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WHY IS CHEMISTRY EDUCATION? EXPLORING THE MOTIVATION OF STUDENT CHOICES

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ABSTRACT

Learning motivation is critical to educational success, influencing students' engagement, persistence, and overall performance. Despite its importance, motivation determines students' choices for future careers and struggles in participating in learning activities. The aim was to characterize students' chemistry learning motivation in detail using the Academic Motivation Scale - Chemistry (AMS-Chemistry). This study employs a descriptive qualitative research design. The qualitative approach allows an in-depth exploration of personal experiences and perceptions of learning motivation in chemistry education. The AMS-Chemistry instrument consists of 28 statement items that measure aspects of amotivation, three types of extrinsic motivation, and three types of intrinsic motivation. Data analysis was done by calculating the percentage of student responses for each motivation scale. The results show that the motivation profile to learn Chemistry in Chemistry Education students using the AMS-Chemistry instrument on the amotivation subscale tends to disagree (55,46%). On intrinsic motivation, the to know subscale tends to strongly agree (65,80%), the to accomplish subscale has a high score on strongly agree (48,85%) responses, and the to experience subscale tends to respond strongly agree (35,34%). Extrinsic motivation includes the external regulation subscale tending to strongly agree (55,17%) and the introjected regulation subscale having a high score on strongly agree (62,36%) responses. The identified regulation subscale has a strongly agree (68,97%) response tendency.

Keywords: Chemistry Education, Learning motivation, Self Determination Theory

INTRODUCTION

Chemistry, often dubbed the "central science," is pivotal in connecting and integrating various scientific disciplines such as biology, physics, and environmental science (Ramadhani, 2022; Purwanto dkk., 2023). Despite its significance, chemistry is frequently perceived as one of the most challenging subjects by students, leading to varying levels of motivation and engagement (Treagust et al., 2018; Woldeamanuel et al., 2014). Understanding the factors influencing student motivation in chemistry education is crucial for developing effective teaching strategies and fostering a deeper appreciation of the subject (Ferreira et al., 2021). Motivation in educational contexts can be generally categorized into intrinsic and extrinsic motivation (Djarwo, 2020; Gambari et al., 2016). Intrinsic motivation refers to engaging in an activity for its inherent satisfaction and personal interest, while extrinsic motivation involves performing an activity to achieve external rewards or avoid punishments. In chemistry education, fostering intrinsic motivation is particularly important, as it can lead to sustained interest and a deeper understanding of the subject matter.

Several factors influence student motivation in chemistry. These include the perceived relevance of the subject (Woldeamanuel et al., 2014), the difficulty level of the material (Manurung & Manurung, 2021; Treagust et al., 2018), teaching methods (Rustiningsih, 2021; Ningrum dkk., 2022; Prameswari & Hakim, 2021), classroom environment (Cicuto & Torres, 2016), and individual student characteristics (Pratt et al., 2023; Rahayu et al., 2023). Research indicates that when students perceive chemistry as relevant to their daily lives and future careers, their motivation to learn increases (Manurung & Manurung, 2021). This relevance can be highlighted through real-world applications of chemical principles, such as in medicine, environmental science, and technology. The perceived difficulty of chemistry can also impact student motivation. Chemistry often involves abstract concepts, complex problem-solving, and a significant amount of memorization. Students who struggle with these aspects may feel overwhelmed and discouraged, leading to decreased motivation. Therefore, educators must employ teaching strategies that simplify complex ideas and support students facing difficulties.

Teaching methods play a crucial role in shaping student motivation. Traditional lecture-based approaches may only be sufficient to engage some students. Active learning strategies, such as hands-on experiments (Prameswari & Hakim, 2021; Mogawer, 2018), cooperative learning (Rustiningsih, 2021; Belge et al., 2016), and problem-based learning (Wellhöfer & Lühken, 2021; Baran & Sozbilir, 2018; Tosun & TAÞKESENLÝGÝL, 2012), have been shown to enhance student engagement and motivation. These methods encourage students to participate actively in learning, increasing their intrinsic motivation. The classroom environment is another significant factor. A supportive and inclusive classroom climate, where students feel comfortable asking questions and expressing their ideas, can boost motivation. Additionally, positive teacher-student relationships, characterized by respect and encouragement, are vital for fostering a motivating learning environment. Individual student characteristics, such as prior knowledge, learning styles, and self-efficacy, also influence motivation. Students with a strong foundation in basic scientific concepts and those who believe in their ability to succeed in chemistry are more likely to be motivated (Ferreira et al., 2021). Educators can enhance self-efficacy by setting achievable goals, providing constructive feedback, and celebrating student successes.

According to the social cognitive perspective, learning motivation is a dynamic interplay between personal, behavioral, and environmental factors (Chen & Tu, 2021). This perspective, rooted in Social Cognitive Theory, emphasizes that students' motivation to learn is not merely a result of internal drives or external rewards but a complex interaction of these elements. One of the key concepts in this framework is self-efficacy (Zhang & Zhou, 2023), which refers to students' beliefs in their abilities to succeed in specific tasks. Higher self-efficacy can lead to greater motivation, as students who believe they can succeed are more likely to engage in challenging tasks, persist in the face of difficulties, and achieve higher levels of performance (Kubsch et al., 2023).

Moreover, the social cognitive perspective highlights the role of observational learning and modeling. Students learn and develop motivation by observing the behaviors and outcomes of others, particularly peers and teachers. For example, seeing a classmate succeed in a difficult chemistry experiment can motivate other students to try harder and believe in their potential for success (Rahayu et al., 2023). The environment is also crucial (Cicuto & Torres, 2016). Factors such as the school climate, the quality of teacher-student relationships, and the availability of resources and support systems can significantly influence students' motivation. A positive school environment that fosters supportive relationships sets high expectations and provides necessary resources can enhance students' learning motivation. This approach comprehensively explains how various elements influence students' willingness and enthusiasm to engage in learning activities.

Self-Determination Theory (SDT) is a comprehensive framework for understanding human motivation, mainly focusing on the factors that enhance or inhibit intrinsic motivation (Pratt et al., 2023; Liu et al., 2017). In learning chemistry, SDT posits that students are most motivated when they experience a sense of autonomy, competence, and relatedness (Elford et al., 2022; Rahayu et al., 2023; Liu et al., 2017). Autonomy refers to feeling in control of one's learning process, making choices, and engaging in activities out of personal interest. When students feel competent, they believe they have the skills and knowledge to succeed in their tasks, which bolsters their motivation. Relatedness involves connecting to others, such as peers and instructors, and fostering a supportive learning environment. These three psychological needs are crucial for nurturing intrinsic motivation, where students learn chemistry out of genuine interest and enjoyment rather than extrinsic motivation driven by external rewards or pressures.

Applying SDT to chemistry education, educators can create a more motivating learning environment by designing lessons that cater to these needs (Elford et al., 2022). For instance, providing students with opportunities to choose topics or projects can enhance their sense of autonomy. Offering constructive feedback and celebrating successes can build their understanding of competence. Encouraging group work and fostering a collaborative classroom culture can satisfy their need for relatedness (Rahayu et al., 2023). By focusing on these elements, educators can help students develop a more profound, self-sustained interest in chemistry, leading to improved engagement, persistence, and, ultimately, better learning outcomes (Liu et al., 2017). This approach enhances academic performance and promotes a lifelong interest in science.

Understanding and enhancing student motivation in chemistry education requires a multifaceted approach. Educators can foster a more motivated and engaged cohort of chemistry students by addressing the subject's relevance, reducing perceived difficulty, employing diverse teaching methods, creating a supportive classroom environment, and considering individual student characteristics. This, in turn, can lead to better educational outcomes and a greater appreciation for the role of chemistry in the modern world. This research is an initial investigation into the learning motivation of prospective chemistry teacher students in chemistry learning activities. The aim was to characterize students' chemistry learning motivation in detail using the Academic Motivation Scale - Chemistry (AMS-Chemistry) (Liu et al., 2017). This research can inform lecturers or other education practitioners to understand student learning motivation in detail to help improve learning practices and promote effective learning.

METHOD

This study utilizes a descriptive qualitative research design to investigate and profile students' motivation in chemistry education. Descriptive qualitative research is a methodological approach that aims to provide a detailed, accurate account of a phenomenon (Creswell & Creswell, 2017). By focusing on providing a rich, detailed account of a specific phenomenon, descriptive qualitative research allows researchers to capture the complexity and nuances of human experiences and social processes. The research subjects were chemistry education students in their first semester. The sampling technique used was convenience sampling with the criteria of early semester students. This study explores student motivation in studying chemistry in detail and choosing a chemistry study program for their future career. The researcher selects a sample that fits the research objectives and is comfortable with the researcher (Gall et al., 2007).

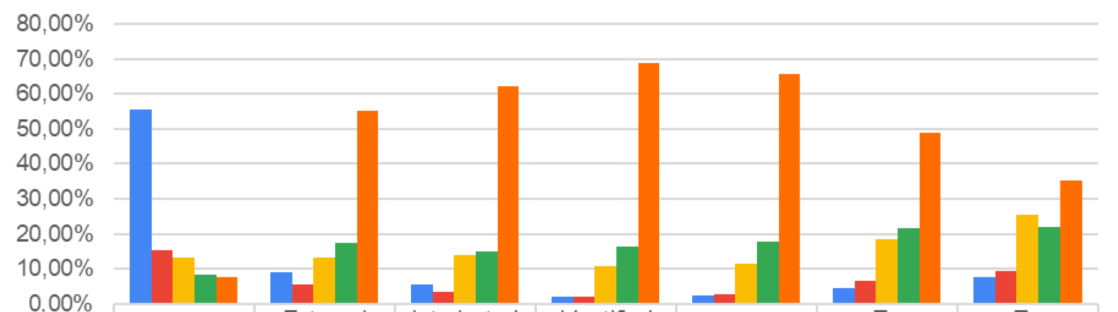
The instrument utilized in this study was a modified version of the Academic-Chemical Motivation Scale (AMS-Chemistry), designed to assess the motivational levels of chemistry education students. This tool measures amotivation, three types of extrinsic motivation, and three types of intrinsic motivation across 28 statements. Each subscale comprises four statements/items rated on a Likert-type scale. The instrument's validity is supported by evidence derived from its content, response processes, and internal structure. Content validity was confirmed through an expert panel discussion that achieved consensus on the relevance and clarity of the items. Response process validity indicated no issues concerning readability or phrasing adjustments. Internal structure validity was demonstrated through various fit indices: The Comparative Fit Index (CFI) value was 0.94, exceeding the recommended threshold of 0.90; the Standardized Root Mean Square Residual (SRMR) value was 0.058, below the suggested maximum criterion of 0.08; and the Root Mean Square Error of Approximation (RMSEA) value was 0.059, with acceptable limits set at less than 0.06. These results suggest that this model closely aligns with the underlying data structure. Additionally, internal consistency for each subscale was evaluated using Cronbach's alpha coefficients at two different time points. At Time 1, alpha values ranged between 0.74 and 0.91—indicating satisfactory reliability—while at Time 2, they varied from 0.79 to consistent within acceptable bounds for all seven subscales. (Liu et al., 2017).

The AMS-Chemistry instrument measures amotivation, three types of extrinsic motivation, and three types of intrinsic motivation across 28 statements. The subscales consist of amotivation, extrinsic motivation (external regulation, introjected regulation, identified regulation), and intrinsic motivation (to know, accomplish, experience). Each subscale comprises four statements/items rated on a Likert-type scale with responses ranging from 1 (Strongly Disagree), 2 (Disagree), 3 (Enough), 4 (Agree), and 5 (Strongly Agree). Then, the results were analyzed in percentage form to obtain a profile of students' motivation for chemistry learning.

RESULT AND DISCUSSION

The analysis to be carried out is to calculate the distribution of the average percentage of responses from each subscale in AMS-Chemistry. This study aims to analyze the distribution of the average percentage of responses from each subscale in the Academic Motivation Scale for Chemistry students (Sangsuwon &

Yooyong, 2019; Zhang & Zhou, 2023). The data on students' motivation included subscales for amotivation, extrinsic motivation (external regulation, introjected regulation, identified regulation), and intrinsic motivation (to know, to accomplish, to experience) (Zeng & Deng, 2023). Insights from existing literature shed light on the reliability and validity of the Academic Motivation Scale and strategies for motivating students in higher education (Zeng & Deng, 2023; Osma et al., 2015). The principles of self-determination theory suggest that individuals have a sense of choice and autonomy in their behaviors and actions. (Zeng & Deng, 2023). Four statements represent each subscale. In summary, data on motivation to learn chemistry for students using the AMS-Chemistry instrument for each subscale is presented in Figure 1.



	Amotivation	External Regulation	Introjected Regulation	Identified Regulation	To Know	To Accomplish	To Experience
STS	55,46%	8,91%	5,46%	2,01%	2,30%	4,60%	7,47%
TS	15,23%	5,46%	3,45%	2,01%	2,59%	6,61%	9,48%
C	13,22%	13,22%	13,79%	10,63%	11,49%	18,39%	25,57%
S	8,33%	17,24%	14,94%	16,38%	17,82%	21,55%	22,13%
SS	7,76%	55,17%	62,36%	68,97%	65,80%	48,85%	35,34%

Figure 1. Percentage of students' responses to each scale

A high amotivation score response indicates that students have no hope and enthusiasm to pass the learning. Based on the graph in Figure 1., the amotivation subscale tends for student responses to be higher towards strongly disagree responses. The average percentage of the high amotivation subscale response is in the response of strongly disagree (55,46%), disagree (15,23%), and sufficient (13,22%). This shows that Chemistry Education students have the motivation to learn in Chemistry courses, which is led by the tendency for scores to strongly disagree and disagree high on the motivational scale or not having the motivation to learn. Learning motivation is important for every student because it forms concepts, learning strategies, and learning outcomes (Tuan et al., 2005). As the prompt suggests, a high amotivation score on the motivational scale represents a concerning tendency for students to strongly disagree or disagree with the motivation to learn in their chemistry courses (Zeng & Deng, 2023). Each student has different reasons for fostering interest in learning. It can be either extrinsic motivation or intrinsic motivation.

Based on the graph in Figure 1., extrinsic motivation tends for student responses to be higher toward agreeing responses. In this study, extrinsic motivation is divided into three subscales: external regulation, introjected regulation, and identified regulation. The average percentage of responses on the external regulation subscale is high in the responses that agree (17,24%) and strongly agree (55,17%). High external regulation scores indicate that students are motivated to take lectures influenced by external factors, namely, to get better careers and jobs in the future. The average percentage of responses to the introjected regulation subscale was high in agree (14,49%) and strongly agree (62,36%) responses. An increased introjected regulation score indicates that students are motivated to take lectures to prove they are capable and successful in completing lessons. The average percentage of responses on the identified regulation subscale is high in agree (16,38%) and strongly agree (68,97%) responses. High identified regulation scores indicate that students believe they can prepare themselves and improve their career skills by taking lectures. Thus, the subscale with the highest score on external motivation is identified as a regulation score, which indicates that students generally have the confidence to prepare skills during the learning process. These skill preparations will help students towards the desired career or job.

Extrinsic motivation is the drive to engage in a behavior or activity for reasons outside the self, such as rewards, recognition, or avoiding punishment (Tanjung & Wahdiniwaty, 2020) (Ryan & Deci, 2020). The current study examines the nuances within extrinsic motivation by exploring three distinct subscales: external regulation, introjected regulation, and identified regulation (Park et al., 2012). External regulation is the most basic form of extrinsic motivation, where an individual engages in an activity solely to obtain a reward or avoid punishment. Introjected regulation involves some degree of internalization, where the individual acts to avoid guilt or shame or to attain ego-enhancing feelings. Identified regulation represents a more autonomous form of extrinsic motivation, where the individual has personally identified the importance of the behavior and integrated it with their values and goals (Pratt et al., 2023; Rahayu et al., 2023; Park et al., 2012). Identified regulation is considered more self-determined than introjected regulation, as the individual has entirely accepted the reasons for the behavior as their own. Integrated regulation, which fully assimilates extrinsic motivations into one's sense of self, represents the most autonomous form of extrinsic motivation and shares many qualities with intrinsic motivation.

Furthermore, intrinsic motivation tends for student responses to be higher towards agreeing to reactions with several additions from sufficient to agree, which is higher than extrinsic motivation. This shows that most students have stronger intrinsic motivation in Chemistry lectures. This study divides intrinsic motivation into three subscales: to know, accomplish, and experience. The average percentage of the subscale responses to know is a high response in enough (11,49%), agree (17,82%), and strongly agree (65,80%). In Education, a high-to-know subscale score indicates that students feel pleasure and satisfaction in understanding something previously unknown or unclear. These results were obtained from student involvement in learning activities. Thus, learning activities are a way to increase student motivation. Learning activities can include the use of worksheets (Husna et al., 2020), the use of modules (Ali et al., 2019), and the implementation of practicum in learning (Sari et al., 2016). The average percentage of subscale responses to accomplish is a high response at enough (18,39%), agree (21,55%), and strongly agree (48,85%). In this case, a high achievement score indicates that the student enjoys the achievement process in and of itself. The average percentage of the subscale responses to experience were high at enough (25,57%), agree (22,13%), and strongly agree (35,34%) responses a high score to experience means that confident students carry out activities in lectures to feel their sensations.

Intrinsic motivation has long been a topic of interest in psychology, with researchers seeking to understand the factors that drive individuals to engage in activities for their inherent satisfaction rather than for external rewards or pressures. In this study, we examine the nuances of intrinsic motivation by dividing it into three distinct subscales: motivation to know, motivation to accomplish, and motivation to experience stimulation (Domenico & Ryan, 2017). Intrinsic motivation has been operationally defined in various ways, with a common approach being the "free choice" measure, where participants are exposed to a task under varying conditions and left alone to choose whether to engage with the task further. The underlying premise of this behavioral measure is that the more an individual voluntarily chooses to continue interacting with the task without any external requirements or incentives, the greater their intrinsic motivation to engage with that particular activity (Ryan & Deci, 2000). Overall, students' intrinsic motivation in studying chemistry showed agree and strongly agree responses with high scores. This shows that students desire to study chemistry, which arises on their own with different goals, namely, to know, accomplish, and experience.

Nonetheless, there is a subscale on intrinsic motivation with the highest tendency score to agree, namely the to know and accomplish subscale. This shows that the learning experiences carried out by students can help those who need to learn something or need to be corrected about a concept to know and understand the concept as a whole. Thus, students can obtain maximum learning outcomes and feel satisfied about it.

CONCLUSION

Based on the study results, the motivation profile to learn Chemistry in Chemistry Education students using the AMS-Chemistry instrument on the amotivation subscale tends to strongly disagree (55,46%) and disagree (15,23%) responses. On intrinsic motivation, the to know subscale tends to agree (17,82%) and strongly agree (65,80%), the to accomplish subscale has a high score on enough (18,39%), agree (21,55%) and strongly agree (48,85%) responses, and then to experience subscale tends to respond enough (25,57%), agree (22,13%), and strongly agree (35,34%) responses. Extrinsic motivation includes the external regulation subscale tending to respond agree (14,49%) and strongly agree (55,17%), the introjected regulation subscale having a high score on agree (14,94%) and strongly agree (62,36%) responses. The identified regulation subscale having an agree (16,38 %) and strongly agree (68,97%) response tendency.

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