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The Interrelationship between Teachers' and Students' Motivation and Empathy in Undergraduate Physics Education

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ABSTRACT

Motivation drives students' effort, persistence, and deep learning, while empathy underpins trust, inclusion, and emotional safety in diverse classrooms. In undergraduate physics education, where courses are often perceived as difficult, selective, and abstract, understanding how teachers' and students' motivation and empathy are related is crucial for creating supportive learning environments. This study explores how lecturers and students in undergraduate physics make sense of the interrelationships between teachers' and students' motivation and empathy. This study employed a qualitative exploratory design. Semi-structured interviews were conducted with physics education lecturers and undergraduate physics students. Lecturers were invited to describe their teaching motivation, their empathy towards students, and how they perceived these qualities as influencing students' learning and well-being. Students were asked to describe their learning motivation and empathy and to reflect on how they experienced their lecturers' motivation and empathy in everyday classroom interactions. The interview data were analysed inductively using thematic procedures to identify recurring patterns and relational dynamics between teachers' and students' motivation and empathy. The analysis reveals that lecturers who describe themselves as intrinsically motivated and caring tend to recount practices such as adapting explanations, providing emotional support, and giving individual attention, which students experience as motivating and affirming. Students often link their own motivation in physics to whether they perceive their lecturers as enthusiastic, approachable, and empathetic, particularly when facing conceptual difficulties. At the same time, some accounts suggest that tensions can arise when strong academic expectations and performance pressures coexist with limited emotional resources, complicating the enactment and experience of motivation and empathy. Overall, the findings illuminate how lecturers' motivational and empathic stances are perceived to shape students' motivation and empathy in undergraduate physics, highlighting the need for pedagogical approaches that intentionally cultivate both.

Keywords: motivation, empathy, undergraduate physics education, qualitative study

INTRODUCTION

Motivation acts as the pivotal force propelling students through their academic endeavors, exerting influence over their levels of engagement, persistence, and ultimately, their achievements (Bandhu et al., 2024; Barkley & Major, 2020; National Academies of Sciences, Engineering, and Medicine [NAS] et al., 2018; Ryan & Deci, 2020; Tinto, 2022). It shapes students' willingness to invest effort and time in their students and, thereby, their broader educational trajectories (Eccles & Wigfield, 2002; Schunk & DiBenedetto, 2021). Consequently, understanding the multifaceted dynamics of motivation is essential for improving the quality of students' learning journeys and their long-term success (Reeve et al., 2022). At the same time, empathy has emerged as a cornerstone of contemporary educational discourse, underscoring the significance of understanding and responding to others' emotions and perspectives (Bloom, 2017; Bock & Goode, 2007; Hoffman, 1996; Perikleous, 2024). Within the educator-student relationship, empathy fosters trust, inclusion, and emotional safety, particularly in diverse and academically demanding learning environments (Goroshit & Hen, 2016; Grant & Hill, 2020; National Academies of Sciences, Engineering, and Medicine [NAS], 2018). Educators who display empathy showcase a greater potential to connect with their students on a sense of trust, understanding, and mutual respect. Empathic interactions not only support effective communication and collaboration but also help create an inclusive and supportive learning environment that promotes positive learning outcomes (Carlson & Dobson, 2020; Cooper, 2011; Çelik & Alpan, 2023).

Theoretical and empirical work has consistently shown that empathetic teaching practices and student motivation are deeply interwoven in shaping students' academic experiences. Teachers who demonstrate empathy toward their students contribute significantly to increased student engagement, satisfaction, and, ultimately, academic performance (Aldrup et al., 2022), especially in science education (Jaber et al., 2024; McCurdy et al., 2020; Sunassee et al., 2021). Motivation, in turn, is repeatedly identified as a key predictor of students' approach to learning and academic success (Affuso et al., 2023; Amida et al., 2021; Bureau et al., 2022; Karabatak & Polat, 2020; Trolian & Jach, 2020). Intrinsic motivation, characterized by an internal drive and personal interest, plays a pivotal role in fostering deep understanding and ensuring long-term retention of knowledge (Deci & Ryan, 2013; NAS, 2018; Ryan & Deci, 2020). Students who are intrinsically motivated typically engage more wholeheartedly in learning activities and are more resilient in the face of challenges (Ryan & Deci, 2020; Shin & Bolkan, 2021). Motivation is indeed a cornerstone in fostering empathic awareness among individuals (Grant & Hill, 2020). The recent emphasis on empathy and motivation within various instructional environments (Cai et al., 2023; De Zoysa et al., 2024; Kotera et al., 2023; Li et al., 2024; Weisz et al., 2022) holds undeniable importance.

These affective dimensions are particularly salient in undergraduate physics education, which is widely recognised as a challenging and selective domain within STEM. Research has documented persistent difficulties in conceptual understanding, high cognitive load, and perception of physics as abstract, mathematically demanding, and disconnected from everyday life, all of which can suppress motivation and persistence (Hachmi et al., 2022, 2025; Kahar, 2018; Setiaji et al., 2024). In many countries, undergraduate physics courses function as "gateway" experiences that strongly influence students' decisions to remain in or leave STEM pathways (Bøe et al., 2025; Feder & Malcom, 2016; National Research Council, 2013). Studies of physics majors and introductory physics classes show that low or fragile motivation, together with feelings or alienation or low self-efficacy, are common and can undermine students' sense of belonging and identity as legitimate physics learners (Bøe et al., 2025; Li & Singh, 2023; Setiaji et al., 2024). These challenges make undergraduate physics a critical context in which the dynamics of motivation are not only theoretically interesting but also practically consequential for student retention, diversity, and the development of a future STEM workforce.

In parallel with concerns about motivation, recent scholarship has underscored the importance of empathy in university science and physics classrooms. Conceptual and empirical studies argue that empathy should be

treated as a core resource for learning complex science, as it can support epistemic engagement, moral development, and more responsive teaching (Arghode et al., 2013; Zeyer & Dillon, 2019). In physics, specifically, emerging work on faculty empathy has proposed frameworks for understanding how physics instructors navigate students' struggles, perspectives, and identities, and how empathy can act as a catalyst for more inclusive and student-centred practices (Hamdan et al., 2024; Merrill et al., 2024). Teacher empathy has been linked to higher quality teacher-student interaction, better emotional support, and improved student achievement and well-being (Lunn et al., 2022; Sun et al., 2023). Yet, despite this growing recognition, empathy in physics higher education remains relatively underexplored, particularly in connection with broader motivational processes.

Taken together, these strands of research suggest that undergraduate physics education offers a particularly demanding and revealing context for investigating how motivation and empathy interact. Physics courses combine high cognitive demands with well-documented issues of under-representation and a fragile sense of belonging, which are strongly influenced by the social and emotional climate of the classroom (Dias-Broens et al., 2024; Li & Singh, 2023). In such settings, lecturers' motivational orientations and their capacity to empathise with students may be especially consequential: they can shape how students interpret difficulty, whether they feel valued and included, and how they balance academic drive with social-emotional well-being (Grant & Hill, 2020; NAS, 2018). However, most existing studies either focus on separate constructs (motivation and empathy) or examine them from the student side only, without systematically exploring how teachers' motivation and empathy relate to students' motivation and empathy in physics higher education.

This study addresses this gap by examining the interrelationships between teachers' and students' motivation and empathy in undergraduate physics education. In alignment with these aims, this study is guided by the following research questions:

1. How do physics education lecturers describe their teaching motivation and their empathy toward students in undergraduate physics education?

2. How do undergraduate physics students report their learning motivation for physics and their empathy?

3. How are lecturers' teaching motivation and empathy related to undergraduate physics students' learning motivation and empathy?

THEORETICAL FRAMEWORK

Learning Motivation

Motivation is a condition that activates and sustains behaviour toward a goal (NAS, 2018). From behavior-based theories of learning, motivation is conceptualized as habits, drives, incentives, and reinforcement schedules (NAS, 2018). Learning motivation is a crucial factor influencing students' academic success. Learning motivation is the process of influencing the direction, intensity, and persistence of an individual's learning behavior (Santrock, 2011). Learners' ideas about their own competence, their values, and the pre-existing interests they bring to a particular learning situation all influence motivation (NAS, 2018). A profound understanding of learning motivation can aid educators and parents in creating supportive learning environments.

Maslow came up with what he called his Hierarchy of Needs theory, which is quite good to help you understand why you want to learn. According to him, humans have five levels of needs that must be met in order, and they range from basic physiological needs all the way up to self-actualization. In education, the need for safety, love and belonging, esteem, and self-actualization plays a big role; these are the major parts of what motivates students' learning (Maslow, 2016). When students' basic needs are satisfied, it paves the way for them to be

more motivated towards achieving success in their academics. Recent studies back up Maslow's theory by saying that indeed, students' basic needs should be looked into if at all we want to promote a good environment for learning (Zajda, 2021).

Deci and Ryan (1985) were the pioneers who came up with the Self-Determination Theory (SDT) (Deci & Ryan, 2000, 2013; Ryan & Deci, 2020). This theory states that our actions are heavily guided by three inherent psychological needs. These include autonomy (the desire to control one's own life), competence (the need for mastery), and psychological relatedness (the need for social connections and care from others), as highlighted by NAS in 2018. The distinction made by this theory is between intrinsic motivation, which comes from within, driven by curiosity or personal satisfaction, and extrinsic motivation that originates externally through rewards or recognition. The National Academy of Sciences et al. (2018) report discusses the concept of intrinsic motivation among students. It defines intrinsic motivation as motivation to engage in a desired activity, a sense of self-agency rather than external coercion. Furthermore, the report affirms that when students believe they can overcome the difficulties of the problem or work. Autonomy and self-efficacy are what the report identifies as intrinsic motivation and positions them as a key component of learning.

Furthermore, the Expectancy-Value Theory stands out as an innovative theory that sheds light on the motivation for learning (Eccles & Wigfield, 2002). It posits that an individual's motivation to learn is contingent upon two primary factors: their expectancy of success and the value they place on the task. If students think that they can be successful and find value in what they are doing, then they will be more likely to be motivated towards learning. These expectations and values are shaped by past experiences, self-perceptions, and environmental support. Recent findings indicate that students' beliefs about their capabilities and the importance of their tasks significantly determine their levels of motivation (Eccles & Wigfield, 2024).

Factors that have an effect on motivation to learn can be classified as internal and external (Ryan & Deci, 2000, 2020). Among the internal factors are interests and talents, personal goals, and self-confidence. Those who have interests and talents in any field are easily motivated. Also, clear and realistic goals enhance learning motivation; similarly, belief in one's own ability enhances motivation (Bandura, 1997). It is reported that students with high self-efficacy coupled with well-defined personal goals exhibit more resilience and are highly motivated towards their academic pursuits (Kim et al., 2021). The family environment alongside school environment plus peer relationships form the external factors of learning motivation (Filgona et al., 2020; Kılıç et al., 2021; Tu & Chu, 2020). The support and encouragement from family members play a major role in fostering learning motivation. Similarly, inspirational teachers and teaching methods full of engagement develop the students' motivation towards learning. Moreover, student interaction with high-motivation peers can further motivate individual learning (Wentzel, 1998). A positive peer relationship and a supportive class climate play a major role in enhancing students' motivation levels, which, in turn, leads to academic success (Robinson, 2023). Studies have shown that intrinsic motivation is more likely to result in better and long-lasting learning outcomes as opposed to extrinsic motivation (Ryan & Deci, 2020). Recent findings have demonstrated that students who show intrinsic motivation tend to be more engaged academically; this has resulted in higher academic performance for such students (Ryan & Deci, 2020; Shin & Bolkan, 2021)

There are multiple ways that can be used to improve motivation and ensure the students learn better. This is through providing positive reinforcement or external reward, which can include praise, rewards, or recognition for their efforts and achievements (Hussain et al., 2023). When students get support from their peers, parents, and teachers to develop self-discipline skills and plan their work and time, they are likely to be highly self-motivated individuals (Odanga, 2018). It helps in making learning more meaningful by connecting it to real-life situations. Providing challenging tasks within the capabilities of the students also increases their motivation to learn (Schunk et al., 2012). Those studies have proven that these strategies work well in enhancing students' motivation, leading to improved academic outcomes.

Teaching Motivation

Motivation plays a huge role in the field of teaching. It includes both what inspires teachers from within themselves as well as those external factors that help them continue with their work. This encompasses all reasons, desires and goals why individuals choose to be part of the teaching profession (Kwok et al., 2022). Identifying these motivational factors among teachers is critical for organizations to develop strategies aimed at boosting job satisfaction levels and performance at work (Kilag et al., 2023). Intrinsic motivation refers to that which comes from inside an individual, their personal interest and enjoyment derived out of satisfaction while carrying out tasks related to teaching (Bukhari et al., 2023). This kind of motivation leads to higher job satisfaction levels thereby more effective teaching since it stresses on finding pleasure within oneself during the teaching process. On the flip side, extrinsic motivation is all about those external factors that influence your behavior. Think salary, think job security, think recognition, they're all extrinsic motivators (Kumar, 2023). And let's not forget that motivation is basically made up of two things: how likely we think we are to succeed at a task and how much we value that task in the first place (Jud et al., 2023). So when teachers see their job as something they can excel at and find value and meaning in what they do, they are more likely to be motivated. The development of this mindset is influenced by personal experiences, self-efficacy, and school support. New studies show that when teachers have faith in their abilities and find their work meaningful, it leads to high levels of motivation (Bönke et al., 2024).

Teaching motivation in an individual can be traced from factors such as personal values and self-efficacy which can be looked into internally (Cai et al., 2022). When it comes to teachers, intrinsic motivation tends to surface when individuals hold their personal beliefs in high regard and display a profound dedication towards the field of education. Another major influencer for teaching motivation is self-efficacy, which is the belief in one's ability to perform teaching tasks effectively. Moreover, harbouring a positive view of professional identity (viewing oneself as a capable and valued professional) can further fuel motivation positively. All these components contribute significantly to igniting the inner drive of teachers in their role as educators. Conversely, factors from outside that affect this include administrative support, student behaviour, institutional pressures, and leadership styles (Ryan & Deci, 2020). The support provided by school leadership, along with the school climate, can further elevate teachers' motivation. Professional growth and career progressions are equally critical to the sustenance and enhancement of motivation levels among teachers (Amponsah et al., 2023). Conversely, positive student conduct coupled with active participation can act as a force multiplier for teachers' self-perceived effectiveness. This, in turn, can lead to job satisfaction and hence motivation (Cents-Boonstra et al., 2021).

Empathy in Teaching and Learning

Empathy within the realm of education can be encapsulated as such a teacher's capacity to grasp and relate to the emotions and viewpoints of students (Bloom, 2017; Bock & Goode, 2007; Hoffman, 1996) and responding in a manner that nurtures their emotional and academic growth (Cooper, 2011). Empathy isn't solely about understanding the cognitive essence of others' feelings but also about sharing those same emotions on an affective level (Davis, 1983). Studies indicate that teacher empathy fosters positive teacher-student relationships and paves the way for a conducive classroom climate (Aldrup et al., 2022). As per Cooper (2011), teachers harboring empathy forge better connections with students, thereby fueling student motivation and interest, which reciprocally boosts engagement in the learning process. Furthermore, empathy acts as an aid for teachers towards effective classroom management since it helps in decoding the emotional needs of students better, thus helping them respond more appropriately (Jennings & Greenberg, 2009).

Empathy of the instructor toward the student has been widely recognised as an important dimension of effective teaching. This is also related to academic results, which found that students showed better academic results when they feel their teachers understand and support them in what they do at school (McAllister &

Irvine, 2002). It contributes to their self-confidence, plus motivation to learn, because children feel valuable and emotionally supported by adults (McAllister & Irvine, 2002). There are many strategies for enhancing empathy in teaching, but one of the most effective methods is training teachers on how they can easily recognize children's feelings and adequately respond to them (Warren, 2018). Also, an environment that is supportive and inclusive enhances empathy among both teachers and students (Gay, 2018).

METHOD

Research Design

In this paper, the term teachers refers to university lecturers/instructors who teach undergraduate physics education courses. This study employed a qualitative exploratory research design (Stebbins, 2001) to examine how lecturers and students make sense of, describe, and explain the perceived interrelationships between teachers' motivation and empathy and students' motivation and empathy in undergraduate physics education. This design was selected because the study aimed to understand meanings, relational dynamics, and perceived mechanisms that participants use to connect these constructs in everyday teaching-learning interactions, rather than to test predefined hypotheses or quantify the strength of associations (Creswell & Poth, 2016).

The exploratory orientation was appropriate because the study sought to map the forms and pathways through which motivation and empathy are experienced as mutually reinforcing within the context of demanding physics learning. By eliciting detailed narrative accounts from both sides of the teacher-student relationship, the study aimed to surface perceived mechanisms and conditions through which motivation and empathy are described as mutually shaping classroom engagement and persistence in physics

Research Context and Participants

This study was conducted in an undergraduate Physics Education programme in Lampung Province, Indonesia. The setting was selected to provide evidence from a less-represented regional context and to examine the motivation-empathy interrelationship in mathematically and conceptually demanding physics courses, where students often face persistence challenges and depend on instructional support. Although the region is in terms of demographics, community characteristics, and diverse cultural backgrounds (Hidayah, 2020), this study did not examine cultural-group or demographic differences. Therefore, the selection process was not intended to "affirm" multicultural representation. The contextual description is provided only to situate participants' accounts within this programme.

Participants were two physics education lecturers and three undergraduate physics education students. We used criterion-based purposive sampling to obtain information-rich accounts aligned with the study aim. Lecturers were included because they taught undergraduate physics education courses and had sustained teaching experience with the target student population. Students were included if they were enrolled in the programme, had taken courses taught by the participating lecturers, and could describe concrete classroom experiences relevant to motivation and empathy. Eligible students were invited, and three who consented and provided detailed, example-based accounts were interviewed. The small sample size reflects the study's focus on depth of narrative and clarity of perceived mechanisms rather than statistical representation (Merriam & Tisdell, 2016; Patton, 2014). Including both lecturer and student perspectives supported data-source triangulation and strengthened the credibility of interpretations within this bounded context. Accordingly, the findings should be interpreted as context-bound and illustrative, and they do not aim to capture the full range of relationship patterns that may emerge across more diverse student groups or settings.

Research Instruments and Data Collection

The primary data source in this study was semi-structured interviews with lecturers and students. Two interview protocols were developed: one for physics education lecturers and one for undergraduate physics education students. The lecturer protocol focused on two main domains: Teaching Motivation and Perceptions of Empathy in Teaching. Under Teaching Motivation, the questions explored intrinsic and extrinsic factors influencing lecturers' motivation to teach physics, their professional identity, and how they sustain motivation over time. Under Perceptions of Empathy in Teaching, the questions examined lecturers' understanding of empathy, how they recognise students' emotional and academic needs, how they respond to those needs in practice, and how they perceive the impact of empathy on students' learning and well-being. Meanwhile, the student protocol explored Learning Motivation and Experiences of Lecturers' Motivation and Empathy. Students were asked how they define and experience learning motivation in physics, what factors enhance or undermine their motivation, and how they describe empathy in the context of learning. They were also invited to reflect on concrete experiences in which they perceived their lecturers as motivated, enthusiastic, or empathetic, and to explain how these experiences influence their own motivation and empathy in learning physics.

All interviews were conducted individually, using a semi-structured format that allowed the interviewer to ask follow-up questions and probe for clarification when needed. With participants' consent, the interviews were audio-recorded and subsequently transcribed verbatim for analysis.

Data Analysis

Qualitative data obtained from the lecturer and student interviews were analysed using thematic analysis to identify recurring themes and patterns in participants' narratives (Creswell, 2015). The analysis began with repeated readings of the interview transcripts to gain an overall sense of the data. Initial codes were then generated inductively from the transcripts, focusing on how participants talked about motivation, empathy, and the interrelationships between them. These codes were iteratively grouped into broader categories and refined into themes that captured key aspects of: (1) lecturers' teaching motivation and empathy toward students; (2) students' learning motivation and empathy; and (3) perceived interrelationships between lecturers' motivation and empathy and students' motivation and empathy. Throughout the analysis, attention was given to similarities and differences between lecturers' and students' accounts, providing data-source triangulation across the two participant groups (Oleinik, 2011). This helped to build a more comprehensive understanding of how teachers' motivation and empathy are perceived to relate to students' motivation and empathy in undergraduate physics education.

Rigour and Trustworthiness

Several strategies were used to enhance the rigour and trustworthiness of the study. The interview protocols were developed based on a review of the literature on motivation and empathy in higher education and physics education and were aligned with the aims and research question of the study. Draft interview protocols were reviewed by colleagues in physics education and educational research to ensure content, relevance, clarity, and appropriateness of the questions of both lecturers and students, leading to minor refinements in wording and sequencing.

During data collection, the semi-structured interview format allowed the interviewer to use probing questions, paraphrasing, and member checks within the interview to clarify meanings and confirm the interviewer's understanding of participants' responses. In the analysis phase, constant comparison was employed within and across lecturer and student accounts, and attention was given to negative or divergent cases. Data-source triangulation between lecturers and students was used to cross-check emerging interpretations and to identify convergences and discrepancies in how motivation and empathy were described. An audit trail of coding

decisions and theme development was maintained to document the analytic process. Together, these strategies were intended to strengthen the credibility and dependability of the findings.

RESULTS AND DISCUSSION

Lecturers' perspectives (RQ1)

Theme 1: Intrinsic Motivation Rooted in Love for Physics and Teaching

To address the first research question, this theme presents how the two physics education lecturers described their intrinsic motivation to continue teaching undergraduate physics. The focus here is on how they talk about their love for physics and for teaching, and how this inner drive sustains their commitment to the profession.

The first lecturer emphasised that her motivation comes from a deep fascination with physics and the pleasure of sharing this fascination with students:

> *"Physics is closely related to the basic principles that govern our universe. Teaching physics allows me to share this passion with my students and inspire them to explore the world around them. The curiosity and excitement I see in my students' eyes when they understand difficult concepts is what drives me to continue in this profession." [Lecturer 1]*

The second lecturer connected his motivation to a personal trajectory into academia and to the meaningfulness of teaching as a form of devotion and continuous learning:

> *"Starting from my Master's program, where I got a scholarship and was determined to become a lecturer. Thankfully, the opportunity came. Being a lecturer offers many chances to learn, explore, and interact with students and colleagues, even those far away. I pursue this profession as an act of worship because knowledge is everlasting and beneficial." [Lecturer 2]*

In another part of the interview he further highlighted the nature of the discipline itself:

> *"...because natural science is certain, and certainty aligns with reason and logic." [Lecturer 2]*

Taken together, these findings show that both lecturers locate the source of their motivation inside the work of teaching physics rather than in external rewards. Lecturer 1 describes strong enjoyment in working with fundamental ideas of the universe and in seeing students' curiosity and understanding grow. The emotional satisfaction she experiences when students grasp difficult concepts reflects a sense of fulfilment closely tied to her professional identity as a physics educator. Lecturer 2, meanwhile, links his motivation to a life story of academic opportunity, to the enduring value of knowledge, and to the logical, particular character of natural science. For him, teaching physics is meaningful because it aligns with his way of thinking and allows him to continue learning while benefiting others.

These accounts illustrate key aspects of intrinsic motivation as described in SDT, where individuals are motivated because they find an activity inherently interesting and personally meaningful (Deci & Ryan, 2013; Ryan & Deci, 2020). Lecturer 1's narrative reflects interest value and identified regulation. She enjoys engaging with physics concepts and sees teaching as an integral part of who she is as a professional. Lecturer 2's emphasis on the certainty and logic of physics, along with his sense of devotion to knowledge, shows how the task value of teaching (its perceived importance and usefulness) feeds his motivation (Eccles & Wigfield, 2002, 2024). In terms of Expectancy-Value Theory, both lecturers place high value on the teaching task and express confidence in their ability to perform it well, which together support sustained motivation.

The lecturers' accounts foreground intrinsic enjoyment and professional meaning as the core of their motivation. They only briefly acknowledged external rewards, such as salary and recognition, mainly in terms of practical security and workplace appreciation. Lecturer 1 noted that these are important for providing security and fulfilling family responsibilities, but she clearly stated that her motivation comes from intrinsic satisfaction in teaching. Lecturer 2 likewise recognised that external rewards may matter, while commenting that recognition can be unevenly distributed within academic settings. These comments reinforce that external rewards function as background conditions that support their work rather than primary drivers, whereas the core of their motivation lies in their love for physics and the act of teaching itself.

From a broader perspective, this theme suggests that lecturers' intrinsic motivation, rooted in love for physics and for teaching, provides a strong foundation for their engagement with students. Their enjoyment of explaining concepts, interacting with learners, and continuing to learn themselves creates conditions in which they are more likely to invest time and energy in understanding students' needs, an aspect that connects directly to later themes on empathy in their teaching practices.

Theme 2: Valuing Teaching as a Contribution to Students' Futures

Building on the strong intrinsic motivation described in Theme 1, this theme shows that the lecturers also understand teaching physics as a means of contributing to students' futures. Their motivation is not only rooted in the enjoyment of physics and teaching, but also in the belief that their work can influence students' lives beyond the classroom.

When asked how she maintains her motivation in challenging teaching situations, Lecturer 1 emphasised the importance of remembering her impact on students:

> *"When faced with challenges, I remind myself of the impact I can have on my students' lives. I also seek support from my colleagues and engage in professional development activities to find new strategies and perspectives." [Lecturer 1]*

In another part of the interview, she again linked her motivation to seeking solutions that are beneficial for students:

> *"I overcome the factors that reduce motivation by trying to always think positively and think good things about my work, then I also seek support from my friends. In essence, I am a more proactive type and seek solutions that are beneficial to students and myself." [Lecturer 1]*

Lecturer 2 described a slightly different but related strategy, focusing on creating a learning environment that supports students' engagement and comfort:

> *"I try to stay confident and to build a learning environment where motivation can grow. I see motivation as part of the overall classroom climate, shaped by the interaction of many aspects of learning. It is not always easy to change existing patterns, but I keep working to adjust the classroom so that students feel comfortable and able to stay engaged." [Lecturer 2]*

He also highlighted the importance of continually developing himself so that he can respond to new demands in teaching:

> *"Continue to explore my own abilities,[and] the needs required in new knowledge" [Lecturer 2]*

Collectively, these findings suggest that the lecturers sustain their motivation through purposeful actions that support students' engagement and learning. Lecturer 1 sustains her motivation by consciously recalling "the impact I can have on my students' lives" and by actively seeking collegial support and professional development. Her second statement portrays her as proactive and student-oriented when she tries to "seek

solutions that are beneficial to students and myself", suggesting that her motivation is tied to seeing students benefit from her efforts over time.

Lecturer 2 focuses on shaping on the learning environment so that students feel comfortable and able to engage. For him, motivation is closely linked to classroom climate; when the climate supports students' comfort, his own confidence and motivation are also strengthened. His brief remark about "continu[ing] to explore my own abilities" and "new knowledge" indicates an ongoing commitment to learning so that he can keep providing relevant and effective teaching. Across both accounts, teaching is not described solely as delivering physics content, but as supporting students' development and helping them move forward in their educational journeys.

These findings suggest that the lecturers' motivation is grounded in a strong sense of purpose and contribution. In terms of SDT, their narratives reflect identified and integrated regulation, when teaching physics is experienced as consistent with their personal values and with the kind of impact they wish to have on students (Deci & Ryan, 2013; Ryan & Deci, 2020). Remembering their potential influence on students' lives, investing in professional development, and adjusting classroom environments are all ways of nurturing this sense of purpose.

From the perspective of Expectancy-Value Theory (Eccles & Wigfield, 2002, 2024), the lecturers attribute high attainment value (teaching as central to their professional identity) and utility value (teaching as useful for supporting students' continued engagement and learning in physics) to their work. They are motivated not only because they enjoy physics and teaching, but also because they view teaching as a meaningful way to help students grow and persist when facing academic challenges

Overall, this theme suggests that lecturers' motivation to teach undergraduate physics is sustained by a future-oriented commitment to students' learning and development, as reflected in their emphasis on students' engagement, comfort, and progress. Viewing teaching as a meaningful contribution encourages them to keep learning, to adapt their practice, and to persist through difficulties. This future-oriented motivation also provides an important background for their empathetic engagement with students, which is explored in the next theme on empathy as understanding students' struggles and backgrounds.

Theme 3: Empathy as Understanding Students' Struggles and Backgrounds

In relation to the first research question, this theme focuses on how lecturers understand and describe empathy in their teaching practice. In their accounts, empathy is closely linked to recognising students' struggles in learning physics (e.g., anxiety, burnout, or falling behind) and to attending to their diverse backgrounds and circumstances. Empathy for them involves noticing these struggles, understanding the situations in which students live and study, and responding in ways that support both learning and well-being.

When asked what empathy means to them as physics educators, both lecturers define it in terms of understanding students' needs and situations. Lecturer 1 emphasised sensitivity to students' efforts and difficulties:

> *"Empathy means trying to understand my students' needs and providing a supportive learning environment for them. Empathy also means recognizing their efforts in attending our lectures and we can offer appropriate assistance when they experience difficulties." [Lecturer 1]*

Lecturer 2 highlighted perspective-taking and awareness of students' diverse conditions:

> *"Understanding other people's perspectives is important, knowing other people's situations and conditions brings about an attitude of greater appreciation." [Lecturer 2]*

The lecturers also explained how they recognise when students need empathetic support. Lecturer 1 described observing changes in students' behaviour and engagement, combined with open communication:

> *"I realize that my students need that empathetic support from student behavior, performance, and engagement when in class, just observe the changes. I am usually also open in communicating with my students with the aim that they also do not hesitate to express their concerns." [Lecturer 1]*

Lecturer 2 pointed to the students' interactions during learning activities:

> *"[I notice it] from the way of interaction both in the learning environment especially to us as educators. It can be through collaboration, discussion, and motivational support during the teaching and learning process." [Lecturer 2]*

Both lecturers then gave concrete examples of responding to students' struggles. Lecturer 1 recalled a case of exam anxiety and burnout:

> *"At that time, a student once told me about excessive anxiety when taking exams because he felt burnt out. I just offered practical strategies to manage his anxiety, that all of it had to be faced with relaxation but still make efforts, but in the end he was able to work better and feel more confident." [Lecturer 1]*

Lecturer 2 described noticing that a student was lagging behind and taking steps to support him:

> *"Once, a student wasn't keeping up with the others in class. While their classmates were moving forward, he was lagging behind. I had to talk to him to boost his motivation and help him catch up. I gave him guidance and support that suited their situation so he felt better and more eager to learn." [Lecturer 2]*

Taken together, these responses show that both lecturers understand empathy as actively trying to see the classroom from students' percpectives and to recognise the pressures they face. Lecturer 1 stresses "trying to understand my students' needs" and "recognizing their efforts", and she links this understanding to concrete support, such as offering "appropriate assistance" or practical strategies to manage exam anxiety. Lecturer 2 emphasises that students come with different "situations and conditions" and that empathy requires appreciating these differences and avoiding quick judgement.

The lecturers' descriptions of how they recognise when empathy is needed (through changes in behaviour, performance, engagement, and interaction) also suggest that empathy is grounded in careful observation and dialogue rather than assumption. They attend to signals that something is wrong, invite students to talk, and then adapt their responses to the specific situation. In both examples of practice, empathy leads to targeted pedagogical actions by adjusting expectations, providing tailored guidance, and helping students regain confidence and motivation.

These findings are consistent with descriptions of pedagogical or empathetic teaching in the literature, in which empathy involves understanding students' experiences and responding in ways that support their academic progress and emotional safety (Cooper, 2011; Jennings & Greenberg, 2009; Meyers et al., 2019). Lecturer 1's account reflects empathy as attentive responsiveness, when she listens to students' concerns, recognises signs of anxiety and burnout, and adjusts her guidance so that students can cope with assessment demands without feeling overwhelmed. Lecturer 2's focus on perspectives, conditions, and classroom interactions highlights the cognitive dimension of empathy (seeing from the students' struggles and backgrounds) and its role in shaping inclusive and supportive learning environments.

Moreover, the examples of exam anxiety and falling behind indicate that empathy is closely connected to students' struggles and backgrounds. Rather than treating underperformance as a purely cognitive deficit, the lecturers interpret it in relation to students' emotional states and personal circumstances, and they respond with strategies that combine academic support and emotional encouragement. This resonates with socio-constructivist views of learning, which emphasise that students' participation and understanding are shaped by social and emotional contexts as well as by cognitive factors (Vygotsky, 1978).

In the broader context of this study, Theme 3 from the lecturer's perspectives indicates that empathy is not an add-on to motivation but is intertwined with it. The same commitment that leads lecturers to care about students' futures (Theme 2) also drives them to notice and respond to students' difficulties in the present. By understanding students' struggles and backgrounds, lecturers can create conditions in which students feel valued, less anxious, and more willing to engage, effects that the lecturers themselves associate with increased motivation and participation in undergraduate physics classes.

Theme 4: Empathic Responses (Emotional Support, Flexibility, and Extra Explanation)

Following the previous theme, which examined how lecturers understand empathy and recognise students' struggles and backgrounds, this theme focuses on how empathy is enacted in practice. Here, empathy appears in three interconnected forms: providing emotional support, being flexible while maintaining academic standards, and offering additional guidance or explanations so that students with different needs can remain engaged in learning physics.

Lecturer 1 described empathy as something that operates within, not against, clear academic expectations:

> *"While I am empathetic to college students' needs, I moreover emphasize the importance of meeting academic requirements. I set clean mastering consequences and provide steady comments from each instruction I give." [Lecturer 1]*

She also highlighted how empathy helps to create a supportive climate in which students feel safe and confident:

> *"Empathy can build a sense of belonging and trust between students in class, it can also increase students' motivation and willingness to participate in class because they feel valued. It also helps reduce anxiety and build self-confidence." [Lecturer 1]*

Lecturer 2 then stressed that empathic responses need to be adapted to specific situations, including rule-breaking:

> *"It depends on the situation. If a student is facing a challenge due to something like plagiarism, where they've broken the rules, showing empathy involves social interaction. This means that the teacher, the student, and their peers all have a role to play, each according to their part, to address the issue while still upholding the standards of the course." [Lecturer 2]*

He also explained that empathy has an instructional dimension, especially when students are at different cognitive levels.

> *"Yes, being empathetic whilst teaching is vital because no longer all college students have the same cognitive stages. Class discussions and reflections can deal with this. They assist college students to experience understood and supported, improving their getting to know stories.." [Lecturer 2]*

Compared with Theme 3, where the lecturers mainly described recognising students' struggles (for example, noticing anxiety before exams or realising that a student was falling behind), these excerpts show what they actually do in response. First, empathy is expressed as emotional support within a structured framework.

Lecturer 1 emphasises that she does not abandon academic standards. Instead, she combines "clear learning outcomes" and "steady feedback" with attentiveness to produce a sense of belonging and trust, reduced anxiety, and increased confidence. Put together with the earlier episode of helping an anxious student manage exam stress (Theme 3), this suggests that emotional support is given through reassurance, constructive feedback, and a classroom climate where students feel valued.

Second, empathy is linked to extra explanation and differentiated support. By noting that "not all students have the same cognitive stages," and pointing to the role of class discussions and reflections, Lecturer 2 shows how empathic awareness of different levels is translated into pedagogical action: adjusting explanations, creating space for questions, and using reflective activities so that more students can follow the physics content and feel supported.

Taken together, these patterns portray empathic responses as a practical situated pedagogy. Emotional support is evident in efforts to build belonging, trust, and confidence and to reduce anxiety, as research links teacher empathy and caring classroom climates to students' psychological safety and engagement (Jennings & Greenberg, 2009; Meyers et al., 2019). At the same time, the insistence on clear learning outcomes, steady feedback, and fair handling of plagiarism reflects a "caring but demanding" stance. It shows that lecturers maintain high expectations while helping students meet them. This aligns with perspectives that effective empathy in higher education involves transparency about requirements and consistent feedback, rather than simply relaxing standards (Çelik & Alpan, 2023).

Finally, the emphasis on different cognitive stages and the use of class discussions and reflections connect empathy to responsive and differentiated teaching. In socio-constructivist terms, such practices can be seen as forms of scaffolding, where lecturers adjust interaction, tasks, and explanations to students' actual levels so that they can participate meaningfully in learning (Vygotsky & Cole, 1978). In this way, empathy is not only a feeling but a guiding principle for how lecturers support students emotionally, adapt to their circumstances, and provide additional explanation in undergraduate physics education.

Students' perspectives (RQ2)

Theme 1: Students' Own Definitions of Motivation and Empathy

Before examining how lecturers' motivation and empathy are perceived, the students were first invited to articulate their own definitions of motivation and empathy. This theme provides a brief overview of how the three students conceptualise these constructs, which helps to situate their later comments about classroom experiences. When asked what learning motivation means to them, the three students described it as enthusiasm, drive, and support for self-development:

> *"The motivation to learn is something that can make me enthusiastic about studying." [Student 1]*
>
> *"Learning motivation is the drive or support to restore enthusiasm in learning, thereby enhancing the quality of both the learning process and its outcomes." [Student 2]*
>
> *"Learning motivation is the enthusiasm to develop oneself through learning." [Student 3]*

Subsequently, the students were asked how they define empathy. Their responses highlighted connection, concern, and sensitivity to others' situations:

> *"Empathy in my opinion is a feeling that is bound to others, such as being able to feel what others feel.." [Student 1]*
>
> *"Empathy is a feeling or attitude of our concern for others and the environment around us." [Student 2]*

> *"Empathy is a feeling of compassion for situations and conditions." [Student 3]*

These definitions show that, from the students' perspective, learning motivation is closely associated with enthusiasm and support for learning. Student 1 describes motivation as "something that can make me enthusiastic about studying," foregrounding the emotional energy that drives her to engage with learning activities. Student 2 adds an interpersonal dimension, referring to "drive or support to restore enthusiasm," and explicitly links motivation to improving "the quality of both the learning process and its outcomes." Student 3 focuses on self-development, framing motivation as "the enthusiasm to develop oneself through learning." Together, these statements suggest that students view motivation as both an internal feeling of enthusiasm and something that can be strengthened by external support.

Similarly, their definition of empathy emphasises emotional connection and concern for others. Student 1 stresses "being able to feel what others feel" highlighting an ability to share and understand another person's emotional state. Student 2 defines empathy as "concern for others and the environment," pointing to a broader attitude of care that extends beyond individual relationships. Student 3 emphasises "compassion for situations and conditions," suggesting sensitivity to the contextual factors that shape people's experiences. Overall, students portray empathy as a blend of emotional resonance (feeling with others) and attitudinal concern (caring about others' circumtances).

These definitions provide an important backdrop for understanding students' later accounts of classroom experiences. Their description of motivation highlight enthusiasm, support, and self development, elements that resonate with SDT's emphasis on intrinsic motivation, interest, growth-oriented engagement (Deci & Ryan, 2013; Ryan & Deci, 2020). Rather than describing motivation in terms of grades or external rewards, the students focus on feeling energised to learn, receiving support that "restore enthusiasm," and using learning as a way to develop themselves.

Likewise, their definition of empathy align with common educational understanding of empathy as the capacity to feel with others and to care about their situations (Hoffman, 1996). The emphasis on "feeling what others feel," "concern for others,"and "compassion for situations and conditions" mirrors the idea that empathy in teaching involves both affective resonance and recognition of students' specific contexts.

Theme 2: Students' Motivation Shaped by Lecturers' Enthusiasm and Clarity

In response to the second research question, this theme explores how students describe the ways their lecturers' enthusiasm and clarity in teaching shape their own learning motivation in undergraduate physics education. The focus here is on how students experience the lecturer's passion, explanations, and guidance as drivers of their engagement. From the students' accounts, lecturers' enthusiasm is consistently linked to clear explanations and structured guidance. When asked whether their lecturer showed enthusiasm and passion in teaching, all three students responded affirmatively. Student 1 emphasised that the lecturer continuously provides direction and motivation:

> *"My lecturer shows enthusiasm and passion in teaching. For example, when teaching, he continues to give clear directions and continues to motivate us to learn." [Student 1]*

Student 2 highlighted the lecturer's tireless efforts to explain the material and use interactive media to sustain interest:

> *"My lecturer shows enthusiasm and passion, especially during the teaching and learning process, our lecturer is tireless in delivering explanations about the material and is willing to provide input and motivation to us in the learning process, helping us in understanding a material that we have not been able to understand well carefully and patiently, and using interactive learning media so*

> *that we students do not get bored and are also enthusiastic in participating in learning." [Student 2]*

Student 3 added that the lecturer's advice and tasks also contribute to sustaining motivation:

> *"For example, advising in learning." [Student 3]*

> *"For example, the tasks given are very interesting so that my motivation to study to do them is growing." [Student 3]*

Students also explicitly connect this enthusiasm and clarity to their own motivation to complete tasks and persist in learning. When asked to share concrete experiences of whether lecturers' motivation affected their learning motivation, Student 1 and Student 2 described how guidance and encouragement made them feel directed and able to keep going, even in difficult courses:

> *"For example, during learning, the lecturer provides direction or input that supports the project given, I feel directed and enthusiastic in completing the project." [Student 1]*

> *"Based on my experience, the lecturer's motivation during learning makes us enthusiastic in learning, such as for example during certain courses that require mathematical calculations, it is not easy for some students who have deficiencies in their knowledge, they have to study harder than others, of course in this case our lecturer always motivates us to maintain ourselves, mental health and physical health, he motivates that we must also maintain and regulate a healthy lifestyle, and not force ourselves to study in a position that is not good or undesirable because it will only make us sick, so that motivation makes us enthusiastic in learning in our own way and method without having to be pressured and equated with others." [Student 2]*

Descriptively, these excerpts show that students do not separate the lecturer's "enthusiasm" from the way physics is communicated. For Student 1, enthusiasm is visible in the lecturer's behaviour of "continues to give clear directions" and "continuous to motivate us to learn", suggesting that emotional energy and structured guidance are intertwined. Student 2 further elaborates this connection by describing the lecturer as "tireless in delivering explanations", willing to provide input and motivation, and using interactive media so that students "do not get bored and also enthusiastic in participating in learning". Here, enthusiasm is experienced through patient explanation, responsiveness to difficulties, and varied learning resources. Student 3's comments complement these perspectives by shifting attention to advice and task design. The lecturer is perceived as "advising in learning" and assigning "very interesting" tasks that make the student's "motivation to study…growing". This suggests that the lecturer's motivated teaching is not only about how content is explained, but also how tasks are designed to be engaging and meaningful.

The second set of quotes illustrates how these teaching behaviours translate into students' motivation in practice. Student 1 feels "directed and enthusiastic" when the lecturer provides guidance that supports a project, indicating that clear input helps transform potentially demanding tasks into manageable and motivating challenges. Student 2 emphasises the role of motivational messages and care for "mental health and physical healt", particularly in mathematical physics demanding courses. In this account, motivation is not framed as pressure to achieve more, but as support that allows students to learn "in our own way and method without having to be pressured and equated with others".

Interpreted through motivation theory, these findings suggest that lecturers' enthusiasm, clarity, and task design jointly support key psychological needs that underlie intrinsic motivation. SDT emphasises the importance of competence and relatedness, in which students are more intrinsically motivated when they feel capable and when they experience caring relationships with significant others (Deci & Ryan, 2013; Ryan & Deci, 2020). In the students' accounts, perceived competence is fostered through clear directions, patient

explanations, and structured guidance on projects, while relatedness is nurtured through the lecturer's visible passion, encouragement, attention to students' health, and personalised advice.

At the same time, Expectancy-Value Theory proposes that motivation depends on students' expectations of success and the value they attach to the task (Eccles & Wigfield, 2002). The lecturer's efforts to clarify tasks, break down challenging content, and design "very interesting" assignments appear to strengthen both components: students come to believe that they can succeed and that the learning activities are worth doing. Overall, from the students' perspectives, their motivation in undergraduate physics is not simply an individual disposition but is actively shaped by how their lecturer teaches through enthusiastic and patient explanations, clear guidance, and engaging tasks that support both learning and well-being.

Theme 3: Feeling Seen and Supported (Students' Experiences of Lecturer Empathy)

This theme focuses on how students describe feeling "seen" and supported by their lecturer, and how they recognise empathy in everyday classroom interactions. The emphasis here is on concrete practices through which empathy becomes visible to students in undergraduate physics education.

When asked how they notice their lecturer's empathy, the three students pointed to moments of attention, care, and flexibility:

> *"When the lecturer really gives full attention when teaching" [Student 1]*
>
> *"The thing that shows the lecturer's empathy is when they are present in class, where the lecturer accepts student leave with a clear explanation and helps pray for students who are absent due to illness so that they can recover and be able to attend lectures as usual." [Student 2]*
>
> *"When assignments are submitted but past the due date for a logical reason, the lecturer gives tolerance for those who are late in submitting assignments." [Student 3]*

Taken together, these excerpts show that students interpret empathy less as a general personality trait and more as a set of relational actions. For Student 1, empathy is experienced through undivided attention in class, in which the lecturer's "full attention" signals that students' presence and contributions matter. Student 2 highlights the lecturer's consistent presence and understanding of students' life circumstances. Empathy is visible when the lecturer is willing to accept justified absences and even prays for students who are ill, which students read as genuine concern for their well-being beyond academic performance. Student 3 points to flexibility with deadlines when there are "logical" reasons for late submission. Here, empathy is associated with the lecturer's willingness to listen to explanations, take students' situations seriously, and adjust expectations without immediately giving them punishment.

Across the three accounts, students describe a pattern in which they feel seen and supported when the lecturer pays close attention to them, acknowledges their difficulties, and responds in ways that balance academic expectations with human understanding. Empathy, from their perspective, is enacted through being present, caring, and fair. These student narratives resonate with accounts of empathetic teaching that emphasise attentiveness, understanding, and responsive support as core features of caring teacher-student relationships (Meyers et al., 2019). Student 1's emphasis on "full attention" reflects the idea that feeling noticed and listened to is foundational for a supportive learning climate, where students experience themselves as valued participants rather than anonymous learners. Student 2's description of the lecturer accepting legitimate leave and praying for ill students illustrates an extension of care into students' broader lives, consistent with conceptions of empathy as concern for others' situation and emotions, not only their academic performance (Hoffman, 1996).

Student 3's experience of deadline flexibility when there are reasonable explanations exemplifies how empathy can be expressed through pedagogical flexibility. Rather than weakening standards, such flexibility

acknowledges students' diverse circumstances and can help sustain their engagement and sense of fairness (Bock & Goode, 2007). This is also in line with the work on empathetic teaching, which suggests that when students perceive their teachers as understanding and supportive, they are more likely to trust the instructor, participate actively, and remain committed to the course (Meyers et al., 2019). In the context of undergraduate physics education, where concent can be demanding, these forms of empathetic responsiveness appear central to students' experience of "feeling sen and supported", and lay on an important relational foundation for their motivation and persistence.

Theme 4: Tensions (Motivation, Pressure, and Limited Emotional Space)

This theme examines how students' motivation is intertwined with academic pressure and emotional strain in undergraduate physics education. It highlights situations where empathic support from the lecturer helps students cope with discouragement, but within a context where performance expectations remain high.

Student 2 described how she felt when her grades did not reflect her perceived learning, and how the lecturer responded:

> *"There are times when I feel that the grades I get are not in accordance with my learning outcomes, and there I feel down or less enthusiastic in learning, but at times like that my lecturer gives me motivation, helps me accept everything even though it is not in accordance with what is expected but he really appreciates me with my efforts, so my motivation to learn returns and I believe more that in learning the results are important, but the process is very important." [Student 2]*

In this account, Student 2 describes a clear sequence of emotional experiences. First, she encounters a mismatch between the grades she receives and what she believes she has achieved in terms of learning. This perceived injustice leads her to feel "down" and "less enthusiastic in learning," signalling a drop in motivation and confidence. The second part of the quote focuses on the lecturer's empathetic response. Rather than ignoring her disappointment, the lecturer acknowledged her efforts, offered motivation, and helped her "accept everything even though it is not in accordance with what is expected". Student 2 feels that her efforts are "really appreciated", which makes her motivation "return". She ends by re-framing her view of achievement: "the results are important, but the process is very important". Here, the lecturer's reaction does not change the grade itself, but it helps the student reinterpret the experience and regain the desire to continue learning.

This episode sits alongside earlier experiences (see Theme 2 of RQ 2) in which Student 2 described a demanding physics course, especially those involving heavy mathematical calculations, and the need to "study harder than others". In those accounts, the lecturer repeatedly reminded students to maintain their mental and physical health and to avoid being pressured or directly compared to others. Taken together, these narratives show that two coexisting forces shape Student 2's motivation, they are strong academic demands that can lead to feelings of pressure or unfairness, and empathic support that helps her cope with those feelings.

Student 2's story exemplifies the tension between motivation and pressure in demanding physics contexts. On the one hand, grades that feel "not in accordance" with her learning threaten her sense of competence, leading to discouragement and lower motivation. On the other hand, the lecturer's empathetic response by recognising effort, helping her to accept the outcome, and emphasising the importance of the learning process, restores her motivation and redirects her focus from performance to growth.

From a SDT perspective, this episode illustrates how evaluative situations can undermine students' basic psychological needs, particularly competence, but how empathetic teaching can partially repair this by supporting relatedness and reaffirming competence (Deci & Ryan, 2000, 2013; Ryan & Deci, 2020). The lecturer's appreciation of effort and process echoes a mastery-oriented message, consistent with goal-

orientation research that links mastery goals to viewing challenges and setbacks as part of learning rather than as fixed failures.

At the same time, the need for such reassurance, coupled with Student 2's earlier description of having to "study harder than others" and managing health in the face of heavy workloads (Theme 2), suggests that the emotional space to process disappointment is limited. Empathy from the lecturer does not remove structural pressures (grading, comparison, demanding content of physics). Still, it provides brief, meaningful moments in which students can acknowledge feeling "down", feel understood, and then re-engage with learning.

Thus, Theme 4 shows that in this undergraduate physics setting, empathy and motivation are intertwined with tension. Students may be highly motivation, but that motivation is fragile in the face of grades and comparison. Empathetic responses from lecturers help them to recover and reinterpret these experiences, yet they operate within a broader environment where pressure remains a constant background to their motivation.

Perceived interrelationships (RQ3)

Across the interviews, lecturers and students did not talk about motivation and empathy as isolated constructs. Instead, they repeatedly described how lecturers' motivation and empathy shape students' motivation and empathy, and how students' responses in turn feedback into lecturers' motivational energy. The following themes capture these perceived interrelationships.

*T*heme 1: When Lecturers are Motivated, Students Feel More Motivated

This theme explores how participants describe the directional link from lecturers' teaching motivation to students' learning motivation. The focus is on how lecturers' intrinsically driven efforts in teaching are experienced by students as concrete sources of energy, interest, and persistence in studying physics.

From the lecturers' side, both participants described their motivation as shaped by two intertwined sources: a commitment to students' learning and development, and an intrinsic (epistemic) attraction to physics as a discipline. Lecturer 1 explained that when teaching becomes challenging, she deliberately reminds herself of the potential impact she can have on students' learning and seeks collegial and professional support to sustain her teaching energy and perspective. Lecturer 2 described his motivation as also rooted in the intellectual appeal of physics, emphasising natural science as certain and aligned with reason and logic, which he experienced as particularly meaningful and inspiring in his teaching. In other words, their motivation was not only student-oriented but also sustained by enjoyment of, and confidence in, the coherence and rational beauty of physics.

From the students' side, all three participants previously reported that their lecturer's enthusiasm and persistence in teaching directly influenced their own motivation. They mentioned, for example, that the lecturer continually gave clear directions and encouragement, was tireless in explaining difficult material and using interactive media, and designed very interesting tasks that made their "motivation to study" grow.

Taken together, these accounts suggest that lecturers' motivation becomes visible in concrete teaching practices and is sustained by both purpose (supporting students' progress) and passion for the subject (valuing physics as intellectually coherent and reliable). Lecturer 1 anchors their motivation in the anticipated effects of teaching on students' lives and responds to difficulties by actively seeking new pedagogical strategies. This suggests a form of motivation that is sustained not only by enjoyment of physics but by an ethical commitment to students' development. Lecturer 2, by contrast, highlights a more epistemic source of motivation: the certainty, logical structure, and rational beauty of physics. For this lecturer, teaching is energising because it involves sharing a discipline that is intellectually coherent and reliable.

Students, in turn, do not talk about this motivation in abstract terms. They recognise it in what lecturers do. They describe a lecturer who:

- gives continuous and clear directions during learning,
- patiently re-explains the material that many students find difficult,
- uses interactive media so that they "do not get bored" and remain enthusiastic, and
- the tasks are sufficiently interesting to increase their motivation to study.

In their narratives, these behaviours are not neutral techniques; they are interpreted as signs that the lecturer cares, is invested, and genuinely wants them to understand. As a result, students report feeling more "directed", more enthusiastic to complete projects, and more willing to persist in demanding courses, including those with heavy mathematical components.

Thus, the perceived interrelationship described by participants is asymmetrical but dynamic: lecturers' intrinsic motivation leads them to put sustained energy into their teaching, and this energy is picked up by students as increased motivation to engage with physics.

These perceived links are consistent with SDT. SDT argues that intrinsic motivation is fostered when learners experience support for competence, autonomy, and relatedness (Deci & Ryan, 2013; Ryan & Deci, 2020). In this study, lecturers' motivation appears to create precisely this kind of supportive climate:

- Competence is supported when motivated lecturers refine their teaching strategies, give clear directions, break down difficult physics concepts, and design tasks that are challenging yet understandable. Students' comments about feeling "directed" and about tasks that grow their motivation indicate that they feel more capable of succeeding in physics under such conditions.

- Relatedness is supported when lecturers' motivation is expressed through sustained effort and presence, being "tireless" in explanations, willing to give individual input, and investing in engaging media. Students read these behaviours as signs that their understanding matters, which strengthens their emotional connection to the lecturer.

The data also resonate with Expectancy-Value Theory (Eccles & Wigfield, 2002, 2024). Students' testimonies suggest that motivated lecturers increase both:

- Their expectancy of success (because the lecturer's explanations, guidance, and feedback make physics feel more manageable), and

- The value of the tasks (because tasks are "interesting", clearly connected to learning goals, and embedded in a supportive environment).

Seen in this light, lecturers' intrinsic motivation is not simply an individual trait measured on a scale. It functions as a motivational climate that reshapes how students judge the difficulty and worthwhileness of phycis learning. Students' higher motivation is therefore not just a parallel construct but a relational outcome of how motivated teaching is enacted day to day.

Finally, the lecturers' reflections themselves suggest a feedback loop. Lecturer 1's emphasis on finding new strategies and feeling a sense of purpose, and Lecturer 2's satisfaction in teaching a logically coherent discipline, are strengthened when students respond with increased engagement and understanding. This is echoed in your manuscript's synthesis that positive student engagement, fostered by empathetic and motivated teaching, "plays an important role in strengthening lecturers' intrinsic motivation".

In summary, Theme 1 for the RQ 3 shows that, from both lecturers' and students' perspectives, students feel more motivated when their lecturers are motivated, not because motivation magically, but because motivated

lecturers create conditions of clarity, challenge, and relational support that make it easier for students to invest effort, persist, and see value in learning physics.

Theme 2: Empathy as a Link between Teachers' Motivation and Students' Motivation and Empathy

This theme examines how empathy is perceived as the relational bridge between teachers' motivation and students' motivation and empathy. Rather than treating motivation and empathy as parallel traits, participants describe empathy as the channel through which motivated teaching becomes meaningful, emotionally safe, and, over time, shapes students' own empathic orientations.

From the lecturers' side, empathy is not described as a vague feeling but as a deliberate practice that is monitored and adjusted. Lecturer 1 explained that they systematically evaluate their empathetic interactions by using end-of-lecture evaluations and individual consultations, and by watching for positive changes in students' attitudes and performance as signs that empathy is working:

> *"I usually use Google Forms for evaluation, usually at the end of lectures and during face-to-face discussions when students are consulted. I also look for positive changes in student attitudes and performance." [Lecturer 1]*

Lecture 2 emphasised fairness and responsiveness as the core of effective empathy, stating that they assess their empathetic practice by checking whether their actions are objectively fair and responsive to students' needs, rather than relying only on feelings:

> *"I measure how well my empathetic interactions with students are working by being as fair and responsive as possible in my actions as a lecturer. While feelings are involved in social interactions, it's important to objectively observe how we respond to students' needs and whether our actions are fair to everyone." [Lecturer 2]*

Both lecturers explicitly link this empathetic stance to motivation. They report that empathetic understanding of students' needs helps them design more tailored instruction and build trustful relationships, and that positive student engagement arising from empathic interactions strengthens their intrinsic motivation to teach.

From the students' side (as presented earlier in the Results), empathy is experienced when lecturers give full attention in class, accept legitimate reasons for absence, pray for students who are ill, and show flexibility with deadlines when there are "logical reasons" for delay. In those situations, students reported feeling more motivated to participate and more emotionally connected to the lecturer, and some described becoming more aware of the importance of supporting friends and empathising with the lecturer's own struggles.

Taken together, these accounts show empathy operating at three interconnected levels. First, for lecturers, empathy is presented as an intentional extension of their motivation. Because they are motivated to teach well and to have a positive impact, they make a conscious effort to understand students' needs and to adapt their behaviour. Lecturer 1 does this by collecting feedback through Google Forms and Conversations, and by watching for concrete changes (improved attitude, better participation) as evidence that empathy is effective. Lecture 2, in turn, emphasises the need to be consistently fair and responsive, signalling that for them, empathy must be anchored in just and thoughtful action rather than in emotion alone.

Second, from the students' perspective, empathy has immediate motivational consequences. When lecturers give full attention, accept absences with understanding, pray for their recovery, or allow deadline flexibility in difficult circumstances, students interpret these as signs that they are seen as whole persons rather than just academic performers. They report feeling more willing to attend, more enthusiastic to complete tasks, and more able to cope when grades or life conditions are discouraging. Empathy, in their stories, transforms the emotional tone of learning from the pressure and fear of judgment into safety and encouragement.

Third, empathy also appears to shape students' own empathy. Students described how listening to their lecturer's stories of struggle made them empathise with the lecturer's economic and educational challenges and appreciate the value of supporting peers:

> *"Based on my personal experience, my lecturer told me that his struggle to achieve his degree was not easy, support and encouragement for friends is very valuable and needed, and that's where I feel that good friendship and caring for each other are very influential in our achievements." [Student 2]*

> "When the lecturer tells my career experience, I empathize with the lecturer's economic condition." [Student 3]

They not only felt cared for, but they also began to care about the lecturer and their classmates, seeing friendship and mutual support as "very valuable and needed" for collective achievement.

Finally, this process turns back on lecturers. Both lecturers state that when students respond positively by engaging, taking agency in their learning, and showing growth, this reinforces their own intrinsic motivation and encourages them to continue teaching empathically. In other words, empathy is not simply a one-way expression of motivated teaching. It generates student responses that feed back into teachers' motivation.

These patterns align closely with the theoretical grounds. From an SDT perspective, empathy appears as the mechanism through which teachers' intrinsic motivation becomes motivationally effective for students. When lecturers seek to understand students' needs, act fairly, and respond to their circumstances, they are direclty supporting relatedness (students feel understood, valued, and emotionally safe) and competence (students receive appropriately tailored support, encouragement after disappointing grades, and flexibility that allows them to continue engaging rather than disengaging.

Both of these needs are central to fostering intrinsic motivation (Ryan & Deci, 2020), which is consistent with students' reports for renewed enthusiasm and willingness to participate after empathic responses from their lecturers. At the same time, the student accounts of "empathy increasing" when lecturers give full attention, share personal struggles, and talk about the importance of caring for friends are congruent with social learning perspectives. When lecturers model empathy (toward students and toward their own past difficulties), students learn to see empathy as part of what it means to be a good learner and peer in physics. They begin to mirror this stance in their own relationships, empathising with the lecturer's situation and valuing mutual support among classmates.

On the lecturers' side, the finding shows that motivated teachers appear to be more empathic, in which intrinsic motivation "*enhances their empathic skills, enabling them to understand better and respond to the needs of their students*," and empathic interactions, in turn, strengthen their motivation through positive student engagement. This suggests a bidirectional dynamic: motivated teachers invest in empathy; empathy improves student motivation and empathy; students' engaged and empathic responses then reinforce teachers' motivation.

In sum, this theme deepens the picture of interrelationships by showing that empathy is the linking process between teacher and student characteristics. It is through empathic practices (paying close attention, acting fairly, adjusting expectations, and sharing struggles) that teachers' intrinsic motivation becomes visible and influential in students' motivation and empathy. At the same time, these empathic practices create a feedback loop: as students feel supported, become more engaged, and develop their own empathy, they re-energise lecturers' intrinsic motivation to continue teaching physics in caring, responsive ways.

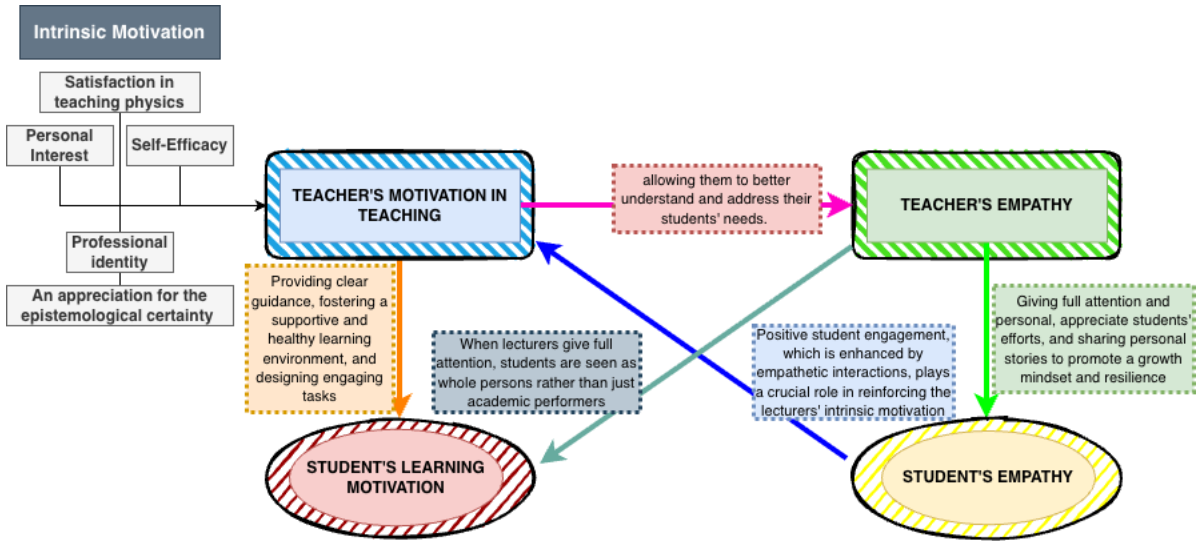

Figure 1. Interrelationships between Teachers' Motivation, Empathy, and Students' Motivation and Empathy in Undergraduate Physics Education

These interconnections are synthesized in **Figure 1**, which presents a qualitative model of how teachers' primary and secondary motivation, their empathic practices, and students' motivation and empathy form a mutually reinforcing system in undergraduate physics education. **Figure 1** does not introduce new constructs but visually organises the pathways identified across the themes for RQ 3 and the three levels of empathy discussed above.

LIMITATION & FUTURE RESEARCH

This study has several limitations that should be considered when interpreting the findings and planning future research. Substantively, the analysis focuses on how teachers' motivation and empathy are perceived to shape students' motivation and empathy. Still, it does not systematically examine the reverse pathway from students' learning motivation to their empathy toward peers and lecturers, so future studies should explore how different motivational profiles relate to students' empathic attitudes and behaviour in demanding physics settings. Subsequently, a key limitation is the small and bounded sample (two lecturers and three students from two classrooms), which limits the range of perspectives and relationship patterns that could be identified. With more participants across different courses and cohorts, additional views and potentially different forms of motivation-empathy interrelationships might emerge. Therefore, the findings should be interpreted as context-bound and illustrative rather than representative of broader physics education populations. Future studies should include larger and more diverse samples across multiple classes and institutions to examine variation and transferability. Furthermore, the data also come entirely from self-reported interviews that may be affected by recall and social desirability bias, so future research could triangulate interviews with classroom observations, course artefacts, and short reflective diaries to capture how motivation and empathy are enacted in everyday practice. Finally, this study is cross-sectional and interpretive and offers only a snapshot of perceived interrelationships at one point in time, so longitudinal, design-based, or quasi-experimental studies would be useful to trace how teachers' and students' motivation and empathy co-evolve over semesters and to test specific interventions that build on the qualitative model proposed here.

CONCLUSION

This study has illuminated how lecturers and students in an undergraduate physics education programme make sense of the interrelationships between teachers' and students' motivation and empathy. The findings indicate that lecturers mainly describe intrinsic motivation, grounded in enjoyment of physics, professional identity, and concern for students' futures, as their primary driving force, while external rewards play only a supporting role. When this motivation is enacted through empathic practices such as adapting explanations, providing clear guidance, designing engaging tasks, paying close attention, acting fairly, and acknowledging students' personal circumstances, students experience physics learning as more understandable, meaningful, and emotionally safe. They report feeling more motivated to persist with difficult, mathematically intensive content and gradually becoming more empathic toward lecturers and peers. At the same time, the data reveal tensions in situations where strong academic expectations and performance pressures coexist with limited emotional space, suggesting that motivation without empathy can be experienced as pressure rather than support. Overall, the study suggests that in undergraduate physics, empathy is a key linking process that make teachers' motivation visible and influential in students' motivation and empathy, while students' engaged and empathic responses in turn help sustain lecturers' intrinsic motivation, which points to the importance of pedagogical and professional development initiatives that intentionally cultivate both motivation and empathy in physics teaching and learning.

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