Use of Modern Technological Devices in Teachin and Learning of Science Subject

R. Rajadharshini, P. Sivananthan

Faculty of Education, University of Colombo, Sri Lanka

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ABSTRACT

In Sri Lanka, Science is an essential subject within the school curriculum. It plays a significant role in preparing students for the world of work and in developing their foundational technological knowledge. Therefore, Science should be taught effectively. For this purpose, various modern technological devices are used in teaching and learning. This study was conducted with the primary objective of identifying the level of use of modern technological devices in the teaching and learning of Science. Specifically, it aimed to examine the availability and usage level of such devices, the contributions of teachers in effectively utilizing modern technological tools in Science instruction, and the relationship between the use of these devices and students' achievement in Science. This study employed a cross-sectional survey design. 18 Tamil-medium secondary schools in Division 02 of the Nuwara Eliya Educational Zone, Sri Lanka were selected. Using purposive sampling, 24 science teachers and 18 principals were selected. 69 students from grades 10 and 11 were selected through stratified random sampling. Data collected through structured questionnaires, interviews and document analysis were analyzed using descriptive statistics such as mean and Pearson's correlation coefficient and content analysis. The results of the study revealed that modern technological devices in schools are not at a satisfactory level for effective use. Furthermore, the average level of use of such devices in science teaching in the second semester of 2025 was very low (31%). Although teachers were found to have a relatively high level of use of technological devices as aids during lesson planning (average 3.5–4.4), their contributions to using these devices to effectively achieve lesson objectives, improve students' understanding of scientific concepts, encourage active participation, make learning more engaging, and promote self-learning were at a low level (average 2.5–3.4). In addition, the correlation coefficient ($r = 0.594$) indicates that there is a moderate positive correlation between the level of use of modern technological devices and students' achievement in science subjects. Based on these results, it is recommended that school administration should recognize the importance of modern technological devices in teaching and learning, ensure their availability, and implement appropriate strategic planning to effectively integrate these tools into the teaching-learning process.

Keywords: Science education, teaching and learning, learning achievement, modern technological devices

INTRODUCTION

In the secondary school curriculum of Sri Lanka, Science is one of the compulsory subjects. It enables students to investigate natural phenomena and to understand their characteristics. Moreover, the subject encompasses complex concepts related to both observable and non-observable natural phenomena, as well as evolving new ideas that change over time (Skinner, 2014). Teaching Science through the use of technological devices makes it easier for both teachers and students to achieve the objectives set out in the curriculum (Osterbas, 2020). Furthermore, the use of technological tools in Science education provides flexibility in terms of time and place for learning, while also promoting students' self-directed learning (Can & Besler, 2018). The integration of modern technologies in Science education offers innovative tools for educators and learners to explore, experiment, and understand the complexities of the natural world (Doyan et al., 2021). When these tools are used appropriately, teaching and learning activities become more effective, and the overall quality of education is enhanced (Shaik Fathima, 2013).

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The theory of cognitive learning emphasizes that modern technological tools—particularly visual demonstrations and interactive applications—facilitate the learning of complex scientific concepts in a simple and more visualized manner (Sutherland, 1988). Furthermore, according to Dale's Cone of Experience, when students gain direct experiences, they are able to understand concepts more easily and retain them for a longer period. Therefore, the necessity of using modern technological devices in the teaching–learning process to enhance students' engagement in Science is clearly highlighted.

In Tamil-medium schools in Division 02 of the Nuwara Eliya Education Zone in Sri Lanka, Science teachers predominantly rely on traditional teaching methods during instructional activities. The use of modern technological devices is observed to be very limited (School Internal and External Evaluation Report, 2024). This situation has negatively impacted students' achievement in Science. As a result, the average level of achievement in Science over the past five years in these schools has remained low, at approximately 47% (Nuwara Eliya Zonal Education Development Division, 2024). Therefore, this study is conducted based on the problem that the use of modern technological devices in the teaching–learning process by Science teachers in Tamil-medium schools in Division 02 of the Nuwara Eliya Education Zone is minimal.

This study assumes significance in the context that the use of modern technological devices in teaching and learning is essential for the 21st century teacher. Accordingly, this study has considered only the uses of technological devices such as multimedia projectors, desktop computers and laptops, tablets, smartphones and smart boards. Other technological devices have not been considered. Thus, this study has been conducted based on the following three main objectives.

- To identify the availability of modern technological devices and the extent of their usage.
- To examine the contributions of modern technological devices in effectively carrying out the teaching and learning of Science.
- To analyze the relationship between students' achievement in Science and the use of modern technological devices.

LITERATURE REVIEW

This study is grounded in multiple learning theories, including constructivism, social constructivism, and the Cognitive Theory of Multimedia Learning, which emphasize active, interactive, and visual learning processes. In addition, the TPACK framework highlights the importance of effectively integrating technology with pedagogy and content knowledge in science teaching. These theories collectively support the idea that modern technological devices enhance students' understanding and achievement in science by promoting engagement, interaction, and meaningful learning experiences.

To transform students studying Science into a knowledge-based community, it is essential to integrate them with information and communication technology (Sari Hutami, 2023). Similarly, the integration of modern technologies provides innovative tools for educators and learners to explore, experiment, and understand the complexities of the natural world (Duan et al., 2021). The limited availability of electronic devices in schools and classrooms hinders their uninterrupted use by teachers. This situation is more pronounced in schools that possess only a few technological devices (UNESCO, 2014).

The application and integration of modern electronic devices in schools have brought significant changes in education. As a result, both teachers and students gain substantial benefits. When these devices are used appropriately, teaching and learning activities become more effective, and the quality of education improves (Shaik fathima, 2013). The use of technology in Science education creates new opportunities for both teachers and students. Moreover, integrating technology into Science education is crucial for preparing students to meet the demands of the modern world. Technology provides a variety of tools to support learning and teaching (Alphonse & Ismayil, 2024). Teaching Science using smart classrooms not only increases students' engagement with the subject but also makes lessons more attractive. It further enhances students' motivation

and understanding, while also enabling the subject matter to be taught in a more concise manner (Duan et al., 2021).

RESEARCH METHODOLOGY

In this study, the teaching–learning process of science was considered as the dependent variable, while the use of modern technological tools was treated as the independent variable. The research was conducted using a cross-sectional survey design. 18 Tamil-medium secondary schools in Zone 02 of the Nuwara Eliya Education Zone in Sri Lanka were selected for this study. From these schools, 48 science teachers and 18 principals were chosen using a purposive sampling technique. In addition, 69 students studying in Grades 10 and 11 were selected through a stratified random sampling method. Accordingly, a total of 135 participants—including teachers, principals, and students—were selected as the sample for this study.

Data collection instruments included questionnaires, interviews, and document analysis. Data related to the availability and usage of modern technological devices, as well as their application in the teaching and learning of Science, were collected from teachers and students through structured questionnaires and interviews. Data regarding the availability and use of technological devices were also collected from principals through interviews. Students' Science examination scores were obtained from official record books. Data analysis were analyzed using descriptive statistics such as mean and Pearson's correlation coefficient and content analysis

Several measures were taken to ensure the validity and reliability of the data collection instruments. These are outlined as follows:

- After the questionnaire was developed, it was revised based on the suggestions of a qualified educationist and an experienced Science teacher.
- It was further refined based on feedback obtained from a pilot study.
- Reliability was tested and confirmed through appropriate statistical procedures.

Table 1: Reliability Statistics

Teacher Questionnaire		Student Questionnaire	
Cronbach's Alpha	N of Items	Cronbach's Alpha	N of Items
0.950	16	0.944	13

According to the table, the Cronbach's alpha values of both the teacher and student questionnaires were above 0.7 and also exceeded 0.9, confirming that the instruments were highly reliable.

Data Analysis

The data obtained for this study were analyzed based on the research objectives and are explained under several sub-headings below.

Availability of modern technological devices and their usability

Table 2: Availability of modern technological devices

Schools	Multi Media	Computer & Laptop	Taplet	Smart Phone	Smart board
Type II	01	01	-	01	01
Type II	-	-	-	01	01

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Type II	-	-	-	01	-
Type II	01	01	-	01	01
1C	01	09	47	03	01
1C	01	03	32	03	01
1C	-	04	23	03	02
1AB	01	06	60	07	02

According to Table 2, in the schools selected for the study, multimedia projectors are available only in two Type II schools, with one unit in each. Among the three Type 1C schools, only two have one unit each. In the Type 1AB School, only one unit is available. Similarly, computers and laptops are found only in two Type II schools, with one unit each. There are 16 units in Type 1C schools and 6 units in the Type 1AB School. In addition, a total of 162 tablets are available in Type 1C and Type 1AB schools combined. Since 24 science teachers possess smartphones, the total number of such devices is 24. Smart boards are available in nine schools, except for one Type II school. Furthermore, the accuracy of the data regarding the availability of modern technological devices was confirmed through interviews conducted with the principals of the respective schools

Table 3: Usability of modern technological devices

Schools	Multi Media	Computer & Laptop	Taplet	Smart Phone	Smart board
Type II	0%	35%	0%	25%	38%
Type II	0%	0%	0%	20%	35%
Type II	0%	0%	0%	25%	0%
Type II	20%	28%	0%	18%	30%
1C	18%	45%	46%	32%	64%
1C	15%	35%	52%	34%	55%
1C	0%	44%	38%	31%	40%
1AB	50%	80%	74%	36%	70%

According to Table 3, the level of utilization of modern technological devices refers to the extent to which they were used in the teaching and learning of science during the second term of 2025. In this context, multimedia projectors were used at a level of 20% in one Type II school, at levels of 18% and 15% in two Type 1C schools, and at a level of 50% in the Type 1AB School. Similarly, computers and laptops were used at levels of 35% and 28% in two Type II schools; at levels of 45%, 35%, and 44% in three Type 1C schools; and at a level of 80% in the Type 1AB School. Tablets were used at levels of 46%, 52%, and 38% in three Type 1C schools, and at a level of 74% in the Type 1AB School. The level of smartphone usage across the eight schools is, on average, 28%. Likewise, the level of smart board usage across seven schools is, on average, 48%. Furthermore, the accuracy of the data regarding the utilization of modern technological devices was confirmed through interviews conducted with the principals of the respective schools.

The Contribution of Modern Technological Devices to Effective Science Teaching and Learning

The contributions of modern technological devices to the effective teaching and learning of science were measured using 16 variables based on a Likert scale. In this scale, a value of 5 indicates “strongly agree,” while a value of 1 indicates “strongly disagree.” The data obtained from teachers and students regarding these

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variables were analyzed using descriptive statistical methods (mean and standard deviation) and are presented below under subheadings.

1. Use of Modern Technological Devices as Support Tools in Science Lesson Planning

In order to effectively use modern technological devices in the teaching–learning process, it is essential to understand how to use them and incorporate them as supportive tools during lesson planning. Based on this, the data obtained from teachers regarding the use of modern technological devices as support tools in science lesson planning were analyzed and are presented in the table below.

Table 4: Status of using of Modern Technological Devices as Support Tools in Science Lesson Planning

Variable	Teachers' responses		
	N	Mean	Std. Deviation
V1	24	3.96	0.550
V2	24	3.38	0.495

According to Table 4, the mean (M) values of teachers' responses for the variables (V1) the use of modern technological devices as support tools during science lesson planning, and (V2) the use of online platforms to obtain teaching and learning materials, fall within the range of 3.5–4.4. This indicates a moderately high level corresponding to scale point 4 on the Likert scale. Therefore, the use of modern technological devices as support tools in science lesson planning, as well as teachers' ability to access and utilize online platforms to obtain relevant materials, are at a moderately high level.

2. Achieving Science Lesson Objectives within the Allocated Time through the Use of Modern Technological Devices

The use of modern technological devices in the teaching–learning process enables the achievement of lesson objectives within the specified time. Based on this, data obtained from teachers and students regarding the extent to which science lesson objectives can be achieved easily within the given time through the use of modern technological devices were analyzed and are presented in the table below.

Table 5: Achieving Science Lesson Objectives within the Allocated Time

Variable	Teachers' responses			Students' responses		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation
V3	24	2.92	0.717	68	3.17	0.105
V4	24	2.83	0.761	68	2.61	0.073

According to Table 5, the mean scores of teachers' and students' responses regarding (V3) achieving science lesson objectives more easily through the use of modern technological devices, and (V4) achieving them within the specified time, fall within the range of 2.5–3.4. Therefore, the variables V3 and V4 indicate a low level on the Likert scale. Based on this, it can be concluded that in the schools under study, the use of modern technological devices in teaching science contributes to a low level of effectiveness in achieving lesson objectives both easily and within the allocated time.

3. Understanding concepts easily through the use of modern technological devices in science teaching and learning

The contribution of teachers in helping students understand concepts more easily through the use of modern technological devices in science teaching—particularly new scientific concepts, abstract ideas such as atoms

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and chemical bonds that are not directly observable, as well as complex concepts like gravity and force—was analyzed based on data collected from both teachers and students. The findings are presented in the table below.

Table 6: Understanding concepts easily

Variable	Teachers' responses			Students' responses		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation
V5	24	3.00	0.722	68	2.96	0.515
V6	24	2.92	0.717	68	2.76	0.639
V7	24	2.88	0.797	68	2.96	0.665

According to Table 6, the mean scores of teachers' and students' responses regarding the variables (V5), (A6), and (V7)—which relate to students' ability to understand new scientific concepts, abstract concepts such as atoms and chemical bonds that are not directly observable, and complex concepts such as gravity and force through the use of modern technological devices in science teaching—fall within the range of 2.5–3.4. This indicates a low level on the Likert scale, around the value of 3.

Based on this, the data reveal that in the schools under study, the contribution of teachers in using modern technological devices to facilitate students' easy understanding of new, abstract, and complex scientific concepts is at a low level.

4. Encouraging student participation in teaching–learning activities

The role of teachers in motivating students through the use of modern technological devices in science teaching—particularly in activities such as experiments, projects, and group work—was analyzed based on data collected from teachers. The findings are presented in the table below.

Table 7: Encouraging student participation in teaching–learning activities

Variable	Teachers' responses			Students' responses		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation
V8	24	2.88	0.741	68	2.57	0.501
V9	24	2.83	0.702	68	2.26	0.444
V10	24	3.00	0.722	68	2.83	0.383

According to Table 7, the mean scores of teachers' and students' responses regarding the variables (V8), (V9), and (V10)—which relate to motivating students in activities such as experiments, projects, and group work through the use of modern technological devices in science teaching—fall within the range of 2.5–3.4. This indicates a low level on the Likert scale, around the value of 3.

Based on this, the data reveal that in the schools under study, the contribution of teachers in motivating students to engage in activities such as experiments, projects, and group work through the use of modern technological devices in science teaching is at a low level.

5. Making teaching–learning activities more appealing to students

Through the use of modern technological devices, it is possible to make teaching–learning activities more appealing to students by creating a conducive learning environment, establishing effective teacher–student

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interaction, and fostering positive student attitudes toward teachers. Accordingly, data related to these variables were collected from both teachers and students, analyzed, and are presented in the table below.

Table 8: Making teaching–learning activities more appealing to students

Variable	Teachers' responses			Students' responses		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation
V11	24	2.96	0.624	68	2.65	0.482
V12	24	2.83	0.702	68	3.02	0.537
V13	24	3.08	0.654	68	2.96	0.665

According to Table 8, the mean scores of teachers' and students' responses regarding the variables (V11), (V12), and (V13)—which relate to teachers' contributions in using modern technological devices to make science teaching and learning more appealing to students by creating a conducive learning environment, establishing effective teacher–student interaction, and fostering positive student attitudes toward teachers—fall within the range of 2.5–3.4. This indicates a low level on the Likert scale, around the value of 3.

Based on this, the data reveal that in the schools under study, teachers' contributions in using modern technological devices to create a supportive learning environment, promote effective teacher–student interaction, and develop positive student attitudes toward teachers—thereby making science teaching and learning more appealing—are at a low level.

6. Encouraging students' self-directed learning

The contribution of teachers in encouraging students' self-directed learning through the use of modern technological devices in science teaching—such as motivating students to search for additional information related to science subjects, encouraging independent learning, and promoting the completion of homework—was analyzed based on data collected from both teachers and students. The findings are presented in the table below.

Table 9: Encouraging students' self-directed learning

Variable	Teachers' responses			Students' responses		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation
V14	24	3.17	0.637	68	2.67	0.474
V15	24	2.88	0.680	68	2.87	0.619
V16	24	3.00	0.722	68	2.59	0.498

According to Table 9, the mean scores of teachers' and students' responses regarding the variables (V14), (V15), and (V16)—which relate to students' self-directed learning, including encouraging them to search for additional information in science, motivating independent learning, and promoting the completion of homework through the use of modern technological devices in science teaching—fall within the range of 2.5–3.4. This indicates a low level on the Likert scale, around the value of 3.

Therefore, the data reveal that in the schools under study, teachers' contributions to promoting students' self-directed learning—such as encouraging them to seek additional knowledge in science, engage in independent learning, and complete homework through the use of modern technological devices—are at a low level.

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Use of Modern Technological Devices and Achievement in Science Learning

The relationship between students' examination scores in science (Grade 10 and 11 students) obtained during the second term of 2025 and the level of use of modern technological devices in science teaching and learning in schools during the same term was measured using Pearson's correlation coefficient.

Table 10: Relationship between the level of use of modern technological devices and achievement in science subjects.

Pearson's correlation	Relationship
Correlation Coefficient (r)	0.594*
Sig. (1-tailed) (p)	0.005

*. Correlation is significant at the 0.01 level (1-tailed).

According to Table 10, the relationship between the level of use of modern technological devices and achievement in science subjects is statistically significant, as the p-value is 0.005. The correlation coefficient ($r = 0.594$) indicates a moderate positive relationship between the level of use of modern technological devices and students' achievement in science subjects. The coefficient of determination ($r^2 = 0.353$) further reveals that approximately 35.3% of the variation in students' science achievement is explained by the use of modern technological devices. This suggests that the integration of modern technology contributes meaningfully to improving students' academic performance in science.

CONCLUSION AND DISCUSSION

In the schools under study, the availability of modern technological devices shows that smartphones are available in all schools, while smart boards are available in 7 schools. However, multimedia projectors, computers, laptops, and tablets are available on average in only about 5 schools. Therefore, it is evident that the availability of modern technological devices in schools is not at a satisfactory level for effective usage. Similarly, the average level of use of these modern technological devices in the teaching and learning of science during the second term of 2025 is only 31%, which is considered very low.

With regard to the contribution of modern technological devices to effective science teaching and learning, teachers' use of such devices as supportive tools in lesson planning and their ability to identify and access relevant digital resources are at a moderately high level (Mean = 3.5–4.4). However, the data reveal that teachers' contributions are at a low level (Mean = 2.5–3.4) in areas such as achieving science lesson objectives easily and within the allocated time, facilitating students' understanding of new, abstract, and complex scientific concepts, and encouraging student participation in activities such as experiments, projects, and group work.

Likewise, teachers' contributions in using modern technological devices to make science teaching and learning more appealing to students, as well as in promoting students' self-directed learning—such as encouraging them to search for additional information, engage in independent learning, and complete homework—are also at a low level (Mean = 2.5–3.4), as indicated by the data.

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The correlation coefficient (r = 0.594) of the relationship between the level of use of modern technological devices and students' achievement in science subjects shows a moderate positive relationship between these variables. Furthermore, the coefficient of determination ($r^2 = 0.353$) reveals that about 35.3% of the variance in students' science achievement is explained by the level of use of modern technological devices. Therefore, it can be concluded that the use of modern technological devices has a meaningful and positive impact on students' achievement in science subjects, although other factors also contribute to students' academic performance.

This finding is consistent with previous studies in the field of educational technology. For instance, Richard (2009) highlights that the use of multimedia tools enhances students' understanding by promoting meaningful learning. Similarly, John Hattie (2009) emphasizes that technology, when effectively integrated with pedagogy, has a positive impact on student achievement. These perspectives support the idea that modern technological devices facilitate interactive and engaging learning experiences, which in turn improve students' performance in science subjects.

In conclusion, the study reveals that both the availability and the level of use of modern technological devices in the schools under study are low, and that teachers' contributions to integrating these technologies into science teaching and learning activities are also at a low level.

RECOMMENDATIONS

Considering the importance of using modern technological devices in the teaching and learning of science, school management should undertake appropriate strategic planning to acquire these resources and to effectively implement teaching–learning activities using them.

In particular, necessary steps should be taken to provide professional training related to the use of smart boards and the internet. In addition, plans should be developed to ensure the continuous and effective use of modern technological devices. As pointed out by Sivananthan & Wedikandage (2023), such efforts cannot be accomplished by schools alone; they require adequate community involvement and participation. Therefore, schools should establish effective links with the community and make arrangements to obtain modern technological devices through collaborative support.

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