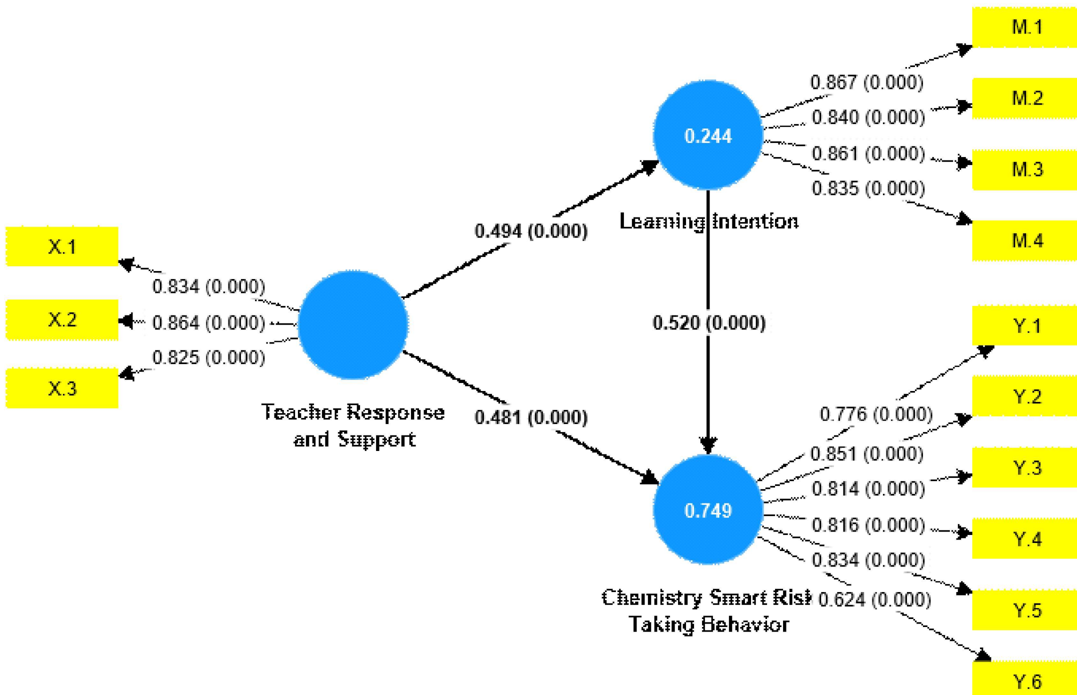

Figure 3. Structural model evaluation output

The analysis of relationships in K-12 chemistry education revealed significant findings, particularly in how teacher support and response impact student behaviours. The finding of a positive and significant effect of teacher support and response on chemistry smart risk-taking behaviour, indicated by a â value of 0.481 and a T-statistic of 7.743, suggests that supportive and responsive teaching methods are key to encouraging students to engage in smart risk-taking activities in chemistry. This has practical implications in classroom settings, where creating an environment that fosters experimentation and learning from mistakes can lead to more innovative and dynamic learning experiences. Additionally, the impact of teacher support and response on students' learning intention, demonstrated by a â value of 0.494 and a T-statistic of 7.855, highlights the importance of teacher-student interactions in shaping students' attitudes towards chemistry. This finding underscores the role of teachers in not only facilitating immediate classroom engagement but also influencing students' long-term educational interests and choices in chemistry.

Furthermore, the significant relationship between students' learning intentions and their engagement in smart risk-taking behaviours in chemistry, as shown by a â value of 0.520 and a T-statistic of 9.571, points to the need for educational strategies that enhance students' interest and enjoyment in the subject. Such strategies can lead to a more engaged and proactive approach to learning, encouraging students to take intellectual risks and explore new concepts. The study also reveals the mediating role of learning intention in the relationship between teacher support and response and smart risk-taking behaviour in chemistry, with a â value of 0.257 and a T-statistic of 5.243. This indicates that the influence of teacher support on risk-taking behaviour is partly due to its effect on shaping students' learning goals and aspirations. This insight is crucial for educators, as it highlights the importance of fostering and sustaining students' interest in learning chemistry, which in turn can enhance their willingness to engage in smart risk-taking behaviours. These findings collectively emphasize the critical role of teacher support and interaction in not only shaping student attitudes but also in promoting effective and dynamic learning experiences in K-12 chemistry classrooms. The results suggest that efforts to enhance teacher-student engagement and nurture positive learning intentions can lead to more meaningful and impactful educational outcomes in chemistry.

Discussion

The comprehensive analysis of this study in K-12 chemistry education, enriched by various research insights, underscores the profound impact of teacher support and response on shaping students' learning experiences and their future behaviour and decision-making abilities. Teachers are called upon to actively send support signals to students, acknowledging that effective feedback reception is crucial for a successful chemistry teaching and learning process. This approach can significantly bolster students' creative confidence and behaviour (Beghetto et al., 2021), by fostering smart risk-taking behaviours essential for creativity. The necessity of encouragement, especially in online learning environments is critical (Sunyono & Meristin, 2022). A lack of proper encouragement can lead to a decreased willingness among students to take intelligent risks, which is vital for their academic and personal growth. Blizak et al. (2020) emphasize the importance of teacher support in empowering students to make intelligent decisions that affect their learning success and career paths. This is especially relevant in contexts like Indonesia, where students' career choices are often influenced more by parental expectations than personal academic abilities (Kristiyani, 2016; Putri, 2020). This scenario underscores the need for educational approaches that enable students to make independent and intelligent decisions, breaking free from external pressures.

Teachers also play a pivotal role in shaping students' character and behaviours, which are critical for their development as future leaders. By providing diverse learning opportunities in and out of the classroom, including extracurricular and sports activities, teachers significantly influence students' personal development. Drawing from attachment theory (Gizynski et al., 1986), a caring and supportive educational environment is essential for children's emotional security and exploratory behaviour. Such an environment, as further supported by the findings of Howes et al. (1994) and Hughes & Rog (2008), boosts students' emotional safety and self-confidence, enabling them to thrive both academically and socially.

The crucial role of teacher involvement in learning activities is highlighted, correlating directly with students' respect for learning and academic achievement (Roorda et al., 2011). This involvement should be inclusive, providing attention and physical assistance to all students and adapting to individual needs for optimal educational and socio-emotional outcomes (Meehan et al., 2003; Wellborn, 1992). Teachers are also called to model risk-taking behaviour. According to Furby and Beyth-Marom (1992), teachers should exemplify risk-taking, creating a safe environment for it and rewarding intelligent failures to encourage learning from mistakes. This fosters a culture where intelligent risk-taking becomes habitual and valued.

Moreover, integrating mindfulness practices into teaching strategies can help students manage the stress associated with risk-taking. Such practices Eysenck and Eysenck (1977) can stabilize adrenaline and cortisol levels, facilitating clearer and smarter decision-making processes. In conclusion, the study emphasizes a symbiotic relationship between teacher-support responses and smart risk-taking behaviour. Effective communication of support by teachers leads to increased student engagement, creativity, and intelligent risk-taking. This holistic approach is essential for creating an educational environment where students are not only academically prepared but also poised for future leadership and personal success.

CONCLUSIONS

In conclusion, this study significantly contributes to our understanding of the dynamics in K-12 chemistry education, highlighting the pivotal role of teacher support and response in shaping students' learning experiences. The findings underscore the importance of creating classroom environments that are conducive to smart risk-taking and innovative thinking. This necessitates teacher training programs that emphasize supportive and responsive teaching methods, equipping educators with the skills to foster a culture of exploration and creativity. The influence of such teacher-student dynamics goes beyond immediate classroom interactions, extending to impact students' long-term educational aspirations and their overall engagement with chemistry. The study advocates for educational strategies that balance effective classroom management with methods that deepen students' interest in chemistry. This can be achieved through integrating real-world applications, interactive learning methods, and technology, making chemistry more relevant and stimulating for students. The significant correlation found between learning intentions and smart risk-taking behaviours highlights the need for curriculum designs that are not only informative but also engaging and enjoyable, thus sparking students' curiosity and encouraging them to explore complex concepts.

Furthermore, the mediating role of learning intentions in the relationship between teacher support and smart risk-taking behaviour opens new possibilities for educational policies. These policies and practices should aim not only at providing direct teacher support but also at cultivating and nurturing students' learning intentions through personalized learning plans and mentorship programs and aligning extracurricular activities with their interests in chemistry. Overall, the insights from this study underscore the need for a comprehensive, interactive approach to chemistry education in K-12 settings. This approach should prioritize teacher-student engagement, fostering a deep-rooted interest and intention in learning chemistry and preparing students for a future where they can contribute innovatively and thoughtfully. The interconnected nature of teacher support, student motivation, and educational outcomes highlighted in this study has profound implications for teacher training, curriculum design, and educational policy. Such an approach is critical in nurturing the next generation of scientists, innovators, and informed citizens, equipped not only with academic knowledge but also with the skills and mindset to tackle future challenges creatively and effectively.

Building on the findings, several academic and practical recommendations can be formulated. Academically, there is an opportunity to delve deeper into the dynamics of the classroom environment. Research could focus on how specific teacher behaviours influence not only the academic performance of students but also their long-term interest in science and their development of critical thinking and problem-solving skills. It would be beneficial to study the impact of different teaching styles and methods on students' willingness to engage in smart risk-taking behaviours and their overall confidence in handling scientific challenges. Additionally, comparative studies across various educational settings could provide insights into how cultural, social, and institutional factors influence the effectiveness of teacher support and response. From a practical standpoint, teacher training programs need to be thoughtfully designed, taking into account the complexities of modern classrooms. These programs should not only focus on pedagogical skills but also on developing emotional intelligence, cultural sensitivity, and an understanding of diverse learning needs. Teachers should be equipped to create inclusive and dynamic learning environments that cater to a wide range of learning styles and preferences. In terms of curriculum design, there is a need for a shift towards more student-centered approaches. This involves designing curricula that are flexible, adaptable, and responsive to students' interests and current scientific advancements. Interactive and experiential learning opportunities should be prioritized, allowing students to engage with the material in meaningful ways. This might include project-based learning, laboratory experiments, field trips, and the use of digital tools and resources.

Moreover, fostering a positive classroom culture is crucial. This culture should celebrate curiosity, reward creative thinking, and view mistakes as learning opportunities. Encouraging an environment where students feel safe to express their ideas and take intellectual risks can significantly enhance their learning experience and lead to a deeper understanding and appreciation of chemistry. Finally, these recommendations also call for policy changes at the institutional and educational system levels. Policies should support innovative teaching practices, provide resources for dynamic curriculum development, and create mechanisms for continuous teacher development. Educational leaders and policymakers must recognize the critical role of teachers in shaping the future of STEM education and provide them with the necessary support and resources to succeed in this endeavour. In summary, enhancing K-12 chemistry education requires a concerted effort that encompasses academic research, practical teaching strategies, curriculum innovation, and supportive educational policies. By adopting a holistic approach that addresses these various components, the education system can better prepare students not only for academic success in chemistry but also for a future where they can apply their scientific knowledge and skills in meaningful and impactful ways.

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