THE IMPACT OF MICRO-LEARNING BASED FLIPPED CLASSROOM MODEL ON ACADEMIC PERFORMANCE AND ENGAGEMENT OF STUDENTS IN BIOLOGY

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Abstract

Objective

The focus of the current article is to investigate the impact of a flipped classroom with micro-learning-based model on academic performance and engagement of students in Biology. It assesses the needs of students and teachers within the model and analyzes the existing literature to compare student academic performance and engagement between experiment and control groups using the model.

Methodology

The analysis and review of the literature of interest adopted systematic, meta-analytic and integrative review research methodologies to meet the objectives of the research article. Also, the article adopted the literature review analysis outline by Kraus et al. (2020) and, in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.

Findings

The study revealed that integrating micro-learning flipped classroom hybrid model is one of the most effective teaching models that addresses the lack of practicability by promoting active learning, customized instruction, and improved student engagement. Students undertake the learning process by themselves through independent learning before class, followed by the teacher in the classroom focusing on the content that students do not understand, to improve students' independent learning ability and problem-solving ability.

Conclusion

The adoption of the micro-learning-based flipped classroom approach significantly boosts both engagement and academic outcomes for students. This educational strategy is affirmed as a potent tool in elevating the quality of learning and teaching experiences in the field of Biology, advocating for its wider implementation to achieve superior educational achievements.

Introduction

In modern society, the concept of education is built upon the ideology of "teachers teach, student learn", a concept that is based on "definition - theorem - derivation - conclusion" methodologies of teaching and learning. In layman terms, teaching is defined as a practice that involves the transmission of knowledge and skills from the teacher to the learner within the context of an educational paradigm (Cevikbas & Kaiser, 2020). There are different teaching methods and practices including inquiry-based learning, problem-based learning, cooperative learning, educational game, collaborative learning and flipped classroom, most of which are directly affected by effects of the ever-changing teaching technologies. While most of these teaching methods have been widely adopted by educational institutions, most methods are not effectively applicable and have not been used within practical environments. The teaching framework applied by most teaching methods gives the teacher a central role and only teach theoretical concepts and limits the practical ability of the students to the classic examples provided in textbooks. As a result, the students lack the consciousness and creative mind to actively find and solve problems in production and satisfy social needs (Marpa, 2021). The inefficiency of the existing methods in terms of practicability highlights the importance of understanding the concept of classroom models and its effect on academic performance and engagement of students in practical subjects such as Biology.

The flipped classroom model is based on the principles of active learning, experiential learning, student engagement and useful feedback. The flipped classroom model is one of the most effective teaching models that addresses the lack of practicability by promoting active learning, customized instruction, and improved student engagement (Busebaia & John, 2020). The model is based on the concept of shifting the delivery of content outside a confined environment to increase practical engagements and interactive activities and thereby, addressing most of the limitations of the traditional lecture-based approach and offers opportunities for more effective and engaging learning experiences. Under the flipped classroom model, the students are given the opportunity to undertake practical activities that are associated with the theoretical concepts learnt in class during their own time by either watching videos or accessing resources, which enhances the understanding of the taught concepts, theoretically and practically. While it is considered as an effective teaching method, the flipped classroom has some limitations including limited access to instructor guidance during the pre-class phase, and the need for additional assistance, which might not be readily available outside the classroom. The shortcomings can be solved by complementing the flipped classroom strategy with another strategy such as micro-learning model. Despite these

limitations, the flipped classroom method based on a micro-learning model is still an effective method for teaching practical subjects such as Biology.

As a subject, Biology is constantly evolving and every day, new developments improve are discovered that affect living this with new species being found while others are facing extinction. The ever-changing landscape of the field of Biology makes it a fascinating subject to teach considering the challenge of keeping up with the latest research, especially in advanced fields such as cell and molecular biology. Teaching Biology requires the students to have access to laboratories for hands-on observation of fresh specimens and practical experience (Nieto-Escamez & Roldán-Tapia, 2021). Practical experience has been adopted by most high school biology teachers based on its ability to influence creativity by allowing students to manipulate objects and conduct studies (Tunnicliffe & Ueckert, 2007). According to Ueckert & Gess-Newsome (2006), active engagement of students leads to efficient transmission of knowledge and skills, especially when teaching biology. The micro-learning has set a new precedent in teaching practical subjects and the incorporation of the flipped classroom model can lead to the development of a powerful and an effective teaching methodology (Corbeil & Corbeil, 2023). The trends of microlearning development were also summarized since the late 19th century and microlearning had a crucial role to play as an on-demand, anytime and anywhere instructional and training instrument.

Based on the existing literature, there are a lot of challenges associated with traditional teaching methods, like teacher-centered method and presentation teaching. The inefficiency of the traditional teaching methods stems from the fact that the needs and requirements from students for new and updated knowledge have moved to higher levels, and that low engagement in classrooms has become more and more obvious. The traditional teaching and learning methods are rigid and there is passive sharing of information. Also, the students' learning mode involves the imitation of the teacher's actions and, therefore, the students learn passively rather than actively (Karalis & Raikou, 2020). As a result, a new multi-model teaching strategy should be designed to address the inefficiencies of the traditional teaching methods. While most of the existing literature have focused on the different teaching methods, very few have investigated the impact of a multi-model strategy that involves the incorporation of more than one teaching methodology. The primary objective of the current research article is to investigate the impact of a flipped classroom with micro-learning-based model on academic performance and engagement of students in Biology. The article focuses on studying the needs of students and teachers within the model and analyzes the existing literature to compare student academic performance and engagement between experiment and control groups using the model.

Methodology

The primary objective of the current article is to investigate the impact of a flipped classroom with micro-learning-based model on academic performance and engagement of students in Biology through a detailed analysis of a literature review. The review of literature adopted systematic, meta-analytic and integrative review research methodologies to meet the objectives of the research article. Under the systematic approach, the article synthesizes the existing literature included in

the literature review of interest, a methodology that is important in overcoming any possible biases associated with the adoption of a specific research methodology. The meta-analytic methodology of the article focused on the findings of the existing literature included in the review to predetermine the findings of similar research. Also, the integrative methodology of the review entailed a detailed analysis of the theoretical literature and provides more information associated with the topic of research. The overall research methodology of the research study followed the generic framework for conducting article reviews including literature research and screening, data extraction and analysis, and the review of the literature. Also, the article adopted the literature review analysis outline by Kraus et al. (2020) and, in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.

The analysis of the literature review incorporated in the article adopted the three aforementioned methodologies of systematic, meta-analytic and integrative review. The original source of the literature review of interest is by Jihua Guo titled "*A Flipped Classroom with Micro-learning Based Model to Improve Student Academic Performance and Engagement in Biology.*" The steps followed in the extraction of information from the sources entailed planning, conducting, and reporting the findings. The planning step of the research article involved the identification of the sources that were included in the literature review. Also, within the same step, the author undertook a detailed analysis of the methodology and findings of the incorporated articles and sources to extract the information related to the topic of interest. The analysis was guided by a preliminary review of the literature of the included articles and their relationship with the the impact of a flipped classroom with micro-learning-based model on academic performance and engagement of students in Biology, and associated aspects. It is important to note that not all the articles included in the literature review of the thesis by Guo (2023) had a direct relationship with the article topic but covered a wider scope of the different teaching methods and their relationship with student engagement and academic performance. Guo (2023) incorporated such articles on the basis of their indirect relationship with the topic and the ability to provide more insight on the relationship between the involved variables.

The conducting step involved a systematic search and selection of relevant literature from various databases and sources, ensuring a comprehensive coverage of topics related to the flipped classroom and micro-learning models. This step was crucial in gathering a broad spectrum of evidence and perspectives on the effectiveness of these educational strategies in enhancing student engagement and academic performance. The search criteria were meticulously defined to include studies that explicitly addressed the integration of micro-learning strategies within a flipped classroom context, specifically in the domain of Biology education. The selection process was guided by the principles of relevance, credibility, and the contribution of each study to understanding the overarching research question. This meticulous approach to literature selection ensured that the review was grounded in a diverse and robust evidence base, reflecting the latest developments and insights in the field of educational research.

Findings

A total of 39 research studies and articles were included in the literature review of the thesis by Guo (2023). A detailed comparative analysis of the sources in relation to the topic of the research is outlined in the Table 1 below:

No.	Author	Year	Relationship with Topic Title of Article
1	Lage et al.	2000	An analysis of 'Inverting the classroom': A gateway to creating an inclusive learning environment.
2	Anderson	2003	Assessed the recent developments and research questions associated with modes of interaction in distance education.
3	Kareem	2003	Investigating the effects of audio-graphic self-instructional packages on senior secondary school students' performance in biology.
4	Fredricks et al.	2004	Investigating the potential of the concept of school engagement and review of existing evidence.
5	Ahlfeldt et al.	2005	Investigated the extent of student engagement in university classes where varying levels of Problem-Based Learning (PBL) methods of instruction are in use.
6	Hug	2005	Exploring possibilities of utilization of narrations and storytelling for the designing of "Micro Units" and didactical micro-learning arrangements.
7	Bruck	2006	A detailed analysis of the micro-learning teaching model and why it should be incorporated in practical education.
8	Ueckert & Gess-Newsome	2006	Assessment of Active Learning in the College Science Classroom.

No.	Author	Year	Relationship with Topic Title of Article
9	Tunnicliffe & Ueckert	2007	An investigative study on teaching biology—the great dilemma.
10	Buchem & Hamelmann	2010	An assessment of the micro-learning teaching strategy and its impact on ongoing professional development.
11	Gerstein	2011	A full picture of the flipped classroom teaching model.
12	Bergmann & Sams	2012	An article focusing on "Flip your classroom" and how to reach every student in every class every day.
13	Jiao	2013	An investigative analysis of micro-lesson and its application and influence.
14	Huang et al.	2014	A reflective analysis of the "the Flipped Classroom" Teaching Design
15	Sweet	2014	Application, creation, and resources associated with Micro lectures in a flipped classroom
16	Jing & Xiaojun	2015	Analysis of the construction of the construction and application of Micro-class Mode of Instruction—With a Focus on College English Visual-aural-oral Course
17	Alrashidi et al.	2016	Provides a detailed overview of the definitions, dimensions, and major conceptualizations associated with student academic engagement.
18	Fredricks et al.	2016	A qualitative analysis of a survey measure of math and science engagement.
19	Emaliana	2017	Comparison between teacher-centered or student-centered learning approaches.

No.	Author	Year	Relationship with Topic Title of Article
20	Ceylaner & Karakus	2018	Analyzed the effects of effects of the Flipped Classroom Model on Students' Self-Directed Learning Readiness and Attitudes towards the English Course.
21	Chris et al.	2018	Investigating flipped classroom and problem-based learning in a programming module for computing conversion course.
22	Emerson & Berge	2018	An analysis of Microlearning learning model and its impact on knowledge management applications and competency-based training in the workplace.
23	Zhang et al.	2018	Determination of the best time to use rubrics in flipped learning.
24	Jones & Carter	2019	Investigating the relationships between students' course perceptions, engagement, and learning.
25	Suartama et al.	2019	An investigation on development of an instructional design model for mobile blended learning in higher education.
26	Yough et al.	2019	Flipping the classroom in teacher education: implications for motivation and learning.
27	Bond et al.	2020	Mapping research in student engagement and educational technology in higher education
28	Bond	2020	A systematic review on how to facilitate student engagement through the flipped learning approach in K-12.
29	Busebaia & John	2020	To investigate whether and how flipped classroom can enhance class engagement and academic performance among undergraduate pediatric nursing students.

No.	Author	Year	Relationship with Topic Title of Article
30	Cevikbas & Kaiser	2020	An assessment of flipped classroom as a reform-oriented approach to teaching mathematics.
31	Cevikbas & Kaiser	2020	Student engagement in a flipped secondary mathematics classroom.
32	Duvall et al.	2020	An analysis of the Flipped Classroom teaching model in terms of implementing multiple, simultaneous pedagogical styles.
33	Hosseini et al.	2020	Analysis of Flipping Microlearning-Based EFL Classroom to Enhance Learners' Self-Regulation.
34	Huang et al.	2021	Analysis of how an SVVR-based experiential flipped learning approach for professional training can facilitate decision making in authentic contexts
35	Lai et al.	2021	A multilevel investigation of factors influencing university students' behavioral engagement in flipped classrooms.
36	Marpa	2021	An Analysis of Teachers' Attitudes during the COVID-19 Pandemic.
37	Nieto-Escamez & Roldán-Tapia	2021	A mini-review on Gamification as online teaching strategy during COVID-19
38	Jung et al.	2022	Investigating the effects of the regulated learning-supported flipped classroom on student performance.
39	Romanenko et al.	2023	Microlearning as a new method of teaching soft skills to university students.

Table 1: Comparative Analysis of the Articles included in the Literature review by Guo (2023)

Discussion

The results of the analysis of the literature review provides a deeper understanding of the concept of educational learning based on the constructivism and autonomous learning theories. According to the analysis, constructivism is based on cognitive processing theory, as supported by the ideas of Bruck (2006). The theory posits that the learning process does not involve passive learning learners, but rather one that involves active building of knowledge (Hosseini et al., 2020). A learning activity based on the constructivism theory is authentic and learner-centered, which makes the learners to be more interested and motivated (Anderson, 2003). As a result, a constructive learning theory can foster critical thinking and make it easier to use different learning methods (Hosseini et al., 2020). Hypothetically, the cognitive development of a child's brain is based on constructivism and the learning process is strongly associated with a person's cognitive growth (Jing & Xiaojun, 2015). As such, constructivism is considered as an effective theory to explain the cognitive rules associated with the learning process, including the creation of meaning, formation of conceptions, and the important factors necessary for an ideal learning environment (Anderson, 2003). According to the constructivism theory, the concept of knowledge is not static but rather changes based on the degree of cognition of an individual of things and information, which highlights the significance of practical knowledge in learning (Suartama et al., 2019). To this end, the theory supports a learning methodology that promotes student engagement and interactive activities.

The research article results further identified the relationship between the autonomous learning theory and the need for student engagement and practical learning of Biology. According to the article, the autonomous learning theory involves the learner taking charge of their own learning and taking full responsibility for it. As a result, the learner is actively involved and make individual decisions based on their needs or preferences and keeping the goals in mind (Bond, 2022). According to Cevikbas, M., & Kaiser, G. (2022), the flipped classroom model aligns to the theory of self-directed learning, reflecting the autonomy of learning and the subjectivity of learners during Biology lessons. Under the model, students undertake the learning process by themselves through independent learning before class, followed by the teacher in the classroom focusing on the content that students do not understand, to improve students' independent learning ability and problem-solving ability (Ceylaner & Karakus, 2018). Based on the autonomous learning theory, the students' desire for self-learning increases leading to improved focus and student engagement (Busebaia & John, 2020). The research show that flipped classroom is an effective learning methodology and students are required to master the knowledge points in teaching through self-study before class, and they need to actively participate in the classroom, communicate with classmates, interact with teachers, understand, and analyze the knowledge they have mastered for proficient application (Duvall et al., 2020; Chris et al., 2018; Huang et al., 2021). Therefore, autonomous learning is fully expressed in the flipped classroom teaching model and significant contributes to student engagement and improved academic performance.

An autonomous and constructivist learning methodology such as the flipped classroom model entails self-monitoring, self-direction, and self-improvement. In a flipped classroom model, the learner takes charge of the learning process and make decisions on their learning activities, pace

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and method, and they should be responsible for their own learning of biological concepts (Gerstein, 2011; Yough et al., 2019). According to Duvall (2020), flipped classrooms require students to take responsibility for their own personal learning experiences and the leadership of learning belongs to the student. Under such conditions, the students enjoy the learning process and the learning activities are completed by the students themselves which enhances student engagement and improved academic performance (Zhang et al., 2018). Also, based on the model, the basic order of the learning process is to learn first and teach later, and students are the focal point of the process (Lai et al., 2021). In the Biology classroom, students become the active participants with the learned ability of solving practical problems encountered during the learning process through communication and cooperative activities with teachers and peers (Huang et al., 2014). The flipped classroom teaching model is an important contributor of self-improvement: whether before, during, or after class, since the learning process is controlled by the learners (Fredricks et al., 2004). Therefore, it can be hypothesized that the flipped classroom model enhances student engagement and improved academic performance on the basis of giving the student the responsibility for their own personal learning experiences.

As a learning strategy, the micro-learning model is based on small content and short media. Proposed by Lindner (2005), the technique was initially designed for adult education but has gradually expanded into the mainstream education system and on-job training and has become an effective in teaching Biology. According to Hug (2005), the micro-learning technique divides the educational content into smaller learning modules and focused on shorter learning activities. The technique applies digital network and new media as the learning environment with a focus on the organization of the new knowledge structure (Buchem & Hamelmann, 2010; Bruck, 2006). The smaller learning modules are important in the development of interrelated learning units and associated learning activities that facilitated the learning processes and communication (Emerson & Berge, 2018). It is further hypothesized that the 'micro' concepts of the micro-learning technique are not only a reflection of the small content knowledge of the constitutional content blocks but also necessary for understanding of the development of the type of learning and the associated attitude. In the modern technological society, the micro-learning content is perceived as an object and is specifically designed to meet the needs of the different types of learners based on the required knowledge or skills within different times and spaces (Bruck, 2006). As such, micro-learning is a learning technique with a short time, fragmented content, personalized learning, and multi-media.

With the different characteristics and features, a combination of the flipped classroom model and the micro-learning technique produces a learning hybrid that can effectively enhance student engagement and improve academic performance. The learning hybrid entails the use of class time under the flipped classroom model for discussion and solution of difficulties and problems encountered during independent learning while the micro-learning technique is used by the student to independently undertake their homework by watching micro-videos with the content matching the original content taught under the flipped classroom model (Bruck, 2006; Jung et al., 2022; Romanenko et al., 2023). Also, it is worth noting that micro-learning can be component of the

flipped classroom model with micro-lessons having direct effect on the transfer of information before the classroom and influence the design of teaching activities in the classroom, which influences the final intended effect of teaching (Huang et al., 2014). By giving the learner the opportunity to direct their own learning process, the students can take the initiative to direct their own path and the self-organization theory of learning is important for development and innovation when learning biological concepts (Lage et al., 2000). Therefore, based on the theories of constructivism and autonomous learning, a micro-learning flipped classroom model follows the principles of classification and stratification, variety of activities, students are the focal point and the teacher is complementary.

The features of the hybrid model of micro-learning flipped classroom are effective in promoting student engagement and improved academic performance. According to Li et al. (2022), an experimental group using mini-game-based flipped classroom reported improved academic performance, flow experience and focus as compared to the control group using a video-based traditional flipped classroom in learning performance. Also, Jung et al. (2022) reported that a self-regulated supported flipped classroom model had a positive impact on student performance and improved their critical thinking skills. On the same note, the integration of innovative pedagogies with flipped classroom can be effective in influencing the attainment of learning objectives, student engagement, decision-making performance, and critical thinking capabilities of the students (Huang et al., 2021; Ueckert & Gess-Newsome, 2006). Crucially, a micro-learning flipped classroom model requires the full attention and active participation of the learner which influences the extent of student engagement and involvement in the learning process (Cevikbas & Kaiser, 2022; Lai et al., 2021). According to Sweet (2014), student engagement during the learning process is influenced by their cognitive state which is associated with associated with mental and motivational efforts including critical thinking, autonomous learning, and deep learning. As a learning model that influences cognitive engagement, a micro-learning flipped classroom model influences student engagement by enhancing their critical thinking capabilities and improving their self-monitoring capabilities.

Conclusions

As an educational concepts, teaching and learning are both processes and products with an end-goal of transmission of knowledge and imparting of skills to the learner by the teacher. There are different teaching methods and practices that have been widely adopted by educational institutions even though most of them are not applicable under practical environments. One of the teaching models, the flipped classroom model, is based on the principles of active learning, experiential learning, student engagement and useful feedback. The model gives the students the opportunity to undertake practical activities that are associated with the theoretical concepts learnt in class during their own time by either watching videos or accessing resources. While it has its own limitations, the flipped classroom model can be complemented by other teaching models to meet the learning objectives based on the needs of the learners and the availability of the necessary resources. A possible learning technique that can complement the flipped classroom is the micro-

learning model which entails dividing the educational content into smaller learning modules focusing on shorter learning activities and, applying digital network and new media as the learning environment.

A micro-learning flipped classroom model is effective in promoting student engagement and improved academic performance. The micro-learning has set a new precedent in teaching practical subjects and the incorporation of the flipped classroom model can lead to the development of a powerful and an effective teaching methodology. The hybrid model is one of the most effective teaching models that addresses the lack of practicability by promoting active learning, customized instruction, and improved student engagement. Under the model, students undertake the learning process by themselves through independent learning before class, followed by the teacher in the classroom focusing on the content that students do not understand, to improve students' independent learning ability and problem-solving ability. Also, the students enjoy the learning process and the learning activities are completed by the students themselves which enhances student engagement and improved academic performance. Based on the research, therefore, it is concluded that the hybrid model of micro-learning flipped classroom learning strategy has a positive impact on student engagement and academic performance by giving the students the opportunity to take control of the learning process leading to motivation and desire to learn Biology.

The hybrid model, integrating micro-learning and the flipped classroom approach, offers significant benefits in educational settings, particularly in teaching complex subjects like Biology. This model not only fosters a deepened engagement among students but also enhances their academic performance by empowering them with the autonomy to tailor their learning journey according to their pace and interests. Furthermore, this strategy underscores the importance of active learning and problem-solving skills, equipping students with the necessary tools to tackle real-world challenges effectively. As such, the adoption of this hybrid model could serve as a catalyst for transforming traditional educational paradigms, encouraging a more dynamic, interactive, and student-centered learning environment.

Contributions

The thesis contributes to the area of teaching methodologies. Specifically, it introduces novel thinking and techniques to the field of micro-learning flipped classroom learning strategy and its application in teaching practical subjects like Biology. The current section addresses contribution of the thesis to theory, methodology, and practice:

1. Contribution to Theory

The thesis contributes to the existing theoretical information on impact of a multi-model on academic performance and engagement of students in Biology. It hypothesizes that the flipped classroom model, is based on the principles of active learning, experiential learning, student engagement and useful feedback, and that it gives the students the opportunity to undertake practical activities that are associated with the theoretical concepts.

2. Contribution to Methodology

The methodological contribution lies in the experience gained through the application of research methodologies and techniques applied for data collection. Also, the methodological contribution of the thesis relates to the appropriateness of application of theoretical concepts and theories developed within the context of the research study.

3. Contribution to Practice

A practical contribution of the thesis is the detailed insight provided by the results of the research. The thesis addresses the shortcomings of the traditional teaching methodologies in relation to learning practical subjects like Biology. It provides practical recommendations on the application of a multi-model solution that gives the students the opportunity to undertake practical activities that are associated with the theoretical concepts.

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