



The Impact of Flipped Classroom Models on K-12 Education in African Countries: Challenges, Opportunities, and Effectiveness

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ABSTRACT

The flipped classroom model, which shifts direct instruction to outside the classroom and brings active learning into the classroom, has shown potential in enhancing student engagement and performance. This study investigates the implementation and impact of flipped classrooms in K-12 education across various African countries. Utilizing a systematic review and empirical data from randomized controlled trials, the research explores the challenges and opportunities associated with this pedagogical approach in resource-constrained settings. Findings suggest that while the flipped classroom model can significantly improve student outcomes, its effectiveness is contingent upon access to technology and ongoing teacher support. The study underscores the necessity for tailored strategies to overcome barriers and optimize the benefits of flipped learning in diverse educational contexts across Africa. Keywords: Flipped classroom, K-12 education, African education, blended learning, active learning, educational technology, student engagement and teacher training

INTRODUCTION

There is general agreement that students learn more from their learning experiences when they have opportunities to articulate and show their understanding by becoming responsible for exploring through concrete and illustrative activities [1]. Yet in the traditional classroom learning, learning typically occurs in the classroom, while doing homework does not include opportunities for discussion and demonstrations of student actions and performances. With regard to feedback mechanisms, because most homework is completed for the teacher, it is often checked and given back after the fact [2-6]. More importantly, students do not have the opportunity to change their learning in response to the subsequent assessment information, and the result is that inconsistencies in assessment feedback are made [2]. However, advances in computer technology, software, science, and communication have made it possible to personalize learning to support more diverse academic needs of learners and enable them to own the responsibilities of their learning [4]. It can largely be argued that students in classrooms come with a variety of diverse background experiences, educational opportunities, and therefore are wired differently [7]. This argument is supported by the theory of multiple intelligences, modularization of the mind, and learning styles. Yet, there is no teaching and learning model that can adequately cater for these differences [5]. Classical classroom models mainly involve a teacher-centered approach towards teaching and learning, following a long-established tradition of schooling, as well as prescriptive content and extended assessment. Most importantly, schools are structured in terms of time and space available for learning, greatly facilitated by the school's regimenting system. In such a classroom environment, students become passive rather than active and independent learners [8-12].

Background of Flipped Classroom Models

At a basic level, an educator can ask themselves, "Does the student, as they exist today, require my physical presence to understand concepts and practice methods?" If the answer is yes, then perhaps the flipped model is appropriate [13-15]. In a broader scope, new questions should involve home dynamics. What would the exposure to the internet and online content be to a child that is used to traditional learning? Are the children of today independent of their parents? While the last question is largely unknowable, the flipped classroom model and the types of technologies and content it uses carry an expectation of independent students open to all sorts of abuse [16-20]. These questions carry special prescience in Africa, where the digital divide is at its greatest. It is precisely due to this emphasis on rural African education that this paper defines flipped classrooms in two ways [18]. Apart from having the background in the terms present in this paper, questions should include effectiveness, classroom evaluation, the role of adults in such classrooms, and what the detrimental effects of a flipped classroom would be. The concept of breaking down the walls of traditional classrooms and effective differentiation and student-centered models has been

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believed to have begun in the United States [21]. There is no clear evidence on the exact point at which this pedagogical transformation began, but according to a web-based article, Bergmann and Sams (2012) of Jon Bergmann and Aaron Sams are credited with coining the term "flipped classroom" to describe their use of recorded lectures and manipulatives in chemistry instruction. Encouraged by the success that these two teachers rapidly had in their classrooms, other educators followed [22-27].

Methodology

The PRISMA statement was used to report on the included studies, which reflect a search that was centered around identifying as many available sources as possible, for a purpose that's internally valid [23]. The inclusion and exclusion criteria used in the study were as follows: which focused on the flipped classroom instruction model, were conducted on K-12 or pre-college settings were implemented in a comprehensive or elementary school, school in South Africa and peer-reviewed [25]. After this, the study was conducted in sub-Saharan Africa, but since none was found, it was further broadened to include other African countries to be consistent with the subject of the study to include potential future research interests [28]. The study utilized systematic review methods in its design, searching databases including ERIC, Scopus, and Web of Science due to their matured and uncluttered nature with the use of the Boolean search method. Keywords which include 'flipped classroom', 'Khan Academy', 'lecture videos', 'homework', 'flipped learning', 'flip teaching', 'hybrid learning', 'pre-class instruction' and 'pre-recorded lesson' were used in different combinations, in order to find as many articles as possible which were closely related to the research question and also met the inclusion criteria of the study [29]. In addition to these keywords, we also searched Social Science Research Network (SSRN), Google Scholar, ProQuest, and JSTOR repositories, as these websites are some of the freely available and largest online databases for finding scholarly works/documents. The only limitation was that the articles must have been written in English [30].

Research Design and Data Collection

This paper empirically investigates the impact of a flipped classroom model aimed at improving students' outcomes in high school and college entrance exams, which play a central role in the Turkish education system. A three-armed experimental design was used in the study [31]. The average treatment effects on the treated values of blended learning and flipped classroom design were measured using data from timed regular class tests in a control group, a treatment class of 156 high school students, and a similar-sized actively treated treatment group [32-36]. The teachers from the treatment class used and blended various digital resources, digital data provision and classroom management tools, and taught based on data [28]. After the posed responses to their classroom management tools items, we calculated the conditional probability of the flagged mistakes, called the FLAG value [29]. The items were structured to help reduce the degree of separation between the high and low achieving students. To verify the benefits of adding the FLAG tool and value to classroom management, we used OLS and reduced form ordered probit models to estimate the effects of the grade components of the assigned homework. We found that the permanent impact of the flagged mistakes on test results is mainly driven by the in-class assessments in net of their own knowledge capabilities as opposed to the midterm or final exams [37-39]. Students exposed to the in-class management tool then registered higher scores than the control group, both in the subject the tool was used for and in math [40]. The group mean differences in scores by number of reinforced responses of the digital tool show a size effect for the calculated FLAG tool and the teachers' review of the flagged mistakes. Moreover, the teachers and policymakers in the group were asked to provide written feedback. We found that one in four randomly selected teachers said the students had difficulty completing the problem-solving task, and less than half believed their students would attempt to contribute more to the lessons [41]. On the other hand, whilst a wet study revealed that the percentage of the students in the managed classes who did not complete the homework task decreased from 61% to 77%, the removal did not lead to a meaningful decrease in the students' performance or grade. After 15 weeks, a randomized control trial was conducted in which the incentive construct of the digital tool was manipulated for a problem-solving task [42]. The literature suggests that flipped classroom instruction can be more effective than conventional, lecture-based teaching, with some qualifications [32]. This paper analyzes randomized trial data from Turkey, assessing the impact of a blended learning program on student assessment metrics and performance in high school and college entrance exams. These exams play a central role in secondary and tertiary education in Turkey [25]. The blended learning program combines face-to-face instruction, outside classroom digital resources, digital data provision and classroom management tools, and teacher-led instruction based on data. Students in the classes exposed to the blended learning program scored significantly higher in their student assessment metrics than students in the control group. We observed significant differences in both cognitive and non-cognitive skills between the blended learning group and the control group. The positive impact of the blended learning program was mainly driven by the students in the socioeconomically disadvantaged schools, students in remote areas, and female students [43-47].

Theoretical Framework

The operationalization of the flipped classroom principles helped develop the questionnaires and facilitate the process of observing learners for surveillance and questioning sessions for formative assessments to enable a quick

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improvement in the flipped classroom model use [34]. Furthermore, the fact that effective communication, collaboration, and networking are the key changes in the Connectivist Model of learning, and that technology such as Classroom4, social media, and LMS are the major resources for these networked environments, meant that achieving success in the flipped classroom model in K-12 education would need an alignment of effective use of these tools on the learning objectives [30]. Utilization of technology was, in a way, adapted as part of the Connectivist principles. The theoretical framework that informed this study was the connectivism theory of learning. This theory, developed by Siemens and Downes (2005), in the recent past has become very popular. [48] explain that connectivism represents a digital, 21st-century outlook relating to learning and development in a rapidly changing era where learning and working are intertwined [20]. The connectivist-based principles guided this study in terms of understanding the effective use of the flipped classroom model in the education of learners in these changing times [40]. These flipped principles attempt to help students think critically about the work they are doing in the classroom, maximize class time so students are doing, on average, ten times the amount of work of a traditional model, and provide a flexible environment to support and nurture flexible personalized learning opportunities for students [44].

Key Concepts and Theories

Before the definition of the flipped classroom, it is helpful to have a basic understanding of the driver of the model. The concept of the active learning model can be learned more fully in 2014 from the work of Meyers and Jones. More details, types of active learning models, and pedagogical research are included in their paper [25]. These will be helpful to obtain a fuller, better understanding of benefits and challenges, especially when the effectiveness in technology-enhanced learning is researched [49-51]. It is important to define the key concepts of this paper. The concept of the flipped classroom model may be defined in different ways in both research and practice. It may be classified, applied, practiced, or implemented in many ways [36]. That is why there are many different definitions in this field of study [52]. The most clear, robust, and formal definition of the model may be the model as created by Aaron Sams and Jonathan Bergmann. According to their work, students anywhere in the world, no matter where they had been (in school, at home, or in another public or academic area), could get open access to gain knowledge from video lectures which had already been created using the patent-pending Teach [53]. It was an app available on both Android and iOS. The flipped classroom concept was obtained from the blended model. Both models have two main common goals: that is, to use technology to have better, more interactive and collaborative pedagogy; and to move from the traditional 20th-century educational paradigm to a more modern 21st-century educational paradigm [54].

Case Studies

Flipped Classroom in Tertiary Institutions A considerable number of studies on the flipped classroom model in Africa are focused on tertiary institutions, even though the majority of these studies still originate from South Africa [45]. For example, in the study conducted by [55], it was reported that among a total of 11 primary studies reviewed by the authors, only three did not originate from South African institutions. Similarly, the study by Onasanya only included studies from higher institutions in Nigeria. Tertiary institutions spotted in some of these case studies include the Durban University of Technology (DUT), University of Limpopo (UL), Stellenbosch University, and Nelson Mandela University, which are all located in South Africa. In this section, we review existing case studies on the flipped classroom across different levels of education, starting from tertiary institutions, through to secondary and primary schools, focusing more on cases from African institutions. It is expected that insights from these case studies can offer a starting point for educators who intend to explore the integration of the flipped classroom model into their pedagogical activities [48-53].

Success Stories in African Schools

There are an increasing number of 'success' stories from African classrooms with FCI. Part of this story, or the genes for the successful variations of FCI across Africa, is in its mandate to actualize inclusiveness [56]. This means that the current crop of 54 independent African states, plus were carved into dependent colonies, cannot afford to ignore this model because of its dependency on technology [57]. Throughout the continent of Africa are and will continue to be elite schools. Among these will historically be 'mission schools', 'white schools', and post-independence top state schools educating children of the political or connected class [58]. Many boarding schools on the continent have long-established wireless routers—a less expensive necessity for modern life today [59]. The flipped classroom, or model of instruction that is grounded in the teacher seeing the child as a collaborative partner in the learning process, is on the rise worldwide. The flipped model turns traditional instruction, by way of direct instruction or lecture, on its head. One of the well-noted benefits of the FCI model is the time saved for doers rather than sitters in the classroom [50, 38, 43]. The variation of the model allows teachers in the poorest of schools or settlement communities to take advantage of these benefits. In these communities, FCI becomes a partnership with the community. Wisely, the variation itself can be influenced by what one imagines would work in a particular setting [59]. This idea of proximity can be seen in the report on the future capabilities and needs in Africa. The

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African learner can and should be seen as a partner in the flipped model that may have the 'headmasters' and 'teachers' in Africa facilitated or even instructed by others with the technical know-how [60-65].

Challenges and Opportunities

Even though nearly all primary schools in the world have access to electricity (99.4 percent), the computer ratio is only 1:16.6 [66]. In Africa, many schools still do not have electricity [67]. According to "African Decade of Persons with Disabilities: 2012-2021", statistics on the state of ICTs in education in Benin, Gambia, Ghana, Kenya, Lesotho, Liberia, Malawi, Mali, Mauritania, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Sudan, Togo, and Zambia conducted by the World Bank, in several countries, including Benin, Gambia, Ghana, Liberia, Senegal, and Zambia, only 10 percent or fewer schools had access to electricity [68]. Furthermore, hundreds of thousands of African teachers need to be trained on how to use ICTs in their teaching. Teachers need digital competence, digital resources, and a digital research community. There is a shortage of funding to reform education systems so that ICTs can be used to reach people with disabilities [69]. With such a steep learning curve, they face numerous challenges. The first major challenge is related to one key assumption about the flipped classroom: that every student has equal access to the Internet. But this is often not the case [70]. As noted in the report "Measuring the Information Society 2015", 53.6 percent of the world's population have no access to the Internet at the end of 2015. Notably, the disparity still exists in the gap between regions. The African region has the lowest Internet penetration, with 25.1 percent of inhabitants connected [71-78].

Barriers to Implementation

For the flipped classroom model to be successful and to ensure impact on student learning, educators need to be adequately and often trained, be monitored and evaluated, and receive feedback on their use of this model of instruction [68]. The initial investment in teacher training, (re)designing discrete courses, and online resources can be high, so teachers need to be regularly supported, and there must be a continuous improvement change and development strategy [65]. However, while there is continuous support for the model, the benefits may not crystallize immediately or in the long term [79]. This factor might also discourage teachers from investing more time and effort in the model. Speaking to the concerns of teachers and finding ways to address their problems and provide some form of upfront support would be important to overcome teachers' resistance to implementation [80]. Financial and material support could also be an indicator that the support is indeed present and tangible, rather than a framework of policies and guidelines that have no impact or effect [81]. Providing a clear roadmap and goal for implementation, as well as resources that would help teachers navigate through the process, could also encourage more teachers to experiment and develop strategies in their classrooms. The effectiveness of the flipped classroom model has been demonstrated in various contexts [82]. Various studies have shown that the model has the potential to produce positive shifts in student learning and motivation [67]. Its integration in the traditional classroom has attracted a considerable amount of interest from educators as well as other stakeholders concerned with student learning outcomes. However, there are also challenges and barriers at both micro and macro levels that affect the effectiveness of the model, especially in resource-scarce environments [83-85].

Conclusion and Recommendations

The reviewed studies all concentrated on K-12 education. All of the studies that met the inclusion criteria were journal articles, and the studies were all written in the English language. As we have seen, one of the common criticisms of using the flipped classroom model is that it is not equal for all students, meaning that those without technology access are disadvantaged and hence not effective in promoting equity in African schools where technology access is a challenge. While this may be true for countries with low broadband/digital penetration, an encouraging observation from this review is that in Ghana and Tanzania, where the researched studies took place, a lot of students have access to the required resources. We call on researchers from both regions to publish more on the same to confirm the effectiveness. We also call on researchers to carry out similar studies in countries with low broadband/digital penetration across the African continent.

Summary of Findings

The existing literature provides a set of explanations about how the flipped classroom model operates. This paper, however, sets out to investigate the effectiveness of the model in K-12 education in selected African countries. The belief is that, using the randomized controlled trials (RCTs) methodological approach, this paper encourages all developing countries to adopt. Researchers can elicit unbiased estimates of the causal effect of the flipped classroom models on pupils' academic performance. Initial findings confirm the possibility of using the flipped classroom model to improve pupils' performance in K-12 formal education. Both traditional and flipped classroom models demand time from the pupils. However, the flipped classroom model has fewer requirements for time from the teacher, and this particular resource is inadequate in many primary and lower secondary school classrooms in peak hours countries. Still, the flipped classroom model can also interfere with the teacher's capabilities to manage and control the learning process in real-time learning. What this means is that many low-income countries can turn to the model to save substantially both in time and money compared with traditional modes of instruction.

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