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Model of Flipped Classroom Environment for Mastery Learning Approach Using the "ZOOMRBT App"

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ABSTRACT

In the digital era that encourages innovation in educational technology, it is crucial to incorporate the use of technology into pedagogy. Since the inception of hybrid learning and other approaches that involve students and instructors in educational activities, the learning environment has undergone significant changes. By utilizing instructional resources such as textbooks and videos, it has become feasible to engage with students beyond the confines of the classroom and during evening hours. Research conducted on students in grades 8 and 9 in Ontario, Canada, revealed that due to their limited spare time, they opted to study and complete their homework after school. Moreover, they exhibited a clear prioritization of their depth of subject knowledge over other factors. The study aimed to adapt the existing learning environment to establish a new environment conducive to mastery learning. It involved fifteen student participants, including an expert teacher in the flipped classroom teaching method. The study employed qualitative techniques such as focus groups, document analysis, expert agreement percentages, and innovative flipping of the classroom. The study resulted in the identification of five thematic analyses: learning flexibility, application skills, usage of application skills, mastery assessment, and the human touch. Collectively, these qualitative findings provide compelling evidence that the research participants actively engage with various aspects of the flipped learning environment, as outlined by the aforementioned themes. The participants in the case study acted as both fresh and established elements within the flipped learning environment.

Keywords: exploration; flipped learning environment; ZOOMRBT App; qualitative study; Malaysian Boarding School.

INTRODUCTION

Integrating technology into pedagogy to support innovation in educational technology can greatly enhance the learning experience and student engagement. Teachers must stay well-versed in the latest technological advancements and how to effectively integrate them into their lesson plans. Professional development should also encompass continuous seminars and training events to keep educators up-to-date on the latest tools and techniques. In this study, the acquisition of new material outside the classroom is facilitated by pre-recorded videos and internet resources. This approach enables the use of class time for debates, problem-solving, and practical exercises. Furthermore, employing group work and information-sharing technologies such as Google Docs, online whiteboards, and project management software can be advantageous for students. Educational materials include mobile learning apps like ZOOMRBT. Given that many students frequently use smartphones and tablets, incorporating educational applications and content optimized for mobile devices can enhance accessibility and flexibility. The teacher will incorporate coding and robotics tasks during the teaching and learning sessions to foster computational thinking and problem-solving skills. Students participating in these activities will develop valuable 21st-century skills.

Soliciting feedback on the integration of technology from parents, teachers, and students more frequently is important. This data can be used to enhance implementation and identify potential areas for further innovation. By implementing these strategies while maintaining a pedagogical focus, educational institutions can cultivate a dynamic and cutting-edge learning environment that fully harnesses technology's potential to enhance education.

RESEARCH BACKGROUND

The research by Nissen et al. (2021) indicates that the competence level of Norwegian students' devices increases during free time or outside of class, and this time gap can be bridged using instructional aids like textbooks and films. Balfe et al. (2016) also studied students in grades 8 to 9 in Ontario, Canada. They found that due to limited after-school activities, students choose to study or do homework and pay closer attention to teacher expectations for mastery. Their study also revealed that all teachers were quite familiar with using iPads, including apps, websites, and instructional techniques. According to Onyema et al. (2016), using a gadget is better for students who prefer autonomous study in larger classrooms with less teacher monitoring. Furthermore, students have access to all instructional materials during their leisure time, benefiting those who need to catch up and want to learn more about covered subjects. However, their research also suggests that teachers need more suitable training, including professional technology courses, to use devices more effectively. Rahman et al. (2019) examined the use of technology in teaching life sciences and found that students' self-learning and information-seeking skills improved. Their research indicates that integrating electronics in pedagogy requires a reliable internet connection, technical assistance, dependable electrical sources, and strategies to cope with student distractions such as social media and games available on devices. Sriwahyuni et al. (2021) conducted a pilot study based on a needs analysis of boarding school students' perceptions. The study focused on two boarding schools in the state of Johor. The primary objective was to gather data for analyzing the device's skill level, content, and mastery learning needs. One weakness in the researchers' work is their lack of consideration for mastery learning. Evaluating students without considering mastery learning does not demonstrate whether learning standards have been truly mastered. According to the Ministry of Education of Malaysia, classroom assessment is an ongoing evaluation conducted during teaching and learning sessions to collect data on students' growth, progress, skills, and achievements (Mansor et al. 2017). It can be summative or formative, aiming for learning about learning or learning for learning. The Ministry of Education states that PBD (Pentaksiran Berasaskan Dewan, or Classroom Assessment) can assist teachers, particularly in boarding schools, in monitoring students' overall development, identifying learning strengths and weaknesses, assessing instruction effectiveness, planning and adjusting teaching strategies, and taking immediate corrective actions. This PBD data is recorded in an offline Excel file. This study also addresses the issue of teacher integrity, as any dishonesty can be detected by students and other teachers using the app. However, the new application also enables online recording of Classroom Assessment scores. Nonetheless, this study primarily concerns the integrity of instructors.

RESEARCH PURPOSES

The initial steps in the preliminary investigation of the flipped learning environment involve exploring how the "Flipped Classroom" setup can leverage the ZOOMRBT program for mastery learning. Furthermore, the study delves into the prerequisites necessary for designing and developing the ZOOMRBT device application within a flipped classroom framework that employs mastery-based instruction, specifically catering to the context of boarding schools. The study's conclusion presents a proposed model for a flipped classroom environment, integrating the ZOOMRBT device application, aimed at fulfilling the criteria for cutting-edge educational technology that supports mastery learning requirements.

RESEARCH SIGNIFICANT

Both flipped classrooms and educational applications generate valuable data about student performance and progress (Yoon et al. 2021). Teachers can utilize this data to identify struggling students, target interventions, and provide personalized support to help them achieve mastery. Flipped classrooms promote active learning as students engage with content before class and actively participate in discussions and activities during class time. This active engagement helps students take ownership of their learning, which is a fundamental aspect of mastery learning. In mastery learning, assessment is continuous, and students are given multiple opportunities to demonstrate their proficiency. Educational applications can facilitate formative assessments, allowing students to receive feedback and iterate on their learning before the final evaluation. By combining the flipped classroom model and educational applications, educators can create a more

student-centered, adaptive, and personalized learning environment, in alignment with the principles of mastery learning. This approach can lead to improved learning outcomes, increased retention, and a deeper understanding of the subject matter among students.

PROTOCOL

The researcher will commence by analyzing documents and conducting focus group interviews to gain insights into the material requirements, design, development, and evaluation of ZOOMRBT mobile apps from the perspective of boarding school students. Following this procedure, the researcher will subject these aspects to thematic analysis. Instructors' expertise has been tapped to validate these elements, aiding in refining and adapting the environment's attributes to suit the boarding school context. The components of the flipped learning environment in this study comprise constructivist theories, learning techniques, and models suitable for a case study (Xu and Shi 2018).

LITERATURE REVIEW

INTRODUCTION

When creating multimedia software, two prevalent approaches are constructivism and the philosophy of student-centered instructional design. One aspect of constructivism's theory of cognitive processes, which addresses the dominant learning environment, has gained prominence in studies of complex learning environments (Sasson et al. 2022). Multimedia has shown that intelligent students when provided with such tools, engage in learning and explore the covered material independently from their teachers (Jin et al. 2021). Instead of acting as mere providers of information, teachers assume the role of mentors, guiding students throughout the learning journey. The focal point of the teaching and learning process shifts to the student, away from the teacher. Multimedia software presents an alternative to traditional teaching and learning methods, offering a means to deliver high-quality education. As a result, the learning process can be enriched through multimedia software. Its purpose is not to replace teachers or the conventional teacher-centric instructional approach (Kadhim et al. 2023).

FLIPPED CLASSROOM INTEGRATION WITH EDUCATIONAL APPS

Integrating app technology with the flipped classroom approach can enhance the learning experience for students and streamline the process for teachers. Seek out educational applications that align with your curriculum and learning objectives, such as those offering interactive content, quizzes, simulations, and opportunities for student interaction (Brown et al. 2020). Subsequently, instructors should utilize the chosen apps to create pre-learning materials for students, which might include practice activities, reading materials, interactive lectures, or instructional videos. Ensure that the material is concise, engaging, and directly relevant to upcoming class activities. Instructors should assign pre-learning tasks using the selected apps before each class, informing students about expectations for their classroom participation (Singh et al. 2020). Numerous educational apps provide data and analytics on student usage and progress. Instructors can monitor this information to gauge students' interaction with the pre-learning materials. This data can aid in identifying students who are struggling or topics that require more attention during in-class sessions (Pichardo et al. 2021). As facilitators, teachers should capitalize on class time for interactive and group projects that build upon the pre-learning materials (Nguyen 2021). This enables instructors to focus on practical activities, group discussions, problem-solving assignments, and projects that expand on the knowledge gained from app-based pre-learning (Chowdhary 2023). Furthermore, this integration encourages peer cooperation beyond the classroom, utilizing the collaborative features of educational applications. Through the app's messaging or collaboration tools, students can discuss concepts, share ideas, and collaborate on assignments. In providing personalized assistance, students can also identify peers in need of additional support or facing challenges. This approach ensures that each student receives individualized attention and feedback throughout in-class exercises, contributing to their mastery. To assess learning outcomes and measure comprehension of the pre-learning material, leverage the app's built-in evaluation features such as quizzes or interactive exercises. Develop summative and formative assessments that gauge their grasp of the overarching learning objectives. By combining educational apps with the flipped classroom approach, a dynamic and interactive learning environment can be established, fostering student engagement, personalization, and a deeper understanding of the subject matter.

MASTERY LEARNING' STRATEGY

According to Diáz-Ramrez (2020), mastery learning is a behavioral teaching strategy that utilizes additional instructional time and opportunities for repeated assessment to improve student learning. Carroll's approach asserts that

the quantity of time spent on studying and the allocation of time for learning significantly impact mastery learning (Meehan & McCallig 2019). In essence, achievement is not merely sporadic (such as within a semester) but rather continuous, with time being granted within a range of limitations, thus accommodating a broader spectrum of student achievements (Meehan & McCallig 2019). Employing flexible time to enhance student learning and performance is referred to as mastery learning (Archambault 2022). For instance, students are occasionally provided the chance to revise tests, assessments, or mastery activities until they attain the level of mastery (Archambault 2022).

FOCUS GROUPS INTERVIEW AND DOCUMENT ANALYSIS

The investigation into the integration of flipped classroom components with ZOOMRBT apps involves the utilization of focus group interviews and document analysis with students and instructors from Malaysian Boarding Schools. While document analysis formed the bulk of the findings from the interviews, the research participants shed light on the kinds of documents used as references during the previous implementation of the flipped classroom. After merging the interview data and document analysis, the researcher employed the nVivo program to analyze the innovative concept of the flipped classroom. Employing a structured tabular approach that relies on word frequency, the thematic analysis employs these themes that have been gathered (Robinson 2022). This method allows for an inductive, deductive, or hybrid approach to the development and analysis of themes, similar to other forms of thematic analysis (Robinson 2022). This tabular structure approach places emphasis on the process of evaluating analyst consensus.

METHODOLOGY

This study encompasses research design, participant selection, qualitative research protocol, research methodology, data gathering strategy, data collection instruments, data analysis techniques, and research ethics.

RESEARCH DESIGN

The integration of the flipped classroom with ZOOMRBT applications and mastery learning is the focus of exploratory research following the qualitative study methodology (Sunardiyah et al. 2023). This methodology incorporates group-focused interviews, document content analysis, case studies, and other research techniques. Within this project, qualitative methods are employed to delineate any novel applications or concepts developed. A robust research methodology necessitates adept data collection and analysis approaches, such as interviews and document analysis, to comprehensively depict the entirety of the application development process.

RESPONDENTS

The researchers' respondents consisted of 25 students and one teacher from a Johor Full Boarding School. These engaged students, who were in their first year of study, chose the topic of design and technology. The sample data gathering procedure employed stratified sampling. Drawing from over 5 years of expertise in teaching Design and Technology courses, as well as having experience with the flipped classroom approach during the COVID-19 pandemic, the teachers will be introduced to a new approach in this study. This approach centers on a flipped classroom model with a subtopic of electronic design, targeted at second-grade students, incorporating the fundamentals of digital technology along with the utilization of ZOOMRBT apps during afternoon prep time and primary class hours. Focus group interviewing techniques can serve as the primary method of data collection, either as a supplementary approach or as the primary research method (Choi et al. 2021). Group interviews and documents are utilized to gather information for this study centered around application development (Moon et al. 2019). Given that there are no predetermined criteria to determine sample size in qualitative research, the number of respondents interviewed is not a primary concern (Hennink & Kaiser 2021).

QUALITATIVES' RESEARCH PROTOCOL

After conducting inquiries with students and teachers, the aspects of the flipped classroom using ZOOMRBT applications were examined in the initial phase of the project. In order to ensure anonymity and safeguard their real identities, pseudonyms were assigned to all of these respondents. Following the guidelines outlined by Yin (2009), the case study format was employed for document analysis and group-focused interviews. This study established research data through instructor input, documented student and teacher insights throughout the study, presented the analysis of application themes, and formulated interview questions.

DATA COLLECTION STRATEGY

The researcher submitted an application through the eRAS 2.0 system to the Malaysian Education Policy Planning and Research Division (BPPDP), KPM. After receiving government approval (JPNJ), the researcher sought clearance from the Johor State Education Department. Subsequently, the principals of the three selected schools, chosen to participate in the study, were presented with letters from KPM and JPNJ to request permission for the study to be conducted at their schools. To ensure the smooth execution of the actual investigation, the researcher has developed a work plan schedule. This consideration is imperative as an ethical factor, ensuring that participants are both agreeable and enthusiastic to participate (Kalkman et al. 2022). Moreover, this documentation safeguards the researcher in case of complications or legal concerns (Dwivedi et al. 2022). The actual research is scheduled to take place from December 2022 to May 2023. At the onset of the data collection process, the researcher will become acquainted with the selected study participants and cultivate relationships with them.

DATA COLLECTION TOOL

This study employs the interview procedure and document analysis as two major data collection tools.

PROTOCOL FOR FOCUS GROUP INTERVIEWS

Interviews are a method employed to delve into the reality of research participants and comprehend their genuine feelings and beliefs within a qualitative case study (Löhr et al. 2020). As per Bdair (2021), descriptive data can be collected through interviews, as articulated by the study participants themselves. The researcher utilizes the interview technique to investigate, refine, and authenticate specific attributes, such as respondents' ideas, emotions, perceptions, and intentions regarding the subject under scrutiny (Gioldasi 2022). To maintain a focus on the objectives and research questions, group-focused interviews were employed in this study as a guiding framework for the researcher (Roberts 2020). These focus group interviews examined the application's strengths and weaknesses, its relevance in the context of ZOOMRBT implementation, and users' proficiency in using it. The researcher supplements the group interviews with document analysis to uncover novel aspects that align with the context.

DOCUMENTS' ANALYSIS

To gather data, the researcher employed the technique of document analysis. The analysis was conducted using several documents, including the circular letter from the Malaysian Ministry of Education, the Assessment Curriculum Standard Document (DSKP), the Malaysian Education Development Plan (PPPM, 2013–2025), as well as the timetable and daily lesson plan record book containing the schedule for each teacher's design and technology teaching sessions. In this context, the researcher sought study participants' consent to photocopy all necessary documents for the purpose of conducting document analysis. The recorded documents of the research participants' daily lesson plans were scrutinized, encompassing the lesson title, teaching objectives, teaching strategies employed by the teacher, and any potential verbal questions posed.

DATA MANAGEMENT

In this phase, the researcher maintains a journal documenting all activities related to data collection. To enhance the organization of the information management process and facilitate adjustments as needed, the researcher includes all data collection activities in an index. Additionally, to safeguard against data loss, all log book entries are replicated on the computer. Each set of data is stored in a separate file categorized by the teacher's name. This approach ensures a more sustainable data storage and management process, enhancing data accessibility. Subsequently, the researcher proceeds with transcription. The information gathered from observations and interviews is transcribed and typed into Microsoft Word. This compiled data is then imported into the NVivo 12 program for analysis. Table 1 delineates the steps employed by the researcher to analyze the data and address the study's research questions.

TABLE 1. Data Analysis Phase

Exploration Primary Data	Exploration Secondary Data	Main Purpose
Use a flipped classroom with a group focus interview and the ZOOMRBT program to teach mastery learning and the criteria that must be satisfied for the design and development of the ZOOMRBT device application.	Stage 1 of the study entails completing a content analysis of the researcher's focus group interview with an analysis document to find themes based on the researcher's deductive reasoning.	Create a thematic analysis framework model using a flipped classroom and ZOOMRBT application development.

CODING ANALYSIS

The researcher's analysis during the coding process centers on breaking down the data into smaller units (concepts or codes) and subsequently organizing them into categories based on shared concepts (or subcategories). Subsequently, in this research, the researcher connects open codes to categories and subcategories. This technique of linking minor data aids in comprehensively viewing and understanding the study. The open coding model is a systematic analysis approach wherein the researcher delves into the causal context of the event being investigated, including its context, intervening factors, strategies, specific actions taken during the event, and their consequences (Strayer 2007). This model helps elucidate the process of the phenomenon in the concluding stages of the study (Strayer 2007). Upon identifying links between categories and concepts, the researcher revisits the gathered data to ascertain whether evidence supports or challenges the relationship. These category-concept associations need to undergo repeated scrutiny for validation. Discrepancies in the data often exist between supportive and opposing instances of the association (Strayer 2007). The development process of research analysis can be further enhanced by recognizing variations in the data and adjusting the connection between categories. During the process of data coding, the data is segmented, filtered, and then interpreted meaningfully to construct a theme. To streamline the data and facilitate the researcher's grouping of components tied to specific research questions and themes, it's imperative to restructure the "chunks" of data.

FINDINGS

The outcomes of the qualitative research conducted for the central case study of this thesis are elucidated in this chapter and the ensuing one. The primary research question of this study was centered around how to effectively employ a flipped classroom approach and the ZOOMRBT application to facilitate mastery learning, along with the prerequisites necessary for the design and development of the ZOOMRBT device application.

EVIDENCE OF FINDINGS

The findings from the group-focused interview thematization and keyword analysis of document analysis in the integrative review are detailed in this section. Upon completion of the exploratory research technique, instructors will employ ZOOMRBT and other applications as the foundation for their learning and teaching support. The themes and their descriptions will serve to identify and educate about the prerequisites necessary for the design and development of the ZOOMRBT device application. The ensuing results are presented below, organized under headings corresponding to each theme of the model. As a concise representation of the data, the outcomes of the coding are outlined in Table 2, displayed below, which pertains to the analysis of the ZOOMRBT applications mastery theme, participant response types, file quantities, and references.

TABLE 2. Participant Responses to ZOOMRBT applications mastery

Name (Theme and Category)	Files	References
Flexibility		
Mastery of ZOOMRBT Application Flexibility	1	1
Presentation Flexibility	1	1
Presentation Confidence	2	4
Presentation Software	2	2
	1	1
Application Management		
Learning Reflection	1	1
Application Skills		
Medium Skills	1	1
Device Compatibility	1	2

continue ...

.... cont.

Application Usage Creativity		
Hands-On Skills	1	1
Visual Creativity	2	2
Mastery of Assessment		
Assessment Level	1	1
Disadvantages of Assessment Technology	1	1
Group Projects	1	2
Human Touch		
Teacher Assistance	2	3
Combination of Teachers and Devices	1	1

Five primary themes surfaced from the data analysis: flexibility, application skills, application usage skills, mastery assessment, and human touch. For each of these subjects, references, quotations, and categorized categories were employed for support. These five themes effectively structured the instructors' insights into their encounters with the implementation of flipped learning environments. Each theme was substantiated with coded categories and exemplifying quotes. These six themes collectively elucidated the teachers' perceptions and experiences related to the components of implementing flipped learning environments. An additional theme pertains to future prerequisites for the adoption of the flipped classroom approach.

FLEXIBILITY THEME

In the context of flipped classrooms, technology apps with flexibility pertain to software applications or tools that allow educators and students to tailor and customize the learning experience according to their individual needs and preferences (Cevikbas & Kaiser 2022). The flipped classroom model entails an instructional approach where conventional teaching techniques are reversed: students independently study instructional material outside of class (often using digital resources), while class time is reserved for more interactive and collaborative endeavors such as discussions, problem-solving, and group projects (El Miedany & El Miedany 2019). As further expounded below, flexibility must also encompass options for students to choose their preferred assessment methods and formats. The researcher identified five subcategories within the flexibility theme: Mastery of ZOOMRBT Application Flexibility, Presentation Flexibility, Presentation Confidence, Presentation Software, and Application Usage Software. Research involving the flipped classroom indicates that many border students tend to be reticent and hesitant when it comes to posing questions (Poskitt et al. 2021). Consequently, the utilization of the ZOOMRBT application has assisted students in feeling less inhibited and in generating novel ideas. The majority of students who participated in focus groups expressed the following sentiments:

"Therefore, students who are reluctant to present their projects might use Google Classroom and the ZOOMRBT program to demonstrate proficiency."
(MBS - Focus Group Interview - Q1)

When facing shyness about asking questions and while becoming proficient in using iPad device applications, boarding school students exhibit increased flexibility in presenting projects or engaging with learning. This arises from their heightened willingness to experiment, even if their mastery isn't yet comprehensive. They are adept at employing the ZOOMRBT application in conjunction with other applications for presentations, benefiting from a wider array of options. Their assertion is as follows:

Researcher *: Can documentation, such as PowerPoint, be used for presentations outside of the project?*
Students *: Yes (answer en masse)*
Researcher: What additional tools are there for making presentations?
Students*: Canva, Keynote, and PowerPoint.*
Researcher*: Who is proficient in Photoshop?*
Student*: Photoshop is hard.*
Researcher*: However, a more attractive automated garbage can design may be created using Photoshop. Who can use Canva effectively?*
Student*: All of us (Answer en masse)."*

(MBS - Focus Group Interview - Q2-Q5)

With access to a diverse range of applications, including ZOOMRBT, students exhibit heightened confidence when presenting group projects. This assertion

is substantiated by an analysis of the Daily Lesson Plan documents of the participating teachers, which reveals their encouragement for students to collaboratively create presentations while utilizing the application. The objectives outlined in the teachers' Daily Lesson Plan for this study are as follows:

"1. in teams; 2. Define the terms microprocessor (microprocessor) and microcontroller (microcontroller).

Describe the components that make up a microcontroller."
(SBP1, Document Analysis)

The temporal flexibility afforded by using the ZOOMRBT application and other apps during the course of this study augments student mastery within the flipped classroom framework. This latitude permits students to review content, craft presentations, and generate more sophisticated notes on their iPads. Below is a discourse on the subject of time flexibility extracted from a focus group interview:

Researcher: *allowing for usage of this iPad app during afternoon prep time and school breaks. Is afternoon prep permissible?*
Teacher: *If there is a learning session, a teacher will oversee it.*
Researcher: *If the teacher allows it.*
Student: *Yes.*
Researcher: *It implies that this application's use is adaptable. This iPad software may be used for studying during breaks from school and afternoon prep. Agreed, is it flexible?*
Students: *Agree (answer en masse)*

(MBS - Focus Group Interview - Q6-Q8)

This research further promotes contemplation of the utilization of the ZOOMRBT application, as it enables users to record and preserve their projects in video format. Such a form of reflective adaptability was highlighted during the interview, as illustrated below:

"Students will be able to look back on past school work ten years from now. Visual reflections on the project are another option. And we may use this application as much as we can throughout afternoon prep"

*(*MBS - Focus Group Interview - Q9)

In essence, technology apps endowed with flexibility play a pivotal role in bolstering the flipped classroom model. They provide customizable, interactive, and adaptable learning experiences, catering to the diverse requirements of students. Simultaneously, these apps offer teachers invaluable insights to enhance their instructional methods (Tomas et al. 2019).

APPLICATION SKILLS THEME

For the successful execution of the flipped classroom model, it's essential for both teachers and students to possess specific device software application skills (Xiao-Dong & Hong-Hui 2020). These proficiencies empower them to adeptly navigate and employ diverse digital tools that are integral for crafting, accessing, and engaging with educational materials. The level of mastery exhibited by boarding school students in utilizing application devices prior to this study is elucidated below:

Researcher: *Proficient to semi-proficient when using the application?*
Student: *Moderately proficient.*
Researcher: *It means you haven't fully or you have used the application. Thirdly, without an application or without an iPad, can you study or not?*
Students: *Can*

(MBS - Focus Group Interview - Q10-Q11)

This is substantiated by the subsequent statement regarding the suitability of the device: The students' moderate proficiency in using the technology prompted the instructor to adapt the device's usage:

Researcher: *Can you not? i.e., the sensor cannot be represented visually or programmatically. i.e., a laptop or an iPad is required for creating code. Can it be USB-connected?*
Student: *No way*
Researcher: *Therefore, the iPad cannot be used with Arduino. How would you want to connect your iPad, Arduino, and Tinkercad?*
Student: *No way*
Researcher: *need to utilize a laptop as well.*

(MBS - Focus Group Interview - Q12-Q13)

Due to the project's requirement for precision and appropriateness, students and instructors evaluate the applicability of the application when implementing the project within the flipped classroom. The ensuing discussion furnishes substantiating evidence for this assertion:

Researcher: *Do you utilize Tinkercad while creating a robotics project?*
Student: *No*
Researcher: *What do you use?*
Student: *We use Bluetooth.*
Researcher: *How is the code created, and how does a robot wish to avoid obstacles?*
Student: *Python apps.*

Researcher: *I assume you can do it on an iPad.*
Student: Yes.
Researcher: *For the garbage can project in the robotics project, you must utilize python or Magnetcode. Can you create a code for a movement sensor using Tinkercad to simulate an LED circuit?*
Student: Yes
Researcher: *Have you ever done it?*
Student: Never did.
Researcher: *It implies that you haven't yet attempted. You worked on this undertaking until it was finished. If Tinkercad is not an option, you can use Magnetcode or Python instead.*
Students: *These applications cannot be used on iPads; only on devices.*
Researcher: *With magnet code, Android may download phyton. Tinkercad is exclusively used on iPads for making and simulating circuits.*

(MBS - Focus Group Interview - Q14-Q21)

Keep in mind that the particular applications and software skills needed might differ based on the school's technological setup and the inclinations of both teachers and students. Consistent professional development and training opportunities can aid educators and learners in augmenting their device software application skills, thus contributing to a successful flipped classroom experience (Aidoo et al. 2022).

APPLICATION USAGE CREATIVITY THEME

The incorporation of technology into the flipped classroom can be viewed as highly innovative within the education domain. It marks a substantial shift away from the conventional teacher-centered approach, reshaping how students interact with and access instructional material. As individuals are responsible for harnessing technology, students' creativity remains indispensable. This progression commences with the teacher aiding the student, as illustrated by the ensuing example:

Researcher: So what is the end result of this technology, still the human touch, your own creativity, you have to think about how you want to install the wiring for example. For example, this ZOOMRBT application gives you ideas, but in the end, the teacher helps you to install it.

Student: Yes.- (MBS - Focus Group Interview - Q22)

The subsequent analysis of the teacher's lesson plan, which underscores the concept of designing a car race and encourages student innovation, serves to illustrate the resourcefulness of incorporating the program within the flipped classroom:

"Precisely draw a car race using a microcontroller."

(SBP1 - Document Analysis)

Students' creativity in mastering applications can be observed not only in drawing but also in sensor coding, simulation, and presentation within this study. This is substantiated by the subsequent assertion:

Researcher: *How would you like to create a product similar to a sensor?*
Teacher: *Students will code on a laptop that I will have ready. Additionally, students may build simulations in the Tinkercad program, including project examples, although these creations cannot be exported to an iPad. The migration of student downloads to the iPad*
Researcher: *It implies that the iPad is employed for presentation, simulation, and creative reasons.*

(MBS - Focus Group Interview - Q23)

This is corroborated by BPK1's guidance on local assessments, wherein he mentions his experience of evaluating students' understanding and knowledge by considering their responses to questions or their presentation of an electronic project.

MASTERY ASSESSMENT THEME

In the flipped classroom, mastery assessment is enacted through a blend of formative and summative assessments aimed at measuring students' comprehension, advancement, and mastery of learning goals (McLaughlin et al., 2021). The crux of proficient assessment in the flipped classroom lies in its alignment with the instructional material offered outside of class, as well as the in-class engagements that foster profound learning and the application of knowledge. However, a limitation in this study's utilization of the ZOOMRBT program and the Quizizz website is highlighted in the ensuing exchange:

Researcher: *I'll keep an eye on your project as well. Have you ever responded to a quiz on one of the ZOOMRBT apps?*
Student: *Yes*
Researcher: *During the preparation period, how challenging or easy are the quiz questions?*
Student: Depends.
Researcher: *There are two types of difficulty. Do you have an essay-format inquiry or do you require a description-format response?*
Students: Objective questions
Researcher: *It indicates that the question may be answered and that it has an answer. You may respond to a question in 5 seconds or less of thought. He didn't have to ponder too much since he could just respond. Right, it implies to respond promptly.*
Student: *Right.*

Researcher. *Does that imply that no descriptive question exists?*
Student: *Yes.*
Researcher: *The meaning is more about the level of knowledge only, right?*
Student: *Right.*

(MBS - Focus Group Interview - Q24-Q29)

Teachers in a flipped classroom who pose higher-level questions such as analysis, synthesis, evaluation, and creativity can aid students in surmounting this sort of assessment hurdle, which primarily encompasses the level of knowledge and comprehension facilitated by the utilization of the ZOOMRBT application. When incorporating the ZOOMRBT device application within a flipped classroom, the instructor also showcases the category of mastery, as illustrated in the subsequent example from their daily lesson plan:

"The students are grouped. Each group is given a card with a question on it, distributed by the teacher. Instructions for the gallery walk activity to be conducted are provided by the teacher. At each bus stop and museum, every group will be permitted to explore in search of a suitable solution."

(SBP1- Document Analysis)

HUMAN TOUCH THEME

The human touch plays a pivotal role in the application of technology within the flipped classroom. While technology serves as a potent tool that enhances the learning experience, it is the human element—teachers and students—that imparts the flipped classroom with its distinct and impactful attributes (Gómez-Carrasco et al. 2020).

Researcher: *The fourth is that the majority of items have icons that resemble applications. In terms of technology, do you as a person value the iPad more than your teacher?*
Student: *Teacher*
Researcher: Obviously the teacher. The iPad is quite helpful, but it can't replace a teacher, right?
Student: *Correct (all student answers)*

(MBS - Focus Group Interview - Q24-Q29)

EXPERTISE AGREEMENT

The flipped classroom learning environment has garnered the approval of expert teachers, as depicted in the chart below. The number of points awarded should be halved. The expert instructor provides a rating of 9 on a scale of 1 to 10. Even though there may be certain imperfections that can be addressed through human intervention, they express contentment and are in agreement that the ZOOMRBT device application is well-suited for use in flipped classroom instruction:

TABLE 3. Expertise Percentages Agreement

Name (Theme and Category)	Percentages /10
Mastery of ZOOMRBT Application Flexibility	9
Presentation Flexibility	9
Presentation Confidence	9
Presentation Software	9
Application Usage Time	9
Learning Reflection	9
Medium Skills	9
Device Compatibility	9
Hands-On Skills	9
Visual Creativity	9
Assessment Level	9
Disadvantages of Assessment Technology	9
Group Projects	9
Teacher Assistance	10
Combination of Teachers and Devices	10

CONCLUSION AND RECOMMENDATION

In a flipped classroom learning environment that emphasizes adaptability, application skills, creativity, assessment mastery, and the human touch, device applications play a central and instrumental role. These applications serve as essential tools to support and enhance the various aspects of the flipped classroom model. Here's how device applications can be employed effectively:

Adaptability and Personalization: Device applications allow for flexible and personalized learning experiences. Teachers can use a variety of apps to curate content that meets individual student needs, interests, and learning styles. For instance, adaptive learning platforms can adjust the difficulty of questions based on student's performance, ensuring they receive appropriately challenging content.

Application Skills and Creativity: Device applications can foster creativity and application skills. For instance, creativity apps, such as graphic design tools, video editing software, or coding platforms, enable students to express their understanding of concepts in innovative ways, such as creating multimedia presentations, videos, or interactive projects.

Interactive Content Delivery: Applications designed for interactive content delivery, such as educational games, simulations, or virtual reality experiences, can engage students and promote active learning. These tools can immerse students in real-world scenarios, encouraging them to apply their knowledge and problem-solving skills.

Assessment Mastery: Device applications provide opportunities for diverse assessment methods. Teachers can employ formative assessment apps to gauge student understanding in real-time during class discussions and activities. Additionally, digital assessment platforms can be used for quizzes, tests, and projects to evaluate students' mastery of learning objectives.

Communication and Collaboration: Applications like video conferencing tools, instant messaging platforms, and collaborative workspaces are crucial for fostering communication and collaboration among students and between students and teachers. They facilitate real-time discussions, group projects, and peer-to-peer interaction.

Feedback and Reflection: Device applications can support timely feedback and self-assessment. For example, teachers can use feedback tools to provide comments on student work, and students can use reflective journaling apps to assess their progress and understanding.

Data Analysis and Decision Making: Device applications offer data analytics capabilities that assist teachers in tracking students' progress, identifying learning trends, and making data-driven instructional decisions. These insights enable educators to adapt their teaching strategies to better support individual students.

Social and Emotional Learning (SEL): SEL apps can help foster emotional intelligence, empathy, and social skills, enhancing the human touch aspect of the flipped classroom. These applications may include mindfulness exercises, emotional regulation tools, or digital platforms that promote positive communication and collaboration.

Teacher Professional Development: Device applications also serve as resources for teacher professional development. Teachers can access webinars, online courses, and educational resources to continuously improve their instructional practices and stay updated on innovative teaching methodologies.

Accessibility and Inclusivity: Device applications contribute to making education more accessible and inclusive. With features like text-to-speech, closed captioning, and language translation, these tools accommodate diverse learners, including those with different learning styles or disabilities.

In summary, device applications play a pivotal role in facilitating adaptability, creativity, assessment mastery, and the human touch in a flipped classroom. They empower teachers and students to engage in dynamic, interactive, and personalized learning experiences, making the flipped classroom a highly effective and inclusive educational approach. Flipped learning or the flipped classroom is a strongly learner-centered approach that provides learners sufficient autonomy to choose their own time, pace, place, and supporting materials for the learning content (Alfaifi & Saleem 2022).

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DECLARATION OF COMPETING INTEREST

None

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