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Inquiry-Based Stem Education: Fostering Active Learning Through Student Engagement

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ABSTRACT - This exploratory case study investigated how orientation-phase activities can enhance students' engagement in the classroom and hence increase their academic performance. The participants involved consists of three diverse group: A Dual Language Programme (DLP) student, a remedial student, and a student with dyslexia. Over a period of four weeks, these students were employed with three to eight minutes orientation-phase activities incorporating physical and mental activities in their Malay Language lessons. A mixed-method approach which involves quantitative and qualitative data collection was used in this study. the quantitative data was gathered using a pre- and post-test whereas the qualitative data was collected using pre- and post-interviews with students, benchmarking observation, and teacher reflections. The results showed clear improvements in test scores for all the participants after the intervention was carried out. The qualitative findings have revealed that students were motivated, attentive, less disruptive and highly engaged throughout the lesson when the intervention was employed. Overall, the study suggests that orientation-phase activities can be simple yet very effective way to prepare students cognitively, nurture positive learning attitudes, and improve academic outcomes.

INTRODUCTION

In an effective lesson, the orientation phase which often referred to as set induction plays a vital role in engaging students at the very beginning of learning (Othman & Kassim, 2016; Johnston, 2010). Typically lasting three to five minutes, this stage carried out at the start of the lesson (Hashim et.al, 2005). Beyond introducing the day's topic, the orientation phase also serves to boost students' motivation, foster a positive attitude toward the lesson, provide a brief overview of what will be delivered (Mohamed & Jasmi, 2021; Othman & Kassim, 2016). According to Hunter & Russell (1976, as cited by Mohamed & Jasmi, 2021; Johnston, 2010; Ishak et al., 2012), a variety of methods can be employed during this stage to attract students' attention and prepare them for effective learning such as showing pictures, cartoon, visual, graphic, concept map, telling stories and showing a discrepant event.

PROBLEM STATEMENT

Despite its proven importance, the orientation phase is often overlooked by educators, or carried out in ways that are irrelevant, unattractive, and monotonous (Halim et al., 2022). In contrast, research has shown that when this phase is implemented effectively, students either remain attentive to the teacher's storytelling or actively respond to questions and prompts, indicating higher engagement and readiness to learn (Halim et al., 2022; Mohamed& Jasmi, 2021). In this sense, a well- planned orientation phase not only captures learners' attention but also enables them to build initial understanding of the lesson, thereby fostering meaningful participation throughout the learning process (Azubike, 2021; Ishak et al.,

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In general, the orientation phase can be viewed as a form of mental warm-up for both teacher and students before the lesson begins (Sukri & Purwanti, 2016). This aligns with behaviourist learning theory, where teaching is seen as a process of stimulus and response (Thorndike, as cited in Asfar et al., 2019). In this context, orientation phase serves as the stimulus, while students' reaction reflects the responses (Sandy et al., 2021). Effective orientation, therefore, is more likely to generate positive learning behaviours. Conversely, a poor executed orientation can result in passive or minimal responses, reducing the overall impact of teaching (Halim et al., 2022; Mohamed& Jasmi, 2021).

According to Kilue & Ariffin (2017), activities involving physical and mental enhances active learning among students. If such activeness is established at the beginning of the lesson, it can sustain students' engagement throughout the lesson (Sandy et al., 2021). In addition, when students develop a positive attitude towards the teacher, a happy mood and eagerness to learn are created (Sandy, 2021). This positive climate indirectly nurtures curiosity and encourages students to ask more questions from the very beginning of the lesson, guiding them towards inquiry-based learning (Mardhiyana & Sejati, 2016). Such engagement increases concentration, enhances memory and ultimately facilitates the application of knowledge daily life (Othman & Kassim, 2016).

Past studies have also highlighted that enjoyment in learning is closely tied to engaging teaching strategies, including those used in the orientation phase (Jamian & Ismail, 2016). Lessons that begin with creative, stimulating activities not only foster excitement but also make the entire learning experience more meaningful. However, many teachers still rely on traditional, predictable approaches that fail to spark curiosity or active involvement (Halim et al., 2022).

This gap indicates the need for innovative practices in the orientation phase, particularly those that integrate problem-solving and manipulative skills. In this study, a short daily intervention was introduced before the lesson, where students were given 3-8 minutes of IQ-based challenges such as drawing symmetrical patterns with both hands or completing diagrams without looking at it. These activities were designed not only to stimulate the brain and activate psychomotor coordination (Acosta et al., 2023) but also to create a positive emotional climate that triggers healthy hormonal responses (Yilmazer, 2024). By doing so, the intervention aims to increase students' engagement from the very beginning of the lesson, optimize knowledge absorption, and ultimately enhances academic performance.

OBJECTIVE

This study was conducted to test the following objectives:

1. To examine the effectiveness of orientation-phase activities in enhancing students' engagement during lessons among diverse learners
2. To investigate the impact of orientation-phase activities on the academic performance among diverse learners
3. To explore students' perception of the orientation-phase activities among diverse learners after the intervention period

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RESEARCH METHODOLOGY

Research Design

This study employed an exploratory case-study design with mixed-methods elements to examine the effectiveness of orientation-phase activities among diverse learners. An exploratory case study was chosen because the intervention involved a new approach, implemented with a small number of participants, and within a context where limited prior research exists. The study integrated both qualitative and quantitative data collection methods: interviews and classroom benchmarking (qualitative), alongside pre- and post-tests (quantitative).

Ethical considerations were addresses prior to the commencement of the study. Approval letters were obtained from the respective school administrations, and consent forms were signed by the students' parents to ensure voluntary participation. Confidentiality and anonymity were maintained throughout the research process.

Participants

According to Piaw (2020), the number of participants in case study depends on the research questions and the nature of the research problem. Exploratory case studies in particular are suitable for small samples. Therefore, this study involved three participants with diverse learning abilities:

- One high-achieving student (brilliant student),
- One remedial student, and
- One student with a learning disability (OKU-dyslexia).

All three participants were 10-year-old boys from the same town. The brilliant student, who was enrolled in the Dual Language Programme (DLP), and the remedial student were from the same mainstream school. Both were suggested by their subject teachers based on their low motivation and passive classroom engagement despite their academic potential. The third participant, a student with dyslexia, was selected with the assistance of a partner teacher from a school offering a Special Need Integration Programme (Program Pendidikan Khas Integrasi, PPKI).

The participants were selected from the same gender to minimize further diversity variables (e.g., gender differences), allowing the study focus specifically on differences arising from learning profiles.

Intervention

The intervention was carried out over a period of four weeks during Malay Language lessons. Since the student with special needs only attended Malay language classes twice a week, the same schedule was applied to the DLP and remedial students for consistency.

At the beginning of each lesson, for a duration of three to eight minutes, the students were given warm-up activities designed to stimulate both mental and physical engagement. Examples of these activities included:

- Drawing symmetrical patterns with both hands simultaneously,
- Drawing shapes without directly looking at the paper,
- Grouping coloured balls withing a set time limit, and
- Joining dots in a diagram following specific rules.

After completing the warm-up activities, the lesson proceeded as usual. During each session, benchmarking of students' engagement was conducted, starting from the beginning of the lesson and continuing until the end.

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The procedure of the intervention is as simplified below.

1. Before Intervention
    - Administration of a pre-test consisting of 20 items (grammar, vocabulary and comprehension)
    - Semi-structured interviews with participants to capture their initial perception, attitude, motivation and engagement in the lesson

2. During Intervention
    - Before lesson: Orientation-phase warm-up activities for 3-8 minutes
    - During lesson: Continuous observation and benchmarking of students' engagement levels along the lesson

3. After intervention
    - Administration of the post-test using the same set of questions as in the pre-test.
    - Follow-up interview with participants to explore perceived changes in motivation, engagement and attitude after the intervention
    - Short reflective interviews with the subject teachers to provide additional perspective on students' engagement and classroom behaviour

Data Collection Method

The study adopted a mixed-method approach for data collection which are quantitative and qualitative dataset.

Quantitative data

The quantitative data is collected twice which are before and after the intervention as followed.

- A pre-test consisting of 20 questions which was administered before the intervention
- The same test was administered as a post-test after the four-week intervention

The test items were developed by a certified End Session Akademic Test Item Construction Master Trainer (Jurulatih Utama Pembina Item UASA), ensuring content validity and appropriate difficulty level which is suitable for the different streaming students. Both tests were given 30 minutes to complete.

Qualitative Data

Three types of data were collected under qualitative dataset as follows:

- Semi-structured interviews which were conducted with each participant before intervention and after intervention. The questions focused on students' motivation, engagement and attitude toward learning Malay Language. Similar questions were used for pre- and post- intervention to track changes in perception.
- Benchmarking Observation was carried out during intervention lessons by both researchers. Engagement indicators included attentiveness, participation, responsiveness and enthusiasm. Notes and checklists were used to document observations systematically.
- In addition to student-based data (pre- post- tests, interviews and benchmarking), short reflective interviews were conducted with the students' teachers. These aimed to validate classroom observations and provide an additional perspective on students' engagement and behaviour during the intervention.

Data Analysis Method

For the quantitative data collection, the pre- and post- scores were compared for each participant whereby the results were analysed descriptively to identify the academic impact of the intervention. Although the sample size was too small for inferential statistics, the descriptive analysis provided

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meaningful insights into individual progress.

On the other hand, for the qualitative data, there are two types of data collected, interview and benchmarking. The interview transcripts were coded and thematically analysed to identify recurring themes related to students' motivation, perceptions and attitudes toward the orientation-phase activities. Observational notes were analysed to track engagement patterns across lesson.

Triangulation

According to Denzin (1978), and Creswell & Creswell (2018), the credibility, validity and trustworthiness can be enhanced by employed triangulation in a study. Thus, several forms of triangulation were applied in this study.

1. Methodological triangulation (Ediyanto et al., 2025; Carter et el., 2014; Bekhet & Zauszniewski, 2012)
    - Both quantitative and qualitative data were used. Quantitative evidence was gathered through pre- and post- tests, while qualitative insights were obtained from semi-structured interviews and benchmarking of engagement.
    - This integration provided a comprehensive understanding of both academic performance and learner experiences.

2. Participant triangulation (Ediyanto et al., 2025; Carter et el., 2014;)
    - The study involved three participants with distinct learning profiles: a high- achieving student, a remedial student and a student with dyslexia.
    - This variation allowed cross-comparison across different learner types, strengthening the applicability of findings to diverse educational contexts.

3. Researcher triangulation (Ediyanto et al., 2025; Carter et al., 2014; Denzin, 1978)
    - Classroom observations and engagement benchmarking were cross- validated with the input of a teacher from main-stream school and teacher from the Special Needs Integration Programme (PPKI).
    - This collaboration minimizes individual observer bias and increased reliability.

4. Data Triangulation (Ediyanto et al., 2025; Carter et al., 2014)
    - The data source was collected from multiple sources
    - Students: pre-test, post-test, pre-intervention interview, and post- intervention interview
    - Researchers: benchmarking observation
    - Subject teachers: Reflective reviews

5. Time triangulation (Ediyanto et al., 2025)
    - Data were collected at multiple stages: before the intervention (baseline pre- test and interview), during lessons (observation and benchmarking), and after the intervention (post-test and interview).
    - This ensured consistency of findings over four-week period rather than being limited to a single event.

6. Theory triangulation (Ediyanto et al., 2025; Carter et al., 2014; Denzin, 1978)
    - The interpretation of results drew upon the Behaviourist Theory by Thorndike by testing the stimulus-response principle
    - Specifically, Needham's Five-Phase Model (Orientation, Elicitation, Restructuring, Application and Review) guided the design of the intervention. The *Orientation Phase* was employed in this study because it goes beyond just grabbing attention but it set the context, sparks curiosity and prepare learners physically and mentally.

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RESEARCH FINDINGS

This research employed both quantitative and qualitative methods. The findings are presented below.

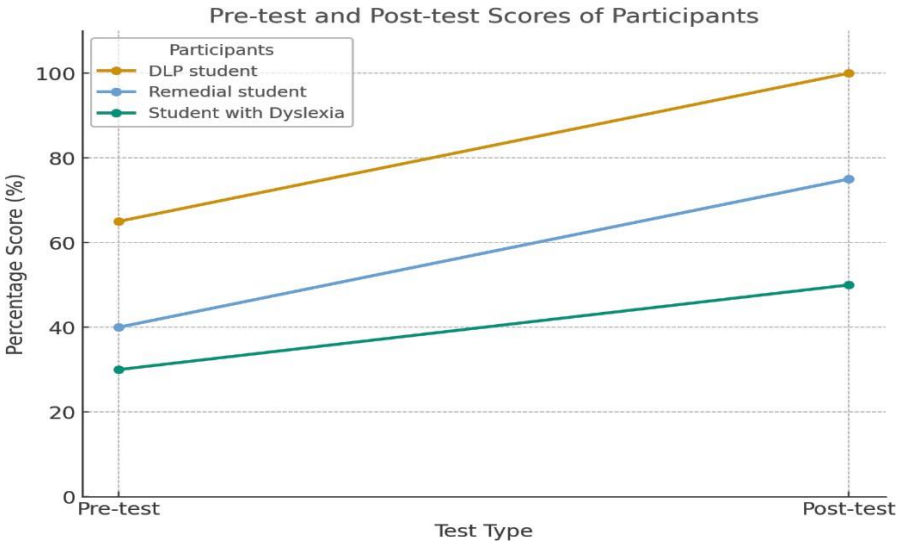
Quantitative data

For the quantitative data, pre- and post-tests consisting of 20 multiple choice questions (covering the grammar, vocabulary and comprehension items) were administered to all three participants. The results are presented in table 1.

Table 1 The results of pre- and post-tests of the participants

Participants	Pre-test		Post-test	
	Score	Percentage (%)	Score	Percentage (%)
DLP student	13	65	20	100
Remedial student	8	40	15	75
Student with Dyslexia	6	30	10	50

Figure 1 The results of pre- and post-test scores of the participants



The results clearly show an improvement in post-test scores for all three participants compared to their pre-test results. This indicates that the orientation- phase intervention positively contributed to their academic performance.

Qualitative data

Three types of qualitative data were collected: pre- and post-interviews with participants, benchmarking observation during the lessons, and reflective interviews with the students' teachers.

Student interviews

Pre-intervention interviews revealed a general lack of motivation among all three participants. The DLP and remedial students reported preferring physical activities over classroom-based learning, while the student with dyslexia admitted to losing focus only a few minutes after lessons began.
In contrast, the post-intervention interview showed a clear shift. All participants reported being more engaged and able to follow lessons effectively. The remedial and dyslexia students in particular highlighted that they felt "present" throughout the class and were less prone to distraction. This suggests

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that the orientation-phase activities helped sustain their attention and engagement.

Benchmarking observations

Observation data further supported these findings. From the first day of intervention, the DLP and remedial students demonstrated enthusiasm and actively engaged in classroom activities. The student with dyslexia, however, showed noticeable improvements only after the third intervention session, and by the sixth session, his engagement and motivation were consistently evident.

Reflective interview with teachers

This interview was done informally from the subject teacher to further validation of the findings. The DLP student's teacher noted that the student showed increased motivation, engagement, and positive classroom behaviour, with fewer instances of disruption. The remedial student's teacher reported greater attentiveness and a willingness to ask questions, reflecting curiosity and eagerness to learn. Similarly, the teacher of the student with dyslexia expressed satisfaction that the student could now remain focused and engaged for the duration of the lesson, showing marked improvement in attitude and participation.

SUMMARY OF FINDINGS

The combination of quantitative and qualitative findings demonstrates that orientation-phase activities were effective in enhancing students' academic performance and engagement.

1. Academic performance: All three participants showed significant improvement in their post-test scores, indicating that the intervention contributed to better mastery of grammar, vocabulary and comprehension.
2. Engagement and motivation: Students reported higher levels of focus, interest and enjoyment in lesson, with reduced passively and distraction.
3. Positive attitudes: Participants developed more positive perceptions of their teachers, lessons and classroom activities.
4. Validation from teachers: Teacher reflections confirmed the observed changes in student engagement and behaviour further strengthening the credibility of the findings.

In short, the orientation-phase intervention effectively supported diverse learners-including high achieving, remedial and special need students by improving both their academic outcomes and classroom engagement.

DISCUSSION

This study is an exploratory case study which is set out to address the problem of low engagement and limited motivation among students during lesson. The study involves three diverse learners who are a Dual Language Programme (DLP) student, a remedial (pemulihan) student and a special need student (dyslexia) from two different schools. The intervention was carried out twice a week for four weeks. Same intervention was employed to all the three students for three to eight minutes before lesson. The intervention involved orientation-phase activities designed to stimulate both cognitive and psychomotor skills before the main lesson began. Quantitative data (pre- and post-test) and qualitative data (pre- and post-interview with participants, benchmarking observation, and reflective interviews with teachers) were collected to strengthen the findings of the study.

The findings demonstrate that incorporating orientation-phase activities positively influences both engagement of the students in the lesson as well as their academic performance across diverse learners. The increase in post-test scores compared to pre-test among the three participants indicates that the intervention had a positive impact on their concentration and understanding of the lesson. This supports the argument that meaningful beginning of a lesson can optimizes students' readiness to absorb new knowledge (Mohamed & Jasmi, 2021); Halim et al., 2022).

Results from the qualitative data has revealed that students became more motivated, attentive and focused throughout the lesson during the days when the intervention was carried out. This pattern is in

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align with previous studies that emphasize the importance of engaging orientation activities in stimulating curiosity, promoting inquiry-based learning, and sustaining attention (Mardhiyana & Sejati, 2016; Othman & Kassim, 2016). Similarly, a study by Kilue and Ariffin (2017) has found that activities involving both physical and mental simulation contribute to active involvement of students in classroom activities, which was evident in the present study whereby the participants showed positive attitude towards the lesson, engage well in the lesson and show high motivation.

The progress of the student with dyslexia is particularly notable, whereby the student initially struggled to give focus but has gradually started to demonstrate engagement and motivation from the third session of the intervention. This result is in line with the findings of a study by Ibrahim et al. (2021), who highlighted that the special need students often face problems in the aspect motivation, engagement and paying attention during class, yet they can show significant improvements when teachers adapt lessons to meet their need. In addition, the benchmarking results from this study is also similar to the statement by Abdullah et al. (2018), who has mentioned that the learning environment and instructional approach are the core factors of the success of a learning process.

Apart from this, the findings of this study also consistent with the behaviourist theory by Thorndike's stimulus-response principle, whereby the intervention activities in the orientation-phase act as the stimuli and students' attitude, focus, motivation and classroom behaviour function as the responses (Asfar et al., 2019). The benchmarking results further validated by the results of reflective interviews with subject teachers which proved that after the intervention activities during orientation-phase, students became less disruptive, motivated to learn, show interest in engaging themselves in classroom activities, and show traits of good understanding of the lesson.

In general, this study has proved that diverse learners showed good engagement in classroom, develop positive attitude towards the subject, increase motivation to learn which eventually increases their academic performance due to the intervention employed to them. therefore, it proved that the orientation-phase activities are not merely introductory activities for the students but stimulate effective teaching and learning process.

IMPLICATION

The findings of this study have many theoretical and practical implications as follows:

1. Theoretical Implication: The behaviourist theory by Thorndike's Stimulus- Response Theory along with application of Needham's Five Phase Constructivism Model were applied in this study which proved to be very practical and effective in teaching and learning.
2. Practical Implication: The structured orientation-phase activities involving physical and mental stimulation in the beginning of the lesson is very practical to be implemented by teachers to increase students' engagement along the lesson flow. By embedding these strategies in lesson plans provide simple but great effect in students' performances.
3. Future research: The findings of this study has highlighted the needs to carry out future researches across wider scope.

CONCLUSION

This exploratory case study on academic performance through orientation- phase engagement among diverse learners has provided significant results. The intervention has enhanced students' motivation, attitude, readiness to learn, engage students towards the lesson and significantly improve their academic performance. By stimulating cognitive, physical and emotional readiness during the orientation-phase of a lesson, the teaching and learning process can be optimized.

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LIMITATION

Despite the important outcome of this study, it has several limitations as stated below:

1. Small sample size: The sample size is very small to ensure the generalizability of the findings.
2. Short intervention period: The intervention was only carried for four weeks duration which may not capture the long-term sustainability of the outcome.
3. Single subject focus: The intervention was carried out in one subject only.
4. Contextual limitation: The intervention was tested with specific age group from the same locality and with same gender which may influence the transferability of the results.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest. This includes financial, political, personal, or professional relationships that could be perceived as influencing the content or conclusions of this manuscript.

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AUTHORS CONTRIBUTION

All listed authors have made a significant scientific contribution to the research in the manuscript, approved its claims, and agreed to be an author.

DECLARATION OF GENERATIVE AI

During the preparation of this work, the authors used ChatGPT (OpenAI) to enhance the clarity and readability of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

ETHIC STATEMENTS

Not applicable.

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