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Science Motivation Profile of Students on the Concept of Particle Dynamics Topic

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Abstract. Science education is something that is very crucial in forming an intelligent and creative generation. Science learning needs to be developed so that it can facilitate students in developing scientific thinking skills and motivation in studying science. This research aims to determine the Science Motivation profile students on the concept of particle dynamics. The research was conducted on class XI students of SMA Negeri 2 Boyolali. Samples were taken from class XI students totaling 67 male and female students. The data collection method used was the use of a Science Motivation questionnaire. The questionnaire data was tabulated using Excel and then the percentage was calculated. Based on analysis of the results of the student science motivation questionnaire, it shows that the science motivation of students at SMA Negeri 2 Boyolali is 79,85. Meanwhile, in terms of each indicator, it is as follows: the intrinsic motivation and personal relevance indicator is 78.45 (medium criteria), the packaging assessment indicator is 78.63 (medium criteria), the career self-determination indicator is 79,52 (medium criteria), career motivation indicator 82.69 (medium criteria) and class motivation indicator 84.18 (medium criteria).

Keywords: motivation, particle dynamics, self beliefs

1. Introduction

Science education is something that is very crucial in forming an intelligent and creative generation. Science learning needs to be developed so that it can facilitate students in developing Scientific Thinking Skills and Motivation in Learning Science. [1]. Knowing students' science motivation in particle dynamics learning has significant importance in enhancing the effectiveness of the educational process [19]. First, understanding students' motivation can help teachers and educators design teaching strategies that are more aligned with students' needs and interests. [9]. By adjusting the learning approach to the level of students' motivation, particle dynamics learning can become more engaging and relevant for them. [3]. This has the potential to increase student involvement in learning, trigger curiosity, and stimulate creativity, which in turn can enhance their understanding of related physics concepts [11].
In addition, understanding students' science motivation can help identify potential problems and obstacles that students may face during particle dynamics learning [15]. By knowing the factors that influence motivation, educators can take steps to address these challenges, create a supportive learning environment, and provide the necessary support for students' academic development [35]. Therefore, studies on students' science motivation become important not only to improve particle dynamics learning but also to support students' holistic development in the context of science education [27].

Particle dynamics is a branch of physics that studies the motion of objects at specific points [8]. Particle dynamics ignores the size and shape of objects, focusing only on their motion. [39]. This theory is based on Newton's Laws, particularly Newton's Second Law. [19]. Newton's Second Law states that the force acting on an object is the result of the mass of that object multiplied by its acceleration [24]. This concept provides a foundation for understanding how an object moves in response to external forces acting on it [34].

In the context of particle dynamics, a particle is considered a mass point without dimensions, allowing for simplified motion analysis. [24]. Particle dynamics also introduces the concept of momentum, which is the product of an object's mass and velocity [7]. The Law of Conservation of Momentum states that the total momentum of an isolated system remains constant unless acted upon by an external force [5]. The application of this momentum concept helps in understanding changes in motion and collisions between particles. [19] Particle dynamics serves as a basis for a broader understanding of the motion of objects in the context of classical physics. [25]. The concepts of particle dynamics play an important role in advanced studies such as classical mechanics and the dynamics of more complex systems. [12].

Science motivation is a factor that can enhance students' interest in studying physics material [31]. Motivation can be seen as the main driver behind students' desire to learn and seek a deeper understanding of physical phenomena. [36]. In the context of particle dynamics, motivation can be enhanced by linking theoretical concepts with practical applications in everyday life or modern technology [17]. For example, detailing how the principles of particle dynamics play a role in the design of vehicles, medical devices, or other technologies can stimulate students' interest in understanding and applying these concepts [4].

Teachers also play a significant role in stimulating students' motivation [23]. The use of engaging teaching methods, such as laboratory experiments, computer simulations, or creative projects, can create an interesting and motivating learning experience [20]. Providing real-life examples of how physics and the principles of particle dynamics are used in everyday life or in industry can give students an understanding of the relevance of these concepts, which can then trigger intrinsic motivation [2]. Additionally, cooperative learning and communication among students can also enhance motivation [41]. Group discussions or collaborative projects involving problem-solving based on particle dynamics can provide students with opportunities to learn from one another, develop critical thinking, and feel engaged in learning [10 Recognition of students' efforts and achievements in understanding and applying particle dynamics concepts can also increase their motivation to continue learning and delve deeper into science material, in particular. physics [37]. By understanding that the study of particle dynamics can provide insights into the fundamental principles behind the motion of objects, students can feel personally engaged and inspired to pursue a deeper understanding of the science of physics [18]. Science motivation can be measured using a science motivation questionnaire with indicators presented in Table 1.

Table 1. Indicators and Sub-Indicators of Science Motivation

Num.	*Science Motivation Indicator*	Description
1	Value of a career	Measuring the extent to which students feel motivated to learn science due to personal interest and the relevance of the material to their lives.
2	Science motivation questionnaire	
	Sub Indicator Science Motivation questionnaire	Items in this instrument may include questions about the enjoyment they feel when studying science, personal interest in science topics, and the relevance of science topics to their daily lives.
	A. Intrinsic Motivation and Personal Relevance	Measuring the extent to which students feel motivated to learn science due to personal interest and the relevance of the material to their lives. Items in this instrument may include questions about the enjoyment they feel when studying science, personal interest in science topics, and the relevance of science topics to their daily lives.
	B. Packaging Assessment	Assessing students' views on the presentation of science material, including visual aspects and the delivery of information in learning media. Questions may include opinions about the quality of teaching materials, clarity of presentation, and aesthetics of learning materials.
	C. Self Career Determination	Measuring the extent to which students view science as an important part of their future career plans. This instrument may include questions about

Num.	*Science Motivation Indicator*	Description
		career aspirations related to science, how science influences career decisions, and education plans related to science.
	D. Career Motivation	Measuring students' motivation in studying science based on career influences. Questions may include views on the importance of science for achieving their career goals, motivation to study science in order to obtain desired jobs, and career expectations related to science.
	E. Class Motivation	Assessing student motivation in the context of science class, including interaction with teachers and classmates. Questions may include learning experiences in class, level of participation in class discussions, and involvement in science class activities.
3	Academic Self Concept	Measuring students' self-perception regarding their academic abilities in the field of science. This instrument may include questions about self-confidence in completing science assignments, perception of their academic abilities compared to classmates, and views on their ability to achieve good academic results in science. Previous research on students' science motivation was conducted by Ratnawati. From the analysis of the questionnaire results, it shows that the science motivation of students at SMPN 2 Taman is 61, which falls into the moderate criteria . Several of the above points form the background of the author's interest in conducting research on students' science motivation at SMA Negeri 2 Boyolali. This research aims to determine the profile of science motivation among XI grade students at SMA Negeri 2 Boyolali on the concept of Particle Dynamics.

Previous research on student science motivation was conducted by Ratnawati. Analysis of the questionnaire results showed that the science motivation of students at SMPN 2 Taman was 61, which falls into the moderate category [28].
The above factors motivated the author's interest in conducting research on the science motivation of students at SMA Negeri 2 Boyolali. This study aimed to determine the science motivation profile of 11th-grade students at SMA Negeri 2 Boyolali regarding the concept of Particle Dynamics [28].

2. Method

2.1. *Research Subjects*

This research was conducted at SMA Negeri 2 Boyolali with a research population of XI grade students at SMA Negeri 2 Boyolali totaling 249 students. The research sample consists of 67 students randomly selected from classes XI 1, XI 2, XI 3, and XI 4.

2.2. *Research Instruments*

The instrument used in this research is a questionnaire adapted from the Science Motivation Questionnaire II (SMQ) developed by Glynn et al. , consisting of 25 questions structured into five indicators, namely:b. 5 c. 5. 5 Motivation, ande. 5 questions on Class Motivation:

a. 5 questions on Intrinsic Motivation and Personal Relevance
b. 5 questions on Assessment Packaging
c. 5 questions on Self-Career Determinationd
d. 5 questions on Career, and
e. 5 questions on Class Motivation.

2.3. *Research Procedure*

This research is descriptive. This research was conducted at SMA Negeri 2 Boyolali in the fourth week of December 2023.

2.4. *Data Analysis and Interpretation*

Next, data analysis was conducted to determine the science motivation scores of students using the following formula.

$$\text{Score SM} = \text{Score MI} + \text{Score PK} + \text{Score PKS} + \text{Score MKarir} + \text{Score MClass} \quad (1)$$

To determine the high or low Science Motivation, it can be seen from Table 1.

Table 2. Criteria of science motivation questionnaire.

Score Value	Criteria SMQ
106 – 125	Very high
86 – 105	High
66 – 85	Medium
45 – 65	Low
< 44	Very Low

3. Results and Discussion

The results of the science motivation questionnaire for class X I students were calculated to determine the high or low science motivation at SM A Negeri 2 Boyolali. In general, from the five indicators, the average science motivation score of students at SMA Negeri 2 Boyolali was 79.85 with a medium criterion. Although categorized as medium, these results indicate a need to enhance student motivation to reach a high category. This effort is important considering that high learning motivation can increase concept understanding, active involvement in the learning process, and overall learning outcomes. Motivation is a major driver of success in science learning [13], particularly in abstract topics such as particle dynamics. Other research [40] also emphasizes that strong science motivation is closely related to academic achievement and career orientation in STEM fields. Therefore, teachers and schools need to develop teaching strategies that not only convey concepts cognitively, but also touch on the affective aspects of students, such as giving challenges, rewards, and problem-based and project-based learning, so that students are more motivated intrinsically and extrinsically in learning physics concepts such as Particle Dynamics. Learning strategies need to be directed towards more contextual and meaningful approaches, such as relating physics material to real phenomena in daily life or to fields of work relevant to students' interests [38]. The profile of science motivation per indicator is presented in Figure 1.

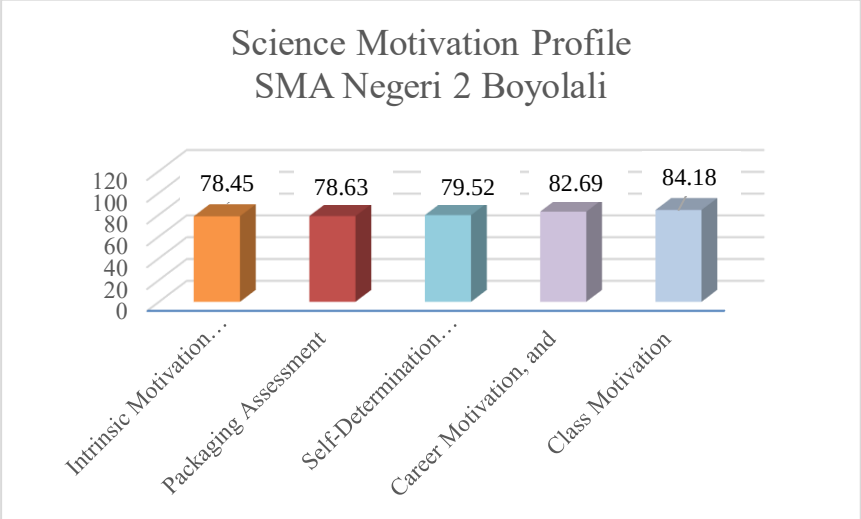

Figure 1. Profile Science motivation of grade XI students of SMA N 2 Boyolali.

The results of the research show that intrinsic motivation and personal relevance of students towards science learning are in the moderate category, with a score of 78.45. This indicates that the majority of students have internal interest in science and consider science lessons to have meaning in their personal lives, although it is not yet fully optimal. Intrinsic motivation is an important aspect in fostering perseverance and interest in learning science, especially when students feel that the subject is relevant to real life and their personal interests [6]. Thus, although it is already at a moderate level, more contextual and personal learning strategies are still needed so that students can be more intrinsically motivated

In the packaging assessment indicator, the result of 78.63 shows that students moderately appreciate the way science materials are packaged and presented in learning. This means that they are quite interested in how the material is arranged, the teaching methods used, and the use of learning media [6]. Engaging learning design and innovative material presentation can improve students' perception of science and encourage more active engagement [26]. Therefore, to increase motivation in this aspect, teachers need to continue to develop project-based learning approaches, hands-on experiments, or more varied interactive technologies. An achievement of 79.52 on the self-determination indicator indicates that students are quite able to relate science lessons to their future career choices and decisions, but are still at a moderate level. This is in line with the Motivation's role in students' science literacy and career expectations study which found that science motivation (including students' perceptions of the career they might take) becomes an important predictor of science literacy and career expectations, even when socioeconomic variables are precipitated [40]. In addition, the study Career motivation of secondary students in STEM: a cross cultural study between Korea and Indonesia shows that career motivation in the context of science, technology, engineering and mathematics (STEM) is influenced by cultural and educational factors, but the aspiration to choose science-related careers remains quite strong among students who see relevance and support in school.

Students' career motivation towards science is categorized as moderate with a score of 82.69. This indicates that students have a good understanding of the relationship between science and available career opportunities. This motivation becomes an important indicator in forming more directed learning goals [16]. Motivation influenced by career goals will increase effort and perseverance in learning [16]. To enhance this motivation, there needs to be an integration of learning material with career insights and direct student involvement in activities relevant to the science work world, such as industrial visits or collaboration with practitioners.

The classroom motivation indicator recorded the highest score among other indicators with a score of 84.18. This indicates that the classroom environment at SMA Negeri 2 Boyolali is quite supportive of science learning motivation, both in terms of teacher-student interaction, classroom atmosphere, encouragement of participation, and learning dynamics. However, the category is still "moderate," so there is room for improvement. Literature shows that a supportive classroom environment is very important in maintaining motivation. In the literature study "Self beliefs, engagement and motivation," classroom characteristics that provide challenges, foster a sense of engagement, and appreciate students' competencies will help maintain and enhance classroom motivation [22]. These results reflect that students have a sufficient interest and involvement in learning, as well as showing a relatively positive perception of the material of Particle Dynamics [21]. Aspects such as personal relevance to the material, engaging presentation of material, and the relationship of the material to career motivation also contribute to this motivational achievement [14].

4. Conclusion

Based on the results of the research that has been conducted, it is known that the level of science motivation of XI grade students at SMA Negeri 2 Boyolali on the topic of Particle Dynamics is at a score of 79.85, which falls into the moderate category. Thus, this research recommends that teachers and the school consider learning innovations that encourage active student participation and the relevance of the material to the real world. The use of active learning methods, project-based, or problem-based learning can be an effective alternative to increase students' science motivation. Furthermore, further research can be focused on exploring these learning approaches and their effects on students' cognitive and affective aspects in more depth.

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