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Research Article

Enhancing students' behavioural and cognitive engagement through active learning strategies in physics

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The study investigated the impact of active learning strategies such as constructivist teaching strategies, activity-oriented lessons, asking thought-provoking questions and discovery learning on students' behavioural and cognitive engagement. The study employed a pre-experimental design type of one-group pretest-posttest design. Data were collected using a five-point Likert scale from 25 class IX students. The same Likert scale question with a 5 scale was employed before and after a four-week intervention of active learning strategies. The findings revealed that after the implementation of active learning strategies students' behaviour and cognitive engagement have significantly improved. Students exhibited improved enthusiasm, motivation and active participation in the class consequently leading to higher level of behavioural engagement. Furthermore, students showed an improved willingness to tackle challenging tasks in the class, thereby improving cognitive engagement. By facilitating better student engagement, students participate in challenging tasks and exhibit motivated attitudes during the teaching and learning process. The study is significant in understanding the positive impact of active learning strategies on behavioural and cognitive engagement. The study primarily recommends that teachers in Bhutanese middle secondary schools implement active learning strategies to facilitate student engagement. Active learning strategies, such as activity-oriented lessons, asking thought-provoking questions, and constructivist teaching strategies lead to interactive teaching and learning processes. However, the study was limited to one school and focused on only physics classes, and the sample size was relatively small.

Keywords: Active learning strategies, Behavioural engagement, Cognitive engagement, Middle secondary schools

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1. Introduction

Student engagement is one of the key indicators in gauging students' attitudes toward teaching and learning processes, further behaviours and attitudes of the student are directly related to instruction and curricular activities in an academic institution (Delfino, 2019). Moreover, student engagement relates to students' energy, enthusiasm and motivation in academic work and participation by students (Christenson et al., 2012). Additionally, student engagement indicates the relationship between students' motivation and zeal to participate in academic and instructional activities. Furthermore, students' engagement also leads to behaviours such as collaboration and enjoyment of the task resulting in satisfaction and enhancing learning performance (Pérez-López et al., 2020). Student engagement is a collaborative effort between students and organizations lead to a mutually beneficial result (Peters et al., 2018).

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There are numerous definitions of student participation that are attributable to the situation and the perspectives of multiple practitioners and researchers. The history of student engagement over the past 30 years might reveal the existence of multiple definitions of student engagement as researchers apply, and observe different phenomena, consequently drawing numerous conclusions (Wheaton, 2021). Moreover, the definition of student engagement differs from the perspectives of the researcher and the level of detail being analysed, observed and measured, a concept referred to as 'grain size' (Sinatra et al., 2015). Broadly, researchers have acknowledged three critical components of student engagement: behavioural, affective, and cognitive engagement (Fredricks et al., 2004; Trowler, 2010). According to Khan et al. (2021), behavioural engagement refers to behaviours such as presence, participation and being on task, whereas cognitive engagement refers to preparedness to learn and encounter challenges.

The primary determining factor in students' success in higher education, considered student engagement important in the last decade by researchers, practitioners and school administrators (Burke, 2019; Kahu & Nelson, 2017; Lee, 2014). While evaluating the efficiency of the teaching and learning process, student engagement plays a pivotal role (Groccia, 2018). It significantly affects persistence, in-depth learning, student satisfaction, and academic achievement (Christenson et al., 2012; Halverson & Graham, 2019; Kahu, 2013; Mandernach, 2015). Moreover, student engagement is determined by different contexts, including environmental distinctions and strategies employed by a teacher (Bond & Bedenlier, 2019; Kahu, 2013). As such, it is essential to investigate how teachers' strategies foster student engagement. Similarly, Ministry of Education and Skills Development [MoESD] of Bhutan recently changed the curriculum to make it student-centred fostering student engagement. However, enough anecdotal records show that teachers still play a dominant role, thereby not engaging students productively. Therefore, it is crucial to examine the impact of active learning strategies on students' behavioural and cognitive engagement.

1.1. Literature Review

In this section definitions of behavioural and cognitive engagement of students and their significance in academic activities in the school and classrooms in particular were illustrated. Further, it discussed teachers devising teaching strategies and pedagogies to effectively engage students. According to Delfino (2019) student engagement is broadly categorized into three dimensions consisting of behavioural, emotional and cognitive domains. Fredricks et al. (2004) noted that student engagement is multifaceted, where studies and literature categorised into behavioural, emotional and cognitive engagement

The term behavioural engagement describes students' involvement in both academic and extracurricular school activities (Delfino, 2019). The behavioural engagement of the students refers to the multidimensional concept that pertains to students' behaviour in classroom activities, especially participation in school activities accompanied by motivation in academic activities (Hospel et al., 2016; Nguyen et al., 2018). Further, students' classroom behavioural and involvement school-related activities are passive behavioural engagement however, motivation in academic-related activities such as asking questions and discussing in classroom is active behavioural engagement (Kang & Wu 2022). Behavioural engagement has multiple benefits academically and non-academically. Earlier studies have shown a noticeable relationship between student behavioural engagement and academic scores (Klem & Connell, 2004; Lee, 2014). For example, Klem & Connell (2004) explored a correlation between student engagement and academic achievement and found out that students engaged in academic activities perform better than students less engaged. Besides, a relationship exists between accomplishment and student engagement (King & Gaerlan, 2014). Further, King and Gaerlan (2014) noted that the higher the students' positive emotions, the more engaged the students were. Thus, students' behavioural engagement plays a paramount role in student academic activities.

Cognitive engagement has different operationalised definitions. The extensively employed definition of cognitive engagement is a psychological investment (Wehlage & Smith, 1992). Students are cognitively engaged when they are psychologically invested, such as using flexible problem-solving and choosing challenging tasks (Sinatra et al., 2015). According to Sinatra et al. (2015) the definition of cognitive engagement overlaps with definitions of behavioural engagement. It includes readiness and reflection to understand the challenging ideas and skills required (Fredricks et al., 2004). Heng (2013) noted a significant relationship between cognitive engagement and academic achievement. For example, students' learning strategies linked with cognitive engagement are associated with achievement (Park, 2005). Finally, possessing more self-belief in a task is also linked to greater cognitive involvement (Schunk & Mullen, 2012).

In schools across Bhutan, science lessons necessitate the participation of the students in order for them to retain the experiences and use the knowledge in their daily life (Dorji, 2019). Similarly, a study conducted by Dorji and Chophel (2022) in one of the Bhutanese middle secondary Chemistry classes revealed that the

students learn better, foster collaboration, and activate support system among the learners through activity-oriented lesson. However, the Bhutanese classrooms are mostly dominated by teachers playing key role in imparting knowledge, thereby students were not engaged effectively in the classes. Further in the class, students are reluctant to participate thereby clearly indicating students' lack of motivation and enthusiasm to engage in teaching and learning process. Therefore, it clearly demonstrates that teachers fail to engage students sufficiently. Moreover, studies and research indicate that it is teachers' way of teaching that fosters students' active engagement (Cothran & Ennis 2000; Smith et al., 2005).

Generally, teaching and learning process in the class consists of teacher-dominating classes in Bhutan. According to Rabgay (2018), the conventional approach, which uses chalk and a whiteboard coupled with lecture method that only imparts knowledge, still dominates classroom teaching and learning in Bhutan. Correspondingly, in Physics class, the teacher plays a central role by mostly explaining the concepts which leads to minimally engaging students. Further, students hardly ask questions and take responsibility for their learning. Therefore, teachers play a central role in the teaching and learning process. Moreover, it was observed that teaching methods influence students' critical thinking and engagement levels by arousing their curiosity and interest (Kinley & Pradhan, 2022). Hence, it is crucial to determine the impact of active learning strategies on students' behavioural and cognitive engagement.

1.2. Research Questions

Based on the review of literature on student engagement; behavioural and cognitive engagement and in line with the primary objectives of the research the study sought to answer following questions:

RQ 1) Does a significant difference exist between pretest and posttest scores in terms of behavioural engagement for class IX students in Physics classes?

RQ 2) Does a significant difference exist between pretest and posttest scores in terms of cognitive engagement for class IX students in Physics classes?

2. Method

The study examined an improvement in behavioural and cognitive engagement after the provision of active learning strategies. To examine the impact of active learning strategies on students' behavioural and cognitive engagement, the study employed a pre-experimental design type of one-group pretest-posttest design (single group pretest-posttest), whereby one group pretest-posttest consisting of the prearranged group constituted a research sample (Trisnawati & Fathoni, 2023). The single group was measured and compared both before and after the intervention. Furthermore, in experimental research, the effect of one or more variables on the other variable is validated or tested. The independent variable consists of active learning strategies for 4 weeks whereas the dependent variable consists of students' behavioural and cognitive engagement.

2.1. Participants

The participants of the study consists of all 25 students in class IX at Trashigang Middle Secondary School for the academic year 2023. Out of 25 students, 15 students were male and 10 students were female. According to preset criteria, participants were chosen for the study using the criterion sampling approach, one of the purposive sampling techniques, which was used to select participants for the study (Gezer, 2021). Participants attended physics classrooms that employed active learning strategies as an intervention. The lessons were delivered to the participants as per the Instructional guide [IG] designed by the Department of Curriculum and Professional Development [DCPD] under the Ministry of Education and Skills Development of Bhutan.

2.2. Instruments

The study adopted the Likert scale question with a 5 scale. The behavioural engagement scale [BES], and cognitive engagement scale [CES] were used to collect study's data. The instrument was developed by Sherab (2015) in the study titled " Strategies for encouraging behavioural and cognitive engagement of pre-service student-teachers in Bhutan: an action research case study". The original questionnaire has 5 focus areas offering chances for communication channels, active learning strategies, care by tutors, behavioural engagement and cognitive engagement. For this study only two focus areas were chosen, namely behavioural and cognitive engagement. All items were in the affirmative and rated on a 5-point, Likert-type scale from "not at all true" to "always true,". This study's cognitive engagement is confined to intellectual engagement related to academic activities (see Appendix 1).

For the BES the scale was formed on a 5-point, Likert-type scale composed of 5 items. The minimum score for the scale was 5, while the maximum score was 25. A good score on the posttest for BES indicated that students had improved after the implementation of active learning strategies. Similarly, the CES was also 5 point, Likert-type scale composed of 9 items. The minimum score for the scale was 9, while the maximum was 45. In the same vein, a strong posttest result for the CES showed that students' engagement had maximised as a result of their involvement in active learning strategies.

2.3. Procedure

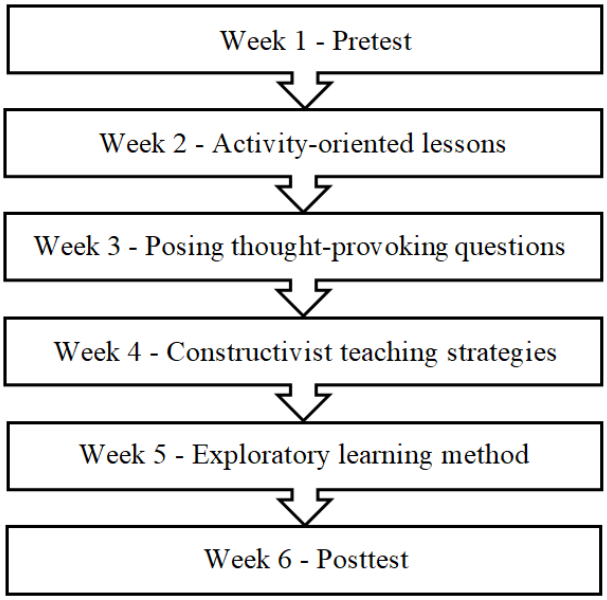
After obtaining the necessary ethical clearance for the study, participants were chosen based on the criterion sample method where participants were briefed about the voluntary nature of the study (Çelik & Alpan, 2022). To collect data from the experimental process participants were administered test before and following their participation in the active learning strategies. Three periods (consists of 40 minutes) are allotted for Physics classes in a week as per directives of the Department of Curriculum and Professional Development under the Ministry of Education and Skills Development.

Active learning involves instructional approaches where students are actively engaged in receiving information through discussion and collaboration, as opposed to passively receiving information (Lee et al., 2018). The active learning strategies included activity-oriented lessons, asking thought-provoking questions to make students discuss and think, and making use of constructivist teaching strategies (carousal, think–pair–share, Rally Robin, Mix-Pair-Share and Quiz-Quiz Trade). The Lesson also included more discovery learning by students searching for information from the internet for the particular topics taught. To make the lesson interactive, the researcher facilitated the classes.

The research procedure comprises several distinct phases. Week 1 involves administering a pretest, while Week 2 focuses on the implementation of interventions, such as activity-oriented lessons. In Week 3, the emphasised on posing thought-provoking questions to encourage student discussion and critical thinking. Moving to Week 4, the approach incorporates various constructivist teaching strategies like carousal, think–pair–share, Rally Robin, Mix-Pair-Share, and Quiz-Quiz Trade. Week 5 introduces a more exploratory learning method, with students tasked to search for information on specific topics from the internet. Throughout these weeks, the lessons were designed to be predominantly student-centred rather than teacher-centred. Finally, in Week 6, a posttest was administered to participants following the successful implementation of intervention strategies.

The phases of the research procedure presented in Figure 1.

Figure 1
Phases of research procedure



2.4. Data Analysis

The data were analysed using descriptive statistics and paired sample t-test. Prior to data analysis, incorrect and missing data were checked. A preliminary analysis was done to evade the potential destruction in data analysis, since web-based surveys lessen the possibility of any missing data, the study contains no missing values. (Hair et al., 2010). Normal distribution was checked for an assumption of paired sample t-test thus determining the statistical method for the data analysis. Both measures of the dependent variable must be normally distributed for running paired sample *t*-test (Taşpınar, 2017). According to Field (2009) and Morgan et al. (2004), indicators of a normal distribution where z scores should not exceed 1.96 (at $p < .05$) and skewness and kurtosis values between −1 and +1, respectively.

Table 1
Results for normality

Scale	*Test*	*Skewness*	*SE*	*z-score*	*Kurtosis*	*SE*	*z-score*
BES	Pretest	.176	.464	0.379	−.123	.902	−0.136
	Posttest	.294	.464	0.634	−.074	.902	−0.082
CES	Pretest	−.305	.464	−0.657	−.567	.902	−0.629
	Posttest	−.245	.464	−0.528	−.859	.902	−0.952

Hence, paired samples t-test were performed to examine the impact of the treatment by comparing the mean pretest and posttest scores in terms of behavioural and cognitive engagement. To this end, the statistical hypotheses for the first sub-problem were formulated as follows:

H_0: There is no significant difference between pretest and posttest scores in terms of behavioural engagement.

H_1: There is a significant difference between pretest and posttest scores in terms of behavioural engagement.

For the second sub-problem statistical hypotheses were formulated as follows:

H_0: There is no significant difference between pretest and posttest scores in terms of cognitive engagement.

H_1: There is a significant difference between pretest and posttest scores in terms of cognitive engagement.

Based on the outcome of the paired sample *t*-test results at the significance level of 0.05 the alternative (H_1) hypothesis was accepted and the null hypothesis (H_0) was rejected. The difference was demonstrated to be significant using Cohen's d, which is a measure of effect magnitude. According to Cohen (1988), effect sizes with an index value of .2, .5, or .8 were small, medium, or large.

3. Results

To examine the first and second sub-problems of the study, paired sample *t*-test was performed to examine whether or not behavioural and cognitive engagement levels significantly differed prior to and following the completion of the active learning strategies. Table 2 presents the result of the *t*-test.

Table 2
Paired samples t-test results for differences between pretest and posttest scores

Variable	*Test*	*n*	*Mean*	*SD*	*df*	*t*	*p*	*d*
Behavioural engagement	Pretest	25	2.78	.597	24	−8.644	.000**	1.7
	Posttest	25	4.18	.536				
Cognitive engagement	Pretest	25	2.84	.538	24	−6.426	.000**	1.3
	Posttest	25	4.12	.734				

Note. $^{**}p <.000$ (critical value).

Concerning the first sub-problem behavioural engagement indicated that their posttest (M = 4.18, SD = .536) was significantly higher than pretest (M = 2.78, SD = .597) with $t(24) = -8.644$, $p < 0.5$ (Table 1). In line with the second sub-problem of the study, concerning cognitive engagement indicated that their posttest (M = 4.12, SD = .734) was significantly higher than the pretest (M = 2.84, SD = .538) with $t(24) = -6.426$, $p < 0.5$ (see Table 1).

Cohen (1988) claimed that the effect size for *t*-test measurements is small at a value of d =.2, medium at a value of d =.5, and high at a value of d =.8. Cohen's d value revealed that for behavioural engagement had a high impact size (d = 1.7), and similarly, cognitive engagement had a large impact size (d = 1.3). Hence Cohen's d was calculated to interpret the effect size and was found to be significant.

The null hypothesis which suggests that there is no significant difference between pretest and posttest scores of students in terms of behavioural and cognitive engagement was rejected as value p was lower than a significant level, α ($p < .05$). Also, we can conclude that behavioural and cognitive engagement significantly improved after an intervention of active learning strategies.

4. Discussion

The study examined the effectiveness of active learning strategies on behavioural and cognitive engagement. The result revealed that implementation of active learning strategies had a positive impact on behavioural and cognitive engagement. This may be explained by students' positive attitudes and good values towards curricular and academic activities in the school. According to Delfino (2019) student engagement is one of the most important metrics for assessing students' attitudes toward the teaching and learning process; in addition, a student's behaviour and attitude are closely tied to the curriculum and instructions awarded in any academic setting. Additionally, according to Christenson et al. (2012), student engagement refers to students' vigour, passion, and motivation in their academic work and participation. However, in Bhutanese settings, teachers frequently use lecture methods and chalkboards for the teaching and learning process (Rabgay, 2018).

This study showed that employing active learning strategies significantly improved the behavioural engagement of students. Improvement in behavioural engagement after active learning strategies can be attributed to student's active participation in class discussions, and providing of avenues for students to express their thoughts. The term "behavioural engagement" refers to a multifaceted idea that concerns students' behaviour in classroom activities, particularly participation in curricular activities coupled with motivation for academic pursuits (Hospel et al., 2016; Nguyen et al., 2018). Additionally, students' behaviour in school and in the classroom is passive behavioural engagement, but motivation in academic-related activities like asking questions and participating in class discussions is active behavioural engagement (Kang & Wu, 2022). Thus, students actively participate in academic works such as classroom discussions, clearly articulating during discussions with friends and teachers.

The current study result indicated that cognitive engagement of students was quite low prior to the intervention of active learning strategies. After the intervention, students' cognitive engagement was found high. This could be because students were engaged in motivated behavior such as engaging in challenging activities. When students are psychologically engaged, such as when employing flexible problem-solving and selecting difficult problems, they are cognitively engaged (Sinatra et al., 2015). Cognitive engagement entails willingness and taking time to consider in order to comprehend the difficult concepts and abilities needed (Fredricks et al., 2004). The result of the study concurs with that of Wen (2021) who noted that there is an improvement in students' cognitive engagement when students were actively engaged in designing challenging activities using augmented reality-supported activities. Thus, engaging in behaviour like participating in difficult tasks encourages cognitive engagement.

5. Limitations and Recommendations

The study has proven the effectiveness of active learning strategies on behavioural and cognitive engagement of students in grade 9 of middle secondary school in Bhutan. Therefore, teachers teaching in middle secondary schools and teachers in general can adopt active learning strategies. Active learning strategies include activity-oriented lessons, asking thought-provoking questions, facilitating students' discussion, and making use of constructivist teaching strategies (carousal, think–pair–share, Rally Robin, Mix-Pair-Share and Quiz Quiz Trade).

There are virtually no empirical studies conducted on the impact of active learning strategies on behavioural and cognitive engagement in the global scenario, similarly, in Bhutan there are no studies on the aforementioned topic conducted at the Middle Secondary level. Therefore, there is a need, to conduct more studies on the effectiveness of active learning strategies on behavioural and cognitive engagement in other disciplines and confirm its effectiveness in the Bhutanese context. Furthermore, more studies need to be conducted at different educational levels to gauge and include more sample size of the study.

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Appendix 1. Baseline survey questionnaire on classroom engagement of class IX Students in Biology classes

Trashigang Middle Secondary School.

This survey question collects information on active engagement, behavioural and cognitive engagement. All the information collected will be confidential. Please feel free to share your honest and frank opinion on the classes that I have conducted with you till date. You do not have to write your name.

I. Your gender (tick or circle the appropriate) **Male**

Female

Other

I. Please read each statement below and decide how much it describes YOU with regard to the BEHAVIOURAL ENGAGEMENT (in learning and academic tasks) in the class. Then circle the appropriate number.

1 = The statement is **not at all** true of me.
2 = The statement is **slightly** true of me.
3 = The statement is **moderately** true of me.
4 = The statement is **mostly** true of me.
5 = The statement is **always** true of me.

(1) I actively participate in class discussions	1	2	3	4	5
(2) I visit library for additional knowledge on the concept or idea taught by the teacher	1	2	3	4	5
(3) My language is good enough to express doubts and participate in class discussions	1	2	3	4	5
(4) Whenever I have some free time I get engaged in academic work	1	2	3	4	5
(5) I show great care in completing the learning task provided in the class	1	2	3	4	5

II. Please read each statement below and decide how much it describes you with regard to the COGNITIVE ENGAGEMENT in the class. Then circle the appropriate number.

1 = The statement is **not at all** true of me.

2 = The statement is **slightly** true of me.

3 = The statement is **moderately** true of me.

4 = The statement is **mostly** true of me.

5 = The statement is **always** true of me.

(1) I have a desire to learn more than what is taught by the teacher	1	2	3	4	5
(2) I am a believer of hard work	1	2	3	4	5
(3) If I don't understand something, I make sure that I work at it until I do understand	1	2	3	4	5
(4) I have a strong desire to master knowledge and skills taught in the class	1	2	3	4	5
(5) I always feel that I should do better than peers in the class	1	2	3	4	5
(6) I do not divert my attention when the teacher is teaching	1	2	3	4	5
(7) I enjoy doing challenging activities in the class	1	2	3	4	5
(8) I get more encouragement when I fail to understand/learn something in the class	1	2	3	4	5
(9) I get reenergized when I fail to do class works/assignments	1	2	3	4	5

III. Please feel free to share your comments and suggestions on the following open-ended questions.

If you agree (above) that you have not been able to make many contributions in the class discussions during Biology classes, what would be some of the possible reasons from your opinion? (Contribution in the class discussions would mean that whenever a teacher asks questions to the class you voluntarily respond, sharing your opinions and experiences willingly, asking questions for clarifying doubts, etc.)

What are some of the strengths that you have noticed in your Biology teacher?

What are some of the weaknesses that you have noticed in your Biology teacher that you want him to improve?

Do you have any other additional comments and suggestions with regard to my teaching that you have not covered above?

This is the end of questionnaire.

Thank you very much for your valuable comments and suggestions