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Enhancing Student Engagement in Physics Education through Autonomy-Supportive Intervention Program: An Experimental Study in Jaffna Educational Zone

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ABSTRACT

Student engagement in physics education is a persistent challenge, particularly in the Jaffna district of Sri Lanka, where traditional teacher-centered approaches limit autonomy and intrinsic motivation. Grounded in Self-Determination Theory (SDT), this study examines the impact of an Autonomy-Supportive Intervention Program (ASIP) on students' engagement in junior secondary physics education. The study employed experimental design with Jaffna Educational Zone all grade seven public school science teachers (n = 60) and their 559 students (experimental group male =126, female=153, total=279 and control group male =145, female=135,total=280) were selected as the samples such that one teacher from each school where the number of students in grade 7 is greater than 4 and if number of teachers more than one in a school one teacher was selected by randomly toasting to ensure a balanced and representative for the generalizability of experimental findings. Teachers were randomly assigned to either an experimental group (n = 30, male =7, female=23), which underwent the 17-week ASIP, or a control group (n = 30, male =7, female=23), which received no intervention. The intervention included professional development workshops that trained teachers in autonomy-supportive teaching strategies. Quantitative findings from the Student's Learning Climate Questionnaire (LCQ) revealed a significant increase in student-reported autonomy support in the experimental group ($p < 0.001$, $\eta^2 = 0.970$). Thematic analysis of qualitative interviews with five students of experimental group identified key themes such as increased student choice, initiative, and engagement in hands-on learning activities. The results underscore the effectiveness of ASIP in fostering autonomy-supportive instructional behaviours, leading to enhanced student motivation and deeper learning in physics. This study contributes to the growing body of research advocating for autonomy-supportive pedagogical practices in physics education and offers practical recommendations for teacher training and curriculum design.

Keywords: Student engagement, physics education, autonomy-supportive teaching, Self-Determination Theory, instructional intervention.

1. INTRODUCTION

Physics education plays a crucial role in fostering scientific literacy and problem-solving skills. However, student engagement in physics learning remains a significant challenge, particularly in Jaffna district, Sri Lanka. Traditional teacher-centred approaches, coupled with a lack of student autonomy, contribute to decreased motivation and interest in physics [1]. Autonomy-supportive teaching (AST), grounded in Self-Determination Theory (SDT) [2], emphasizes student choice, meaningful learning experiences, and intrinsic motivation.

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Autonomy-supportive teaching, rooted in Self-Determination Theory [3], has gained attention as an effective approach to fostering student motivation, engagement, and learning outcomes. The following reviews existing literature on autonomy-supportive teaching, its applications in physics education, and the significance of teacher professional development in resource-constrained settings.

SDT was first conceptualized by Deci and Ryan [3], who distinguished between intrinsic and extrinsic motivation. The theory posits that individuals are most motivated when their psychological needs for competence, autonomy and relatedness are fulfilled[2]. Autonomy-supportive teaching involves instructional practices that nurture these needs, such as providing meaningful choices, acknowledging students' perspectives, and minimizing controlling behaviours[4]. Studies have consistently shown that autonomy-supportive teaching enhances intrinsic motivation, engagement, and academic performance [2,5]. For instance, Reeve et al. (2004) found that students in autonomy-supportive classrooms displayed higher levels of curiosity, persistence, and satisfaction compared to those in controlling environments [6]. These findings underscore the potential of autonomy-supportive teaching in addressing student disengagement, a common issue in science education.

Consistent with self-determination theory (SDT), people possess inherent psychological needs that, when valued and maintained by the social context, it will bring fully capable of energizing their engagement, positive functioning, and well-being in their activity or tasks [3,7]. The social context best appreciates and supports people's psychological needs through the facility of autonomy support [7,1]. When autonomy supportive, science teachers tend to (1) take the perspective of their students as clients to engage students in lessons (e.g., conduct formative assessments to ask what they want, need, think, and prefer); (2) introduce activities to bring that vitalize and support (rather than neglect or frustrate) the psychological needs; (3) provide explanatory rationales for their requests to make

all the students' success in the lessons; (4) communicate using informational (rather than pressuring) language to make good relationship with teacher; (5) acknowledge and accept expressions of negative affect; and (6) display patience[8-11]. These six acts of autonomy-supportive behaviour are all positively intercorrelated, mutually supportive, and synergistic[12,9]. Collectively, they convey an interpersonal message of support and understanding (e.g., "I am your ally; I am here to support you and your strivings.") that others generally find to be need supportive [10].

In the context of Physics instruction, teacher-provided autonomy support benefits both students and teachers. As to student benefits, students taught by autonomy-supportive physics teachers, compared to those taught by control-supportive physics teachers, experience higher-quality motivation (i.e., greater need satisfaction and greater autonomous motivation, lesser need frustration and lesser amotivation) and display numerous educational benefits, such as greater classroom engagement, conceptual learning, skill development, academic achievement, and psychological well-being [8,13-18]. Further, physics students' high-quality (autonomous) motivation has been linked to multiple indicators of their classroom and leisure time physics related activity levels (e.g., accelerometers, pedometers, heart rate, self-report, raters' observations. As to teacher benefits, science teachers who participate in (autonomy-supportive intervention program) ASIP, compared to science teachers in a no-intervention control group, report greater post-intervention teaching motivation (need satisfaction, autonomous motivation, and intrinsic goals), teaching skill (teaching efficacy), and teaching well-being (vitality, job satisfaction, lesser emotional and physics related exhaustion) [12]. As SDT researchers became increasingly aware of the benefits of autonomy-supportive teaching, they began to design intervention programs to help science teachers learn how to become more autonomy supportive during instruction [14,6].

An autonomy-supportive intervention program (ASIP) is a step-by- step plan of action to help

teachers become more autonomy supportive toward students. When science teachers participate in carefully designed, theory-based (self-determination theory) ASIPs, they learn how to become more autonomy supportive [9-24]. Further, this intervention enabled changes in teachers' autonomy-supportive motivating style tend to be more than just temporary or situationally induced changes, because follow-up investigations show that these teachers continue to show a highly autonomy-supportive style one year later [14,6]. The conclusion from about a dozen carefully designed and implemented ASIPs is that these teacher-focused interventions produce large and enduring effect sizes [21].

Given these benefits, Reeve and colleagues explored why ASIPs work, focusing on teacher beliefs, contextual pressures, personality factors, cultural context, and administrative support (22–24). Among these, teacher beliefs are most malleable and responsive to intervention.

Reeve et al. proposed seven instructional behaviours shown below.

Autonomy-supportive instructional behaviour definition and example

PERSPECTIVE TAKING

1. Take the Students' Perspective Definition: The teacher sees and experiences classroom events and activities as if he or she were the students (rather than the teacher).
Example: Conduct formative assessments, such as starting a class (or activity) by soliciting students' input into the forthcoming lesson and then integrating those suggestions into the lesson plan.

SUPPORT INTRINSIC MOTIVATION

2. Invite Students to Pursue Their Personal Interests   Definition: Invite and encourage students to pursue their own personal interests and goals.
Example: Begin a lesson on the electrostatic in Physics by asking, "What would you like to know about the electric charges?" Students might then take the lesson in a personally interesting direction, "How did charges play?"

3. Present Learning Activities in Need Satisfying Ways   Definition: Present a learning activity in a way that creates an opportunity for students not only to learn new information but also to experience autonomy, competence, or relatedness satisfaction while doing so.
Example: Offer students a choice: "Here is a list of several different topics you may write your essay on."

SUPPORT INTERNALIZATION

4. Provide Explanatory Rationales Definition: Introduce teacher requests, procedures, and rules by explaining their usefulness so that students will see each request's personal benefits, be more open to accept it, and be more willing to engage it.
Example: "Let's use respectful language, because we want a classroom that is welcoming, safe, and supportive for everyone."

5. Acknowledge and Accept Negative Feelings Definition: First, acknowledge that a teacher request may be at odds with students' preferences; then, accept that any aroused negative feelings may have potential legitimacy.
Example: "I see that everyone looks bored about today's lesson (i.e., acknowledge negative feelings). "Yes, we have practiced this same routine many times, haven't we?" (i.e., accept negative feelings as understandable reactions).

6. Rely on Invitational Language Definition: When making an engagement request and when helping students diagnose a problem, use a tone of voice (higher, softer pitch) and word choice that communicates understanding and support. Minimize pressure ("you must," "you have to") while conveying choice and volition.
Example: "You may want to conduct a Google search. You might find it helpful."

7. Display Patience   Definition: Show an optimistic calmness as students struggle to start and adjust their behaviour.
Example: Watch, listen, be responsive to students' initiatives, communicate your willingness to help, and await a student generated signal that your help would be welcomed and appreciated.

In physics education, autonomy-supportive strategies enhance conceptual understanding and problem-solving skills [17]. Research indicates that students who perceive their teachers as autonomy-supportive develop greater intrinsic motivation and a deeper appreciation for science [18]. However, teacher training in autonomy-supportive pedagogy is essential for sustaining these benefits [14].

Research objectives

Despite extensive evidence supporting ASIPs positive impact on student engagement and academic performance [21], its implementation in Sri Lanka remains limited. To fill this gap this study investigates how an Autonomy-Supportive Intervention Program (ASIP) influences student engagement and motivation in junior secondary physics education in Jaffna. And the objectives are.
1. To investigate the impact of ASIP on students perceived autonomy support in physics learning.
2. To examine students' qualitative perceptions of autonomy-supportive learning environments.
To achieve the objectives the following research questions were built up.
1. To what extent does the Autonomy-Supportive Intervention Program (ASIP) influence students perceive autonomy support in physics learning?
2. How do students qualitatively perceive and describe autonomy-supportive learning environments in their physics classrooms?

2. METHODOLOGY

2.1 Participants and Design

The study employed experimental design with Jaffna Educational Zone all grade seven public school science teachers (n = 60) and their 559 students (experimental group male =126, female=153, total=279 and control group male =145, female=135,total=280) were selected as the samples such that one teacher from each school where the number of students in grade 7 is greater than 4 and if number of teachers more than one in a school one teacher was selected by randomly toasting to ensure a balanced and representative for the generalizability of experimental findings. Teachers were randomly

assigned to either an experimental group (n = 30, male =7, female=23), which underwent the 17-week ASIP, or a control group (n = 30, male =7, female=23), which received no intervention. Experimental group received 17 weeks of three parts workshops with ASIP training, and the control group (n = 30), which followed traditional teaching methods. A mixed-methods approach was used, combining pre-test and post-test surveys with qualitative interviews.

2.2 Intervention: Autonomy-Supportive Instructional Program (ASIP)

ASIP consisted of a three-phase professional development program:
1. Awareness Training (Part 1 three hours) – Teachers were introduced to AST principles and empirical evidence.
2. Role-Playing and Experience Sharing (Part 2 three hours) – Teachers engaged in collaborative discussions and simulated autonomy-supportive interactions.
3. Discourse of classroom Implementation and challenges (Part 3 three hours) – Group Discussion.

2.3 Tools

Validated standard tools were used and internal consistency was proofed by Cronbach alpha as shown in the Table 1.

Table 1. Reliability of the scale

Tools	Cronbach's alpha	Number of items
Student's LCQ [10]	0.964	6

All Cronbach's alpha values were above the recommended threshold of 0.70 [25], indicating high internal consistency and reliability of the scales. The results confirmed that all instruments were reliable and suitable for the main study.

2.4 Data Collection and Analysis

2.4.1 Quantitative Measures

Students completed the Learning Climate Questionnaire [10] to assess perceived autonomy-supportive teaching before and after the

intervention. Data were analysed using ANOVA and effect size calculations.

Qualitative Measures

Semi-structured interviews were conducted with five students from the experimental group. Thematic analysis followed Braun and Clarke's[26] framework, identifying first-order and second-order codes.

3.RESULTS AND DISCUSSIONS

3.1 Quantitative Findings

Students completed to report their perceptions of their teachers' autonomy-supportive at the beginning, and end of the term. Typically, students complete the Learning Climate Questionnaire to assess perceived autonomy-supportive teaching. With these scores in hand, researcher plotted students' scores on perceived autonomy-supportive teaching over time. At Time 1 (T1, before the intervention) scores for students of teachers in the experimental and control groups do not differ significantly, because teachers have been randomly assigned into condition and because it is still the first week of classes (i.e., teacher-student interactions have not yet taken place).
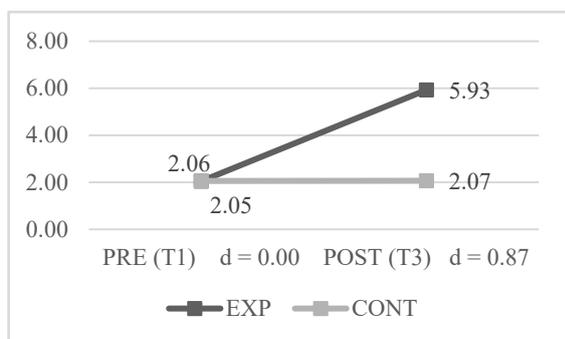

Figure 1. Students' Mean Scores for Perceived Autonomy-Supportive Teaching Engagement Broken Down by Experimental Condition and Time of Assessment

This graph (Figure 1 and Figure 2) displays the mean pre-test and post-intervention students' engagement scores for the experimental (EXP) and control (CONT) groups. A bar graph illustrates the pre- and post-intervention scores for the experimental and control groups. In the experimental group, there is a marked increase in scores from pre-intervention (M ≈ 2) to post-

intervention (M ≈ 6). In contrast, the control group shows relatively stable scores, with only a slight increase from pre-intervention (M ≈ 2) to post-intervention (M ≈ 2).
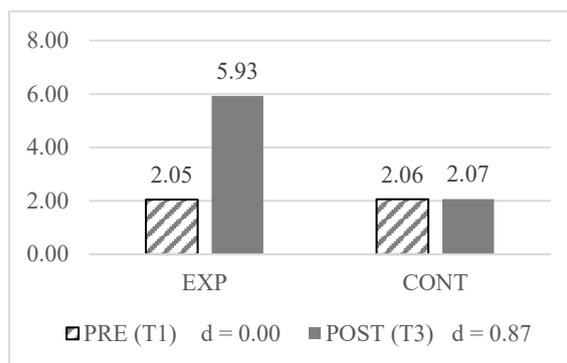

Figure 2. Comparison of Student Pre- and Post-Intervention Scores

As shown in Figure 1, the consistent finding is that students of teachers in the no-workshop control condition (the grey line) show unchanged scores on the measure of perceived autonomy-supportive teaching. That is, teachers in the control condition begin the school term with some level of an autonomy-supportive motivating style and they generally maintain that same style month after month (Mean scores at T1, and T3, = 2.06, and 2.07, using a 1–7 scale). In contrast, students of teachers in the experimental condition perceive a rising level of autonomy support from their teachers throughout the school term, as can be seen in the solid line. That is, like the teachers in the control group, these teachers begin the school term with some level of an autonomy-supportive motivat¬ing style, but their participation in the workshop leads them to be perceived by their students as significantly more autonomy-supportive by the end of the term (T3). In fact, students perceive a rather dramatic jump in perceived autonomy-supportive teaching during the end of the term (see the upwardly sloped solid line from T1 to T3). Thereafter, students perceived autonomy-supportive teaching continues to rise a little more by the end of the academic term (T3), presumably because teachers continue to develop a more autonomy supportive style month-after-month (Mean scores = 5.93).

The capacity of the ASIP to increase autonomy supportive teaching was first assessed by asking

students to report their perceptions of autonomy-supportive teaching. Students of teachers who participated in ASIP rated the teacher higher on autonomy supportive teaching than did students of teachers who did not participate in ASIP it is proofed by the following Statistics.

In this study, the unit of analysis was defined at the class level, with each teacher and their respective students considered as one unit. Accordingly, data were aggregated to reflect the experiences of students within each teacher's class, thereby allowing comparisons between the experimental and control groups to be conducted at the class-unit level. Prior to conducting the ANOVA, the assumptions of normality and homogeneity of variances were tested. The Shapiro–Wilk test indicated that the distribution of scores did not significantly deviate from normality for either the experimental or control groups at both pre-test and post-test ($p > .05$). Levene's test for equality of variances further confirmed that the assumption of homogeneity of variances was met ($p > .05$). Thus, the data satisfied the necessary assumptions for conducting the ANOVA.

At pre-test, there were no significant differences between the experimental (M = 2.05) and control groups (M = 2.06). At the post-test, the experimental group demonstrated a substantial increase in perceived autonomy support (M = 5.93), while the control group remained stable (M = 2.07). ANOVA results confirmed a statistically significant effect of the intervention ($F(1,58) = 1885.962$, $p < 0.001$, $\eta^2 = 0.970$).

Cohen's d indicated a large intervention effect (d = 0.87), supporting previous findings that autonomy-supportive interventions significantly impact student motivation (Reeve & Cheon, 2016).

3.2 Qualitative findings

First-order codes were derived from explicit participant statements, and second-order codes captured broader, interpretative patterns. Themes were then synthesized from the second-order codes.

3.2.1 First-Order Codes

Students

• Appreciation for being asked for input (e.g., "I liked it when my teacher asked for my opinion.")
• Enjoyment of choices (e.g., "I chose diagrams because I like drawing.")
• Positive responses to supportive feedback (e.g., "My teacher said it's okay to try again.")
• Increased interest in science through creative activities (e.g., "We did experiments with springs and wooden blocks. It was fun.")

3.2.2 Second-Order Codes

Students

• Empowerment through choice and voice.
• Relevance of tasks as a motivator.
• Positive feedback as a confidence booster.
• Creative and hands-on activities as engagement tools.

Themes

The following themes were construucted.
Students' interview responses highlighted how the seven autonomy-supportive instructional behaviours influenced their engagement:

1. Providing Choice – Students valued selecting tasks that interested them, increasing engagement.
2. Encouraging Initiative – Students expressed enthusiasm for contributing ideas in discussions.
3. Offering Rationale – Understanding the relevance of physics concepts boosted motivation.
4. Acknowledging Feelings – Students appreciated teachers validating their struggles and progress.
5. Minimizing Control – A less controlling classroom climate reduced stress and increased participation.
6. Using Non-Controlling Language – Encouragement rather than pressure led to greater willingness to learn.
7. Fostering Interest – Hands-on activities and experiments made learning more engaging.

These findings align with previous research, demonstrating that autonomy-supportive

teaching fosters intrinsic motivation and conceptual understanding.

3.3 Implications

Educational Implications

1. **Teacher Training Programs:** Implementing autonomy-supportive instructional practices in teacher professional development programs can enhance physics instruction and increase student engagement.
2. **Curriculum Design:** Science curricula should integrate autonomy-supportive strategies, such as inquiry-based learning and student-cantered activities, to promote intrinsic motivation.
3. Classroom Environment: Schools should foster a culture that supports autonomy by minimizing controlling instructional methods and encouraging self-directed learning.
4. Assessment Strategies: Evaluations should include formative assessments that allow students to demonstrate their understanding in multiple ways, fostering autonomy and competence and relatedness.

3.4 Policy Implications

1. Educational Policy Reforms: Policymakers should prioritize autonomy-supportive teaching in national education policies, promoting student engagement and well-being.
2. Professional Development Requirements: Mandatory professional development workshops on autonomy-supportive teaching should be introduced for science educators.
3. Resource Allocation: Schools should receive support in terms of instructional materials and training to implement autonomy-supportive teaching effectively.

4.0 CONCLUSION

This study provides empirical support for the effectiveness of the Autonomy-Supportive Intervention Program (ASIP) in fostering autonomy-supportive teaching practices in physics education within the Jaffna Educational Zone. The experimental design allowed for a clear comparison between the intervention and control groups, demonstrating that participation in ASIP significantly improved students' perceptions of autonomy support and their classroom engagement. By incorporating the seven autonomy-supportive instructional behaviours, teachers in the Jaffna context were able to create a more engaging and motivating physics learning environment, thereby enhancing student motivation and learning outcomes.

While the findings underscore the potential of ASIP to strengthen student engagement and autonomy support, the study is not without limitations. The sample was confined to one educational zone, which may limit the generalizability of results to broader contexts. Future research could extend this work by replicating the intervention in other regions, exploring long-term impacts, and examining additional subject areas. Such efforts would further validate the robustness and applicability of autonomy-supportive teaching practices in diverse educational settings.

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