The effectiveness of online teaching and learning compared to in-person instruction in science for junior secondary students: a case study in the Kurunegala education zone

A eficácia do ensino e aprendizagem online comparada ao ensino presencial em ciências para alunos do ensino fundamental ii: um estudo de caso na zona educacional de Kurunegala

La eficacia de la enseñanza y el aprendizaje en línea en comparación con la instrucción presencial en ciencias para estudiantes de educación secundaria: un estudio de caso en la zona educativa de Kurunegala

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ABSTRACT
Schools and Universities in Sri Lanka have been closed intermittently during the past three years due to COVID-19 and fuel shortages. During this period, in-person teaching became impossible, and online teaching was developed. However, schools have been reopened for in-person teaching and learning at present. In contrast, other countries adopted both methods, online and in-person. It was noticed that a decline in test scores among junior secondary students in some education zones during online learning. This study aimed to assess and compare the effectiveness of online and in-person teaching and learning science among junior secondary students in a selected school within the Kurunegala education zone. The study objectives were to 1) conduct both online and in-person science lessons for two groups separately and compare grade-eight students' performance in both settings; 2) compare teacher-student interaction, learning resources, peer group interaction, and motivation in both settings; and 3) make suggestions for effective teaching and learning process. Two equally weighted courses were used to teach the two groups. Convenience sample of 72 Grade 8 students was used in the data collection with mixed methods approach. Pre-tests, post-tests, and questionnaires were used in the quantitative data collection. Qualitative data were collected via interviews with ten randomly selected students. The findings revealed that the performance scores of in-person group in Unit 4 (Properties of Matter) of grade-eight Science evaluation were slightly higher than that of online group. Both groups demonstrated similar performance
levels in Unit 8 (Changes in Matter). However, in-person teaching exhibited significantly higher scores (p < 0.05) than the online group for factors such as teacher-student interaction, peer group interaction, learning resources, and motivation. Students achieved high results in both settings but needed more resources, reliable internet facilities, and adequate technology skills for online teaching and learning. The study suggests adapting effective instructional methods, technology usage, resource availability, training, participation, peer interactions, and monitoring well-being for effective online science teaching.

**Keywords:** online teaching, science teaching, in-person teaching.

**RESUMEN**

Las escuelas y universidades en Sri Lanka han estado cerradas intermitentemente durante los últimos tres años debido a la COVID-19 y la escasez de combustible. Durante este período, la enseñanza presencial se volvió imposible y se desarrolló la enseñanza en línea. No obstante, actualmente las escuelas han reabierto para la enseñanza y el aprendizaje. Ambos los grupos demostraron niveles de desempeño semelhantes en la Unidade 8 (Mudanzas de la Matéria). No entanto, el ensino presencial presentó escores significativamente más altos (p <0,05) do que el grupo online para factores como interacción profesor-aluno, interacción de grupos de pares, recursos de aprendizagem e motivación. Los alumnos alcanzaron altos resultados en ambos ambientes, pero precisavam de más recursos, instalaciones de internet confiáveis e habilidades tecnológicas adecuadas para el ensino y aprendizaje en línea. El estudio sugiere la adopção de métodos instrucionais eficazes, uso de tecnologia, disponibilidade de recursos, treinamento, participação, interações entre pares e monitoramento do bem-estar para un ensino de ciências online eficaz.

**Palavras-chave:** ensino online, ensino de ciências, ensino presencial.

**RESUMEN**

Las escuelas y universidades en Sri Lanka han estado cerradas intermitentemente durante los últimos tres años debido a la COVID-19 y la escasez de combustible. Durante este período, la enseñanza presencial se volvió imposible y se desarrolló la enseñanza en línea. No obstante, actualmente las escuelas han reabierto para la enseñanza y el aprendizaje.
presenciales. En contraste, otros países adoptaron ambos métodos, en línea y presencial. Se observó una disminución en las calificaciones de las pruebas entre los estudiantes de secundaria en algunas zonas educativas durante el aprendizaje en línea. Este estudio tuvo como objetivo evaluar y comparar la eficacia de la enseñanza y el aprendizaje en línea y presenciales de ciencias entre estudiantes de secundaria en una escuela seleccionada dentro de la zona educativa de Kurunegala. Los objetivos del estudio fueron: 1) realizar clases de ciencias tanto en línea como presenciales para dos grupos por separado y comparar el desempeño de los estudiantes de octavo grado en ambos entornos; 2) comparar la interacción profesor-alumno, los recursos de aprendizaje, la interacción entre grupos de pares y la motivación en ambos entornos; y 3) hacer sugerencias para un proceso eficaz de enseñanza y aprendizaje. Se utilizaron dos cursos igualmente ponderados para enseñar a los dos grupos. Se utilizó una muestra de conveniencia de 72 estudiantes de octavo grado en la recopilación de datos con un enfoque de métodos mixtos. Se utilizaron pruebas previas, posteriores y cuestionarios en la recopilación de datos cuantitativos. Los datos cualitativos se recopilaron mediante entrevistas con diez estudiantes seleccionados al azar. Los resultados revelaron que los puntajes de desempeño del grupo presencial en la Unidad 4 (Propiedades de la Materia) de la evaluación de ciencias de octavo grado fueron ligeramente más altos que los del grupo en línea. Ambos grupos demostraron niveles de desempeño similares en la Unidad 8 (Cambios en la Materia). Sin embargo, la enseñanza presencial mostró puntajes significativamente más altos (p <0.05) que el grupo en línea para factores como la interacción profesor-alumno, la interacción entre grupos de pares, los recursos de aprendizaje y la motivación. Los estudiantes alcanzaron altos resultados en ambos entornos, pero necesitaban más recursos, instalaciones de internet confiables y habilidades tecnológicas adecuadas para la enseñanza y el aprendizaje en línea. El estudio sugiere adaptar métodos instruccionales efectivos, uso de tecnología, disponibilidad de recursos, capacitación, participación, interacciones entre pares y monitoreo del bienestar para una enseñanza efectiva de ciencias en línea.

**Palabras clave:** enseñanza en línea, enseñanza de ciencias, enseñanza presencial.

1 INTRODUCTION

The COVID-19 pandemic has had a significant impact worldwide, leading governments to implement strict measures to stop economic and social activities. Since March 1, 2020, academic institutions, such as schools and universities, have been instructed to close temporarily to prevent the spread of the virus and safeguard students and staff (Bank Group, 2011).

Over the past three years, Sri Lanka's education system has faced numerous challenges, including school closures due to the COVID-19 pandemic and shortages of fossil fuels. When COVID-19 hits Sri Lanka, schools quickly shut down in March 2020, and the country also grappled with fuel shortages, making it difficult for children to commute to school. As a result, students faced increased difficulties in their studies,
While teachers and educational institutions also encountered challenges (Sharma et al., 2022). In response to that situation, Sri Lankan teachers, educators, and administrators had to find new ways of teaching and learning, with a particular emphasis on online education at all levels, from primary to higher education. Temporary measures were put in place, such as distance learning through the Internet and other channels, to ensure that education continued uninterrupted.

The pandemic disrupted the learning environment, resulting in some students being unable to attend school. Online programs provided some relief, but further research was needed to understand their capabilities and effectiveness. A collective effort was necessary to tackle these challenges, including government intervention, international collaboration, and private-sector support (Liu & Cavanaugh, 2012). Although schools in Sri Lanka had reopened for in-person learning, other countries and higher education systems continued to rely on a blend of online and in-person teaching and learning, which had benefits. This approach provided several benefits, including flexibility and access to educational resources from anywhere, encouraging lifelong learning. However, Sri Lanka was not prepared for online teaching and learning so that transferring to a dual mode of education required professional guidance.

The study reported in this paper examined the academic performance of students in online and in-person learning at a specific school in the Kurunegala Education Zone, covering the years from 2020 to 2022. The study presented three charts that showed the distribution of term test scores during these three years, indicating the percentages of students who had achieved different levels of performance.

Figure 1: Summary of Class Term-Test Marks for 2020, 2021, and 2022

Source: by the authors
The findings of the study revealed that students generally had lower success rates in online learning compared to in-person classes. Although online teaching and learning had varying levels of effectiveness, the study emphasized the need to explore the efficacy of online teaching and learning compared to in-person instruction, particularly at the junior secondary level.

According to the literature, (Walters et al., 2022) traditional classroom instruction is deemed more effective than online instruction for junior secondary students. When discussing teaching online versus in-person with other science teachers, many expressed their concerns about how younger students would be badly affected with online learning. They cited various reasons for their worries. However, some teachers disagreed those concerns, believing that both online and in-person teaching could be effective, particularly with the newer generation of students.

Therefore, the objective of the study was to assess the effectiveness of teaching and learning process of science in online mode compared to in-person mode. In this regards, some units of Grade 8 Science were taught in both modes separately for two groups of students from a selected school in Sri Lanka and possible improvements that could be applicable for online learning process were identified. Comparing students' performance, teacher-student interaction, peer group interaction, access to learning resources, and motivation in both online and in-person teaching were used to understand the most effective approach to teach, engage students and help them succeed in their education.

2 MATERIALS AND METHODS

A mixed methods study was conducted for 13 year old, 72 grade 8 students of both genders in a school located in Kurunegala Educational Zone of Sri Lanka. Convenient sampling was utilized to select participants, and collecting data and analysis were employed using both quantitative and qualitative methods.

Quantitative data were collected by analysing pre-tests, post-tests, and questionnaires to measure factors such as motivation, teacher-student contact, peer group interaction, and learning resources. The students were divided into two groups, Group A and Group B, based on their pre-test results. Group A was given in-person teaching during the fourth unit (Properties of Matter), while Group B was taught the same section online. When teaching the eighth unit (Changes in Matter), the teaching methods were swapped.
between the two groups; Group A was given online instruction whereas Group B was given in-person instruction.

The study's first stage was to develop and implement lesson plans that catered to online and in-person learning for grade 8 students, which was accomplished. The second stage was to evaluate student performance by conducting face-to-face assignment and unit exams for two units. In doing so independent sample tests were done to check their results. The third stage was to collect feedback and insights on the overall experience from all students through questionnaires. Additionally, significant paired sample t-tests were conducted to compare the performance of students in in-person classrooms versus online classrooms. The study employed a qualitative approach further by randomly selecting ten students from each group. Semi-structured interviews and observations were conducted to identify and analyse four main themes: "effective technology use," "individual learning styles," "engagement and active learning," and "clear communication and expectations." These themes were explored within online and in-person teaching and learning contexts. Final stage of the study was to make appropriate suggestions for improving the effectiveness of both online and in-person teaching and learning process based on the research finding.

3 RESULTS AND DISCUSSION

At the first stage of the study, lessons were conducted both online and in-person classes as mentioned in the methodology, and Figures 1 and 2 depict student investigating chemical changes in in-person and online classes, respectively.

Figure 2: Student investigating chemical changes in- person class

Source: by the authors
In both online and in-person classes, students performed their tasks effectively. However, according to their feedback, they favoured in-person classes.

The results of the students’ performance in online and in-person learning were compared based on their examination results. In this regards, the performances of both the in-person and online groups in exams and assignments based on Unit 4 (Properties of Matter) were evaluated. The results are shown in Figure 4.

According to the examination results, the mean performance for in-person Group A and online Group B were 57.3 and 49.42, respectively. The Independent Sample t-tests revealed a p-value of 0.07, greater than the significance level (0.05), indicating no significant difference between in-person and online learning modes in the Unit 4 (Properties of Matter) Exam.
The comparison between the unit 4 assignment for the two study groups is shown in Figure 5.

Figure 5: Comparison of Unit 4 Assignment Performance between in-person Group A (U4ASIP) and online Group B (U4ASO)

![Graph showing comparison between in-person and online groups for Unit 4 assignment performance.]

Source: by the authors

In the Unit 4 (Properties of Matter) assignment, the mean performance for in-person Group A and online group B were 66.75 and 66.67, respectively. The Independent Sample t-tests revealed a p-value of 0.97, greater than the significance level (0.05), indicating no significant difference between the performances of group A and group 2 in Properties of Matter assignment.

Figure 6 reveals the comparison of Unit 8 examination performance between in-person Group A (U8EPIP) and online Group B (U8EPO). According to the results, no significant difference was found between the in-person and online groups implying a similar performance in both groups.

In the Unit 8 (Changes in Matter) examination, the mean performance for online Group A and in-person Group B was 55.69 and 55.61, respectively. Independent Sample t-tests showed a p-value of 0.98, exceeding the significance level (0.05), indicating no significant difference between the two groups in exam performance on Changes in Matter.
In the Unit 8 (Changes in Matter) assignment (Figure 7), the mean performance for online Group A and in-person Group B was 67.53 and 67.89, respectively. Independent Sample t-tests showed a p-value of 0.39, exceeding the significance level (0.05), indicating no significant difference between the two groups in Assignment performance on Changes in Matter.
In both Unit 4 (Properties of Matter) and Unit 8 (Changes in Matter) assessments, the mean values of Group A and Group B showed minimal differences, with p-values exceeding 0.05. Among all four cases, no significant variations were observed between the two study groups.

Under the third stage of research, the differences in teacher-student interaction, peer group interaction, access to learning resources and motivation between the in-person and online settings were examined. The results are shown in Figure 8.

Figure 8: Comparative Analysis of the mean value of In-person (MeTSIP) and Online (MeTSIO) teacher-student Interaction.

![Comparative analysis of Teacher Student interaction in-person vs. online](source: by the authors)

The study conducted significant paired sample t-tests to examine the differences, which yielded statistically significant results. Specifically, the analysis revealed that in-person teacher-student interaction had higher scores, with a mean difference of 0.24, a t-value of 2.29, and a statistically significant p-value of 0.03.
Figure 9: Comparative Analysis of the mean value of In-person (MePGIP) and Online (MePGIO) peer group interaction.

**Comparative analysis of peer group interaction  in-person vs. online**

Source: by the authors

In-person peer group interaction showed higher scores, with a mean difference of 0.68, a t-value of 7.87, and a significant p-value of 0.00. This indicated that peer group interaction employed in-person were more effective than that employed online (Figure 10).

Figure 10: Comparative Analysis of mean value of In-person and Online Learning Resources

Source: by the authors

Furthermore, the in-person learning resources exhibited superior scores, evidenced by a mean difference of 0.66, a t-value of 3.35, and a notable p-value of 0.00.
This supports the conclusion that there is a significant difference in learning resources between the two settings.

Figure 11: Comparative analysis of the mean values of motivation in both in-person (MeMIP) and online (MeMO) settings.

Moreover, motivation levels were higher in the in-person setting, as indicated by a mean difference of 0.53 and a p-value less than 0.00. These results revealed that motivation techniques employed in in-person teaching and learning process were more effective than those used online.

The overall analysis provides evidence supporting the superiority of in-person instruction in terms of motivation, teacher-student interaction, peer group interaction, and learning resources.

As planned under the last stage of research, suitable recommendations were formulated for both online and in-person teaching and learning process. These recommendations include addressing limited interactions in online classes, challenges with limited resources in both online and in-person classes, the need for support and focus in online learning, and restricted access.

Finally, the qualitative approach, the semi-structured interviews and observations provided insights into four themes, allowing for a deeper understanding of how students experienced and perceived aspects such as technology usage, learning styles, engagement levels, and communication effectiveness in their educational environment.
4 CONCLUSION

According to the case study done, teaching and learning science online is more or less effective when it is compared with in-person teaching and learning process. In the study reported here, students achieved good online, and in-person learning results, but their preferences and challenges differed from each other. The study reveals that many students need help in online learning, due to limited access to resources, unreliable internet, and insufficient technology skills, and more peer interaction. To enhance students' learning experiences, it is essential to adapt instructional methods and technology usage. This can be achieved by improving resource availability, providing necessary tools and reliable internet access, offering training and support to teachers, promoting student participation and peer interactions, and monitoring student well-being. These measures if incorporated to the current modes of teaching and learning process will create a positive and inclusive learning environment for all students.
REFERENCES


