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# Curriculum design in the flipped classroom for elementary math lessons

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**Abstract**

This research aims to design a curriculum in the flipped classroom in elementary math courses based on the synthesis research method. The statistical population included all valid scientific papers regarding the flipped classroom. A total of 120 scientific papers were identified based on inclusion criteria, and finally, 60 research papers were selected based on exclusion criteria for final analysis. A researcher-made worksheet was used to collect, report, and record the information of the initial research. Findings were analyzed using Marsh's seven-step model of synthesis research and open and axial coding methods. The results indicated that the flipped classroom in an elementary math course is a student-centered program that creates different roles and responsibilities for the learner, teacher, and knowledge.

*Keywords:* Curriculum, Curriculum elements, Flipped classroom, Research synthesis

## 1. Introduction

The educational system needs an ideology to prefer the previous methods to support the need for change, adapt to the changes in society, and provide many opportunities for teaching and learning in all fields and levels by creating information-communication changes in their system. One of the revolutions in education is using new information and communication technologies for an online education system that continuously changed teaching and learning. This system has encouraged educational systems that have used only an independent approach (using face-to-face or online educational system) to use a different educational system. A media balance must be achieved so that the

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ICT element can play an effective role in more than 50% of the whole process to make the teaching and learning process effective [38].

One of the most important factors in this process is the educational methods of teachers in that community. In traditional education methods, a student is passive with very little intellectual activity whose learning depends on the teacher. In this approach, the role of the student is like a bank to which information is entrusted. This method is not suitable for today's learners who are digital natives themselves. Continued access to information, mass media, and friends through the Internet makes it no longer possible to meet children's educational needs through traditional methods.

Recently, e-learning, which has a wide range, is used to activate students in learning, as well as to deepen this process. One of the methods that is a subset of e-learning and is considered as a kind of blended learning is flipped classroom. This method is student-centered, in which students are more active in learning than the teacher, and the teacher only plays the role of a facilitator to motivate, guide, and provide feedback on student performance.

The flipped classroom method, is sometimes referred to as the flipped classroom, is an educational innovation that can transform previous learning-teaching processes. E-learning is widely used to activate students in learning and deepen the process. One of the methods that is a subset of e-learning and is considered as a kind of blended learning is flipped classroom. This type of innovation affects learning time management, doubles productivity, changes learning activities, the role of teacher and student, and learning place and media.

The teaching design in the flipped classroom begins in the classroom, continues outside the classroom, and returns to the classroom. In this precise design, the learner and the learning groups are formed with complete and transparent awareness of the objective, i.e., the competencies that should be achieved. They follow this process inside and outside the classroom using the media and learning resources that they search for or the teacher provides. Then, they share their results and achievements with their friends in subsequent classroom sessions. The flipped classroom is an opportunity to gain self-confidence while presenting what is taught, a way to revive out-of-classroom learning opportunities, and practice for lifelong learning [13].

A teacher flips the classroom and shifts direct teaching from the classroom to the individual space, providing more opportunities for broader interaction with students, helping students with learning difficulties, and enrichment and the greater challenge for gifted students, problem-solving, and activities that promote high levels of thinking. This method can effectively cope with the large volume of subjects teachers have to convey to students these days and constantly complain about the lack of time to do it. Flipped classroom time is valuable for teachers and students to solve if they have a question, while students usually face problems at home and while doing homework in traditional and standard classes [38].

This issue is more prominent in elementary school because students are at the beginning of the learning path and have not yet acquired the skills of self-monitoring and self-control without any metacognition. Flipped classroom helps them review a lesson repeatedly if necessary, thus eliminating the sluggishness of repetition for gifted students. Another benefit of this method for parents is reducing the cost of educational assistance resources. Establishing a descriptive system in elementary school aims to improve student's learning conditions and eliminate their undesirable anxieties. These anxieties are factors such as the need for repeating more than twice to understand the lesson, especially in math, and the feeling of anxiety and fear of being ridiculed by classmates in this course and flipped classroom is efficient in this regard.

Today's classroom methods seldom pay enough attention to the principles of thinking and intellectual independence, self-reliance, and the application of information and learning. These problems are significantly reduced in flipped learning. The scientific content in flipped learning cultivates the

power of thinking in the individual regarding social and high self-confidence through thinking and reading, using the right time, saving time, and organizing the class time properly.

Ismailifar et al. concluded that the flipped classroom method positively affects students' sense of belonging to the school. Aslani and Doosti indicated that the flipped classroom method significantly affects students' learning than the lecture teaching method. Chai Chang reported that flipped classroom promotes active learning, increases learner interaction and motivation, and makes better use of class time. Mohanty and Parida stated that flipped classroom method positively affected students' learning and led to a higher score. Nwosisi, Ferreira, Rosenberg, & Walsh found that flipped classroom method caused higher academic performance and skills and a better attitude toward learning. Guy and Marquis expressed that students trained in the flipped classroom method had higher academic achievement.

According to the mentioned studies, learners can absorb more information in a shorter time by flipped the teaching-learning activities. This meaning can open a new chapter in some areas for people who have already experienced continuous learning failure. Learners can be more challenging and confident than before. As technology makes it easier for learners to access previously presented lessons, the teacher's role changes from a source of scientific content to a supervisor of the learning process.

Various studies in the flipped classroom are mostly limited to learning outcomes in which students' interest and motivation are more important in the classroom. Therefore, the researcher tried to design and validate a curriculum design in the flipped classroom for elementary courses.

## 2. Methodology

The statistical population included all valid scientific papers regarding the flipped classroom. A total of 120 scientific papers were identified based on inclusion criteria, and finally, 60 research papers were selected based on exclusion criteria for final analysis. The "synthesis research" method was used to design a curriculum in the flipped classroom for an elementary math course. This method is, in fact, the application of knowledge to make thoughtful decisions about the curriculum. This knowledge results from combining the knowledge obtained from other studies and is more suitable for application in practice. To answer this question, the following seven steps were taken:

- Identifying first-hand resources according to the relevant keywords
- Classifying concepts, review, and conceptual analysis of key elements
- Specifying information clusters for the best design based on conceptual analysis models
- Putting information together within each category
- Continuing the repeated cycle of analysis/composition until the categories reach the required validity and the final statement is obtained
- Arranging categories for the desired application
- Interpreting synthetic content

Open and axial coding and qualitative analysis were used to analyze the data obtained from the synthesis. Then, the types of categories, their relationship, reducing and simplifying texts, discovering the relationship between concepts and categories, coding of relationships, results, and conclusion were achieved. Acker's curriculum element model was used to provide a comprehensive model due to its

comprehensiveness compared to other templates of curriculum elements. Two evaluators were used to re-encode the findings to ensure the codin and Cohen's Kappa coefficient was used to confirm the reliability. In this study, the agreement between the evaluators in coding was as much as 0.77.

## 3. Findings

The findings of 60 scientific studies were used for the final analysis containing the paper code, researcher name, publication year, and the operational definition of each research (Table 1).

Table 1: Basic characteristics of the studies and their main results based on open coding

| Paper code | Researchers | Characteristics Of Flipped Classroom |
|---|---|---|
| 1 | Green and Slart [13] | The flipped model relies on the transfer of information from the classroom and process-based learning, including comprehensive access to the PowerPoint provided by the university online learning management system, problem-oriented learning groups, describing and demonstrating evolving competencies through discussion. |
| 2 | Patton Vala et al. [30] | The flipped model involves preparing learners ahead of time to do interactive exercises during the classroom. In the first step, content is provided to learners in videos or audio lectures or reading contents. Learners review these contents ahead of class time, and the teacher emphasizes classroom to apply concepts. Therefore, the efficiency of the flipped classroom depends on the fact that learners are sufficiently prepared before the classroom. |
| 3 | Tai et al. [34] | The flipped class is specifically a combination of blended learning, e-learning, and traditional face-to-face teaching. The flipped classroom is a special type of blended learning in which web-based lectures are given to learners before the classroom. Studies have suggested that learners should be prepared to engage in face-to-face, higher-level interactive activities, including problem-solving, discussion, and debate. In addition, teachers are present in the classroom in person and provide instant feedback to learners while learners engage in learning activities at the highest level of Bloom's cognitive classification. |

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| 4 | Lajoie et al. [32] | The flipped classroom includes events traditionally relocated from inside to outside the classroom, and vise versa. In general, the flipped classroom is based on inclusive inclusiveness and active learning. |
| 5 | Little [35] | The flipped classroom is a teaching method to flip and get rid of the traditional teaching method. In the traditional method, the classroom is dedicated to educational content, and assignments are considered outside the classroom. However, the flipped classroom is a strategy that captures instructional lectures by videotaping and moving them out of the classroom. |
| 6 | Helgeson [28] | The flipped classroom includes spending class time on individual learning and using various teaching and learning, encouraging learners to take responsibility for their own learning, and empowering them to achieve content-driven learning. |
| 7 | Thomas and Philpot [51] | In this type of learning, more time can be spent in the classroom on thinking skills. Learners are also actively involved in learning and creating more knowledge while testing and evaluating their knowledge. |
| 8 | Schultz et al. [49] | This educational model is a pedagogical approach based on direct teaching that moves from the group learning space to individual learning and transforms group results into an active and interactive learning environment, where teachers use the subjects creatively to guide and facilitate learners' learning. |
| 9 | Terriot and Namon [14] | The student's responsibility in flipped learning model is to use self-learning methods to retrieve lessons at home or out of school through flipped learning tools such as Edmundo, YouTube, Aparat, Google App, screencast, learning channels, and cyberspace. The assessment used in flipped learning should be varied to evaluates and measure student achievement to achieve the specific objectives of each lesson. |
| 10 | Willie and Gardner [2] | The flipped learning is a blended learning model and encompasses any application of technology that affects the classroom. Therefore, a teacher has more time to interact with his students instead of lecturing to provide more personal feedback as well as help students get feedback from their classmates on homework and activities they do or do not yet understand. |

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| 11 | Pihler [20] | Flipped learning is an educational approach in which direct learning shifts from group to individual learning. As a result, group space becomes a dynamic interactive learning environment where students can apply concepts and participate creatively in subjects. |
| 12 | Lage, Platt, and Trellis [31] | This method gives students more freedom to learn and move forward based on their individual abilities. The teacher can also focus on the needs of the students, which is great for any individual learning style. |
| 13 | Bishop and Verleger [6, 8] | The flipped classroom can be described as group learning based on classroom activity and direct technology-based training at home for use outside the classroom. A lot of information can be gained through technology, and this feature should be compatible with education, especially in the flipped classroom. Education can be modified from memorization to conceptualization of knowledge using the correct and complete technology. The cost was descending because the classrooms were equipped with state-of-the-art technology and education relied on students' equipment. |
| 14 | Terriot and Nomen [14] | The flipped classroom allows students to study at home and do homework at school through educational technologies as a tool for managing education and assessing students. Therefore, students should have sufficient knowledge of communication and information technologies to learn independently and participate in a flipped classroom that focuses on students' creative thinking achievements. In this context, individual learning methods should lead to individual creativity. |
| 15 | Hamdan et al[25] | The flipped classroom is developed where educational objectives are designed in greater depth, and learning opportunities are increased. Teachers take full advantage of more valuable things than time through interaction and evaluation of students' knowledge. They help students explore learning topics and objectives in greater depth and challenge them by achieving high-level thinking skills. |

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| 16 | Turner and Patrick [40] | A learning environment designed to teach and uses technology to support the learner to achieve educational objectives. Such an environment is just right for the flipped classroom to connect technology to the curriculum. Collaborating and consolidating this approach, created through a technology-rich environment, can help motivate students and help them achieve mastery objectives. |
| 17 | Gholami and Abdullahi [52] | In flipped learning, the Internet should be used interactively for the benefit of groups. Therefore, all facilities for student productivity should be used to achieve this objective. |
| 18 | Wichadi [24] | Interactive learning is one of the principles of flipped learning so that students in the classroom spend most of their time interacting with their classmates and discussing and exchanging videos or educational materials previously at home. It also provides students with exercise packages based on which the teacher has prepared a film, and they solve them in small groups by interacting and participating with their classmates. At the same time, they fully benefit from the experiences and feedback of each other and their teacher. |
| 19 | Torkelson [50] | The flipped classroom is a new method of teaching that returns learning to the student and allows the teacher to facilitate the learning of individual students according to their individual needs. The flipped classroom is an educational strategy that consists of two parts of learning activities Group interaction in the classroom and direct individual instruction with the computer outside the classroom. |
| 20 | Bergmann and Sams [4, 3] | When teachers can walk around the classroom and interact with each student, and are more likely to understand students and respond to their emotional and learning needs. Studies have shown that having teachers who recognize and respond to children's social and emotional needs is beneficial, at least for the academic development of children, especially at-risk students. |
| 21 | John Hattie [44] | Teaching online enables students to move at their own pace and take steps according to their own needs. |
| 22 | Beasley and Opterpe [27] | Providing students with opportunities to practice their classroom skills and corrective teacher feedback is almost four times more effective than homework, in which the teacher has less chance to guide the student through homework. |

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| 23 | Mehrnoosh Karimi [30] | The flipped learning model has a positive effect on students' ability to comprehend reading skills. |
| 24 | Kaviani et al. [29] | The main focus of the student's learning process is active learning in the flipped classroom, which is influenced by factors such as causal conditions, external and internal motivations, learning process strategies (participatory, exploratory, independent, and deep, time management, teaching materials, and lesson plan (intervening conditions), individual, educational, organizational and cultural factors) and leads to the improvement of students' personal and educational outcomes. |
| 25 | Khairabadi [13] | Flipped classroom brings satisfaction and motivation to students. |
| 26 | Kaviani, Liaghatdar [19] | Flipped classroom responds to these challenges by improving learners' understanding and learning activities to gain a deeper understanding of lesson concepts and troubleshooting by moving the lecture out of the classroom and allocating class time. In addition, inclusive learning activities include active learning, peer learning, collaborative learning, problem-solving learning, and collaborative learning, consistent with theoretical evidence of flipped classrooms. |
| 27 | Kaviani [36] | Flipped classroom promotes student self-regulation, group engagement, and academic motivation. |
| 28 | Chang Tea [34] | Flipped classroom promotes active learning, increases learner interaction and motivation, and makes better use of class time. |
| 29 | Mehring [39] | Flipped classroom increases collaboration and interaction in the classroom. |
| 30 | Web and Domain [17] | Flipped classroom leads to increased progress in learning outcomes in the field of education. |
| 31 | Ramadan Bauer, Grani, Marshall [46] | Students take content outside the classroom and then interact with the instructor and classmates in the classroom in the flipped method. |
| 32 | Hang [12] | Flipping the classroom before class and after class engages the student, and that learning outcomes are positive. |
| 33 | Flaherty and Phillips [23] | Flipped classroom records multimedia lectures for learners, and they can watch it outside the classroom based on their reading speed. This approach transforms asynchronous classroom activities into inclusive-centered simultaneous learning. The flipped classroom flips and replaces what used to be classroom content with what used to be a homework assignment and examines them within the classroom. |

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| 34 | Jan Hessie et al. [26] | Flipped learning has emerged as a unique approach that shifts the role of classroom activities and homework. In traditional education, learners acquire new knowledge in the classroom through lecturing and practicing at home through homework. In flipped learning, learners need to acquire knowledge at home, such as watching a video recorded by the teacher and practicing skills in the classroom, where the teacher can demonstrate these skills to learners quickly and correctly. This approach provides an active and interactive learning environment in which teachers guide learners to apply the concepts creatively and engage with the subject. |
| 35 | DeLozier and Rhodes [18] | The flipped classroom is known for lesson plans, pre-recorded lecture content, and pre-class assignments. Hence, classroom time is devoted to working on problem-solving, advanced concepts, and collaborative learning. The presentation of educational content during the classroom is eliminated, and teachers can focus the individual learning. The flipped classroom is an all-inclusive model and learners should be responsible for viewing the recorded lectures, and preparing themselves for appropriate learning activities when entering the classroom. |
| 36 | McLean et al. [41] | This approach aims is to focus on application and discussion during the classroom, while the acquisition of fundamental principles and concepts is done by learners before the classroom. |
| 37 | Zainaldin and Attaran [54] | In the flipped classroom, learners are more active than in the traditional classroom, learning independently through the guidance of technology tools. |
| 38 | Derrousa[33] | The flipped classroom provides learners with basic instructional materials through videos or other transmissions, where they spend time in the classroom and doing activities. This approach, in contrast to the traditional classroom, was dedicated to learning activities outside the classroom. On the other hand, teachers can facilitate access to educational materials and their application for flipped classrooms. |

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| 39 | Young et al. [53] | A flipped classroom involves changing the valuable processes of simultaneously transferring content from a lecture in a classroom and identifying issues for practice and completion by learners at home. This training is viewed asynchronously at home, usually through video lectures, and learners use class time on specific issues, and they can get more help and explanation from a specialist. |
| 40 | Matisse [37] | The flipped classroom is an effective combination of traditional and virtual education using time inside and outside the classroom. |
| 41 | Maft and Mill [43] | One of the benefits of a flipped classroom is the opportunity for individual training. If lessons are provided to learners online, they can access that information anytime, anywhere. Using recorded lectures, learners can proceed based on the speed of their study based on the pause and repetition of observation. |
| 42 | Clark [14] | The flipped classroom model is a relatively new educational strategy that seeks to improve learners' performance and engagement by transferring lectures outside the classroom through technology and transferring homework and exercises with concepts into the classroom through learning activities. The instruction used in the flipped classroom is now available at home from videos and interactive lessons created by the teacher. Things that were used outside the classroom are now done in the presence of the teacher in the classroom. |
| 43 | McNally [42] | Factors that form the main elements of a flipped classroom include providing opportunities for learners to encounter pre-class content, watching recorded lectures, pre-tests, and in-classroom activities that focus on high-level cognitive activities, including active learning, pre-read, and problem-solving. |
| 44 | Prashar [45] | The flipped classroom approach is the first step in trying to avoid re-teaching the absentees. In this approach, teaching peers is a different paradigm for achieving Bloom's revised classification. They emphasize that flipped learning should develop skills that lead to high levels of Bloom's revised classification. These actions promote the participation and application of knowledge in the classroom and conceptualizing perception outside the classroom. |

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| 45 | Rotellar [47] | The rationale behind the flipped classroom approach is that it increases learners' engagement with the content, improves teacher-learner interaction, and enhances learning. In this approach, providing content in the classroom is excluded, and teachers can provide classroom activities by teaching learners how to access problems and apply information in real life. |
| 46 | James et al. [39] | Flipped classroom teaching methods are a pedagogy of blended learning by transferring teaching out of the classroom to apply the learning outcomes in the teaching space. This approach seeks more inclusive activity through experiences by transferring lectures outside the classroom and using the time for learning activities and working with concepts. The flipped classroom teaching methodology allows instructors to teach content and processes and use an inclusive learning environment that The philosophy behind flipped classroom teaching methodology allows instructors to teach content and processes and use an inclusive learning environment. In this approach, learners are confronted with pre-class titles by listening to pre-recorded tutorials or lectures and compiling pre-submitted texts to prepare learners to participate during class time for high-level interactions and activities, including problem-solving, analysis, discussion, and debate. |
| 47 | Kong [25] | Flipped classroom involves replacing traditional in-class lectures with instructional videos, and learners are expected to watch these videos before class. Learners often need to prepare before coming to the classroom to deal with practical problem-solving issues related to the film. In the flipped classroom model, learners do homework, projects, and homework based on watching a lecture video. |
| 48 | Amresh et al. [6] | The flipped classroom model emerged as an innovative measure to improve inclusive learning. The approaches in this structure are related to activities outside and inside the classroom. Pre-classroom activities may include reading textbooks or lecturing by watching instructional videos. Classroom learning activities include case studies, team-based learning activities to enhance the application and composition of teaching. In addition, active learning gives teachers the ability to identify how learners understand teaching materials. Therefore, pre-classroom activities in this method prepare learners for in-classroom activities to engage them in active learning exercises. |

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| 49 | Chen [13] | In the flipped classroom, traditional lectures can take many forms. One direct strategy for teachers is to consider a lecture video or screen, or audio file to teach key concepts, especially topics that are part of learners' homework. In an actual lecture, the instructor, as a facilitator, engages the learners in a range of problem-solving activities that they need to do homework to apply the knowledge. These problem-solving activities are generally performed in small groups, the ideal result of creating small communities of peer learning. The flipped classroom has these characteristics: A change in the use of classroom time/A change in the use of time outside the classroom/Performing traditional activities as homework in the classroom/Performing traditional classroom activities outside the classroom /emphasis on classroom activities on active learning, peer learning, problem-solving/pre-classroom activities/post-classroom activities/use of technology, especially video (film) |
| 50 | Abyssara and Dawson [45] | In the flipped classroom, teachers use technology to perform blended learning to deliver lectures outside the classroom and use the Internet during classroom activities for collaborative activities. The flipped classroom model combines the benefits of direct learning and active learning to engage learners in the learning process. |
| 51 | Clark [14] | The flipped classroom is a teaching method that transfers the lecture's content through electronic means to learners outside the classroom, and the classroom time is dedicated to practical activities. Some characteristics of the flipped model include focusing on the effective use of classroom time, adapting to learners' differences, engaging with problem-based learning, and increasing inclusive learning. On the other hand, this approach allows learners to take responsibility for their own learning to transfer these skills to lessons. |
| 52 | Kim et al. [25] | Flipped classroom models try to use classroom time for active learning and access advanced technologies to support a blended learning approach. In this approach, learners can access online lectures before class and prepare to participate in more interactions through high-level activities such as problem-solving, discussion, and debate. |

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| 53 | Golzari and Attaran [54] | This teaching method works with the same components of the traditional classroom, but the arrangement and the result that results from it can be different, and the teaching of the lesson content takes place outside the classroom. Doing homework, repetition, practice, questions, answers, and discussion on educational topics are part of the classroom activity that replaces teaching in the classroom. This change of layout leads to class dynamics, increased motivation, and deeper learning. |
| 54 | Davis et al. [2] | Several important factors are necessary for the effectiveness of the flipped classroom, including transferring learners from passive listeners to active learners, technologies that often facilitate the effort, class time and traditional homework time are combined, and homework is used in the first step during class to help individual learning, content is presented in a context related to real-world situations, classroom time is used to help learners, especially those with conceptual challenges, or to help learners engage in a high level of flipped learning and problem-solving. |
| 55 | Russi [3] | If learners do not want to spend their time reading the lecture video, they will miss class activities and quickly become discouraged and frustrated. Some learners may find it frustrating to watch movies outside the classroom, which has never been traditionally needed. Therefore, ways should encourage learners to stay that way with lecture videos designed for them. |
| 56 | Bepler et al. [18] | Flipped classroom refers to a learning design that flips inclusive assignments. Lectures are viewed online before the classroom, and its time is devoted to learning activities, in which learners engage with high-level concepts in teacher-organized groups, answer questions, give feedback, and quickly review key ideas. Classroom time is devoted to active learning, where learners solve problems, answer questions, listen to explanations of key concepts, and watch short films. |

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| 57 | Lai and Huang [34] | Flipped classroom represents a learning approach transfers basic knowledge in and out of the classroom changes to apply knowledge or do homework. Teachers can engage learners in learning activities to apply more knowledge. Learners can also learn by practicing, doing projects, and solving problems in the classroom. Learners in the flipped classroom can control their own learning speed and be responsible for the learning process. On the other hand, teachers can consider meaningful activities to stimulate learners' involvement in high-level thinking. |
| 58 | Hutchins et al. [28] | At the most basic level, the flipped classroom attempts to allocate educational materials for pre-classroom learning, which traditionally covers a lecture, while face-to-face time is used for further and active learning. The flipped classroom is the result of assigning learning contents while using classroom time for active learning strategies. Some of these strategies are feedback, group projects, or discussions. The core of the flipped classroom is devoting pre-classroom content, formative assessment, working on learning needs, competency development, and the role of the teacher as a guide. The flipped classroom implementation steps include using a flipped learning design to plan learning activities, creating opportunities for pre-study such as short films or training contents, developing diagnostic and complimentary assessments to determine learning needs, using active learning strategies, and technology to address learning needs and competency development. |
| 59 | Najikar et al [39] | flipped classrooms include individual pre-classroom for learning content, completing textbooks, watching pre-recorded lectures or presentations through PowerPoint slides and interactive videos, completing pre-classroom module tests and homework before the classroom, and interactive group activities in the classroom focuses on empowering learners to respond to course content by increasing and developing ideas in a variety of ways. A flipped classroom model is a participatory combination of active learning, team learning, and important strategies for equipping learners with the skills and competencies necessary for practice. |

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| 60 | Arto Garza [3] | The flipped classroom is a teaching method that transfers the lecture's content through electronic means for learners out of the classroom whose time is dedicated to practical activities. Some of the flipped model characteristics include focusing on the effective use of classroom time, adapting to learners' differences, engaging with problem-based learning, and increasing inclusive learning. On the other hand, this approach allows learners to take responsibility for their own learning to transfer these skills to textbooks. |

According to the findings of studies related to the research purpose (Table 1), first, all components are extracted through the open coding process. Then, all components are categorized based on common concepts based on the selective coding process. According to the coding process obtained from the first stage, in this section, first, the features of the flipped class curriculum are discussed based on Klein curriculum elements according to the code of each paper (Table 2). The findings are then plotted in a general and comprehensive model.

According to the results of synthesis research and open and axial coding, the flipped curriculum design in an elementary mathematics is as follows:

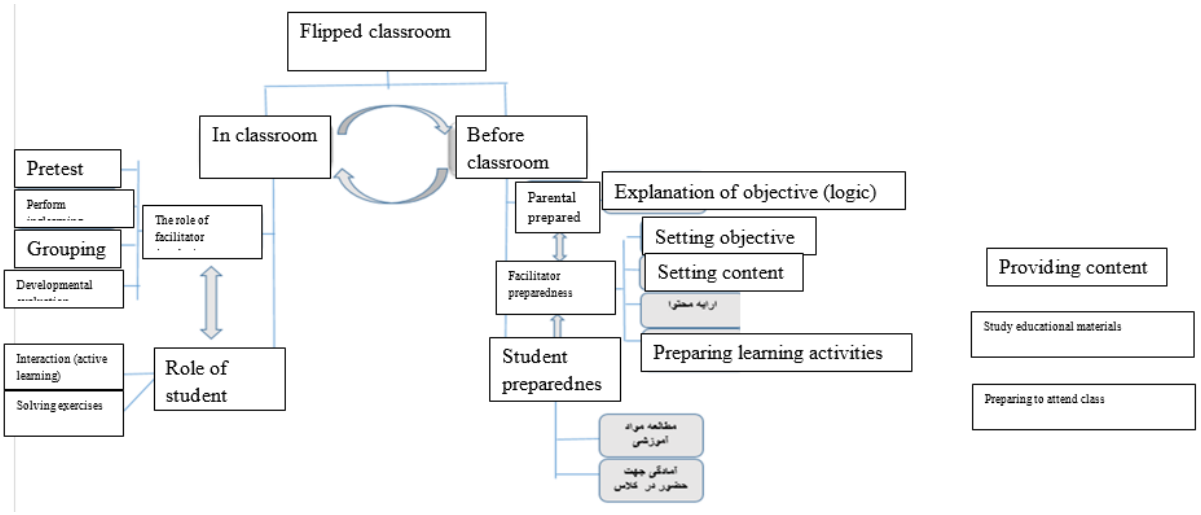


Figure 1: Flipped curriculum design in an elementary math lesson

$$kappa = Pi = \frac{(PA_o – PAE)}{(1 – PAE)} \qquad (1)$$

Table 2: Components of the macro curriculum and answers to related questions in the flipped class curriculum model

| No | Element | Answer based on paper code |
|---|---|---|
| 1 | objective | Learning control, a study based on learners' speed (1, 7, 19, 21, 43) Increasing learners' responsibility for their own learning (1,19,31, 21,36) Study time management, combining e-learning and face-to-face learning, (8, 12, 34) Eliminating classroom lectures (all papers) Individual and independent education and learning (21, 33, 17, 27, 31, 49, 59, 62, 63, 20, 25, 28, 26, 29, 40, 46). Outside the classroom consistent with Bloom's low levels of cognitive classification (understanding and recalling educational objectives); At classroom time, high levels of Bloom's cognitive classification (composition, evaluation, 8 and 17) Using of technology in the learning and teaching process (29, 37) |
| 2 | Content | Theoretical lesson materials (1) Fundamental concepts (3) The main concepts of different texts (11, 17) Key concepts of educational materials (16) |
| 3 | Learning activities | Learning before the classroom (watching educational videos 1, 2, 9, 10, 14, 28, 30, 33, 34, 44, 45) Evaluation and pre-test (30) Learning during the classroom; Problem-solving (9, 16, 20, 21, 25, 27, 28, 2, 29, 34, 45, 46, 7 and 56) |
| 4 | Materials and resources | Materials for reading texts (5, 7, 8, 17, 26, 23, 60) Teacher's recorded lecture video (3, 5, 9, 11, 13, 26, 27) Tutorial content (17) Internet (35) Online Movies (1,59) Educational videos (6, 12 and 17) Interactive videos (10, 11, 27) |
| 5 | Grouping | Interaction between teacher and learner (11) Feedback Exchange (19) |
| 6 | Location | In a class or out of class and any desired place to view Educational materials (all papers) |
| 7 | Time | Out-of-classroom time to watch lectures and instructional videos is devoted to watching lectures and instructional videos, and in-class time is devoted to learning activities. Learners watch videos and educational materials according to their preferred time before attending class, and class attendance time is required (all papers) Classroom time for homework (5,8,12,13,14,15) Using Classroom Time for Difficult Tasks "Application, Analysis, Composition and Evaluation" (All Papers) |
| 5 | Evaluation | Before class: pre-test (6) and development of diagnostic evaluation (15) During the classroom: Developmental evaluation (15) Evaluation methods such as projects and interactive exams etc. (20) Practical evaluation (19) Group-based evaluation (18) Peer evaluation (19) |

## 4. Conclusion

The flipped classroom design for elementary math lessons was developed based on the nine models of Klein curriculum to determine the flipped classroom of elementary math course according to the theoretical foundations in the second chapter through the synthesis research and documentation method.

### A. Objectives

**Strengthening problem-solving thinking:** The flipped method significantly emphasizes problem-solving learning and constructivism, which requires thinking and achieving meaning by the student. Classroom time is used to help learners, especially those with conceptual challenges, or learners engage in a high level of flipped education and problem-solving .

Most math teachers expect students to work on math problems at home, but these problems are so cognitively complex that most students cannot cope and have difficulty completing math homework. Flipping the classroom allows working on problems in the teacher's presence and achieving correct learning and mastery.

**Strengthening students 'communication skills:** Paying attention to socio-cultural categories in flipped method strengthens students' ability to communicate with each other and establishes a more effective relationship between them and their teacher, and their parents. Several cases in the philosophical and scientific foundations of the curriculum clearly addressed the selection and evaluation as one of the human competencies and values. According to the principles of arithmetic, "human's free movement and his choice are always achieved in the light of valuation," and the principles of anthropology state that "human is always in a position and can understand and change the existing situation to the desired situation by making the best choice." Elsewhere in anthropological principles, it is stated that "man can define his identity based on his choice." Therefore, paying attention to flipped education as one of the objectives of the math curriculum is in line with the philosophical and scientific foundations of the national curriculum.

**Strengthening self-confidence, motivation, and a positive view of the subject matter:** Strengthening self-confidence can weaken and reduce anxiety, which is one of the most destructive emotional variables in mathematics, especially for girls. Emotional variables such as self-confidence and motivation are emphasized in objectives and activity design in communication approaches from the 1990s onwards. This result was consistent. The flipped classroom brings satisfaction and motivation to students and leads to self-regulation, group interaction, and students' academic motivation [36].

**Creating a sense of interaction and strengthening independence:** Creating a sense of interaction and independence is another objective that is considered in this program. Therefore, the flipped classroom design for math lessons should stimulate a sense of interaction, cooperation, and participation in students while strengthening decision-making independence. In the flipped classroom, active learning is enhanced, student interaction and motivation are increased, and class time is better used. Communication learning also emphasizes individual learning and education as the main key while considering the interaction between students, students with the teacher, students with parents, students with the natural environment. Therefore, students' dependence on teachers gradually decreases, and their independence of thinking and decision-making increases .

**Strengthening learning management and accountability:** The flipped method emphasizes guiding students in the proper use of metacognitive, learning, communication, social, and emotional strategies and self-assessment to ensure that the correct use of these strategies occurs automatically in students. Proper use of these strategies leads to self-management in learning. Strengthening

learning management and accountability is one of the objectives considered in this model and is in line with other criteria [34]. In the flipped method, it is assumed that learners control progress and responsibility in the learning process based on their individual needs at their own pace.

**B. Content**

Flipped education characteristics indicated:

- Content should be designed in a meaningful context based on students' interests and needs (principle of attention to student interests and needs, principle attention to coherence, principle of active interaction and communication).
- Content should be designed based on the interests and needs of students' day and the introduction of different learning methods and lead students to flipped education. (The principle of paying attention to the student's interests and needs, the principle of lifelong learning).
- Analysis of teachers' opinions indicates a lack of coordination between the content of textbooks and other elements, especially time and its negative effect on the teachers' work as a shortcoming in the current curriculum. Content should be designed according to the allocated time and vice versa to address this shortcoming (principle of coordination).

**C. Learning activities**

Attention to the learning process, students' interests and needs, and attention to emotional variables such as anxiety and self-confidence in designing activities are observed in common approaches since the 1990s.

According to flipped education characteristics:

- Students' individual interests and differences should be considered in designing learning activities. (Principle of attention to the needs and interests of students, Principle of attention to individual differences, Principle of specialist teacher, Principle of student-centered student)
- Learning activities should be designed in a meaningful way and in accordance with the textbook (the principle of meaning-centeredness and flexibility).
- Learning activities should be designed from simple to complex and gradually reduce the teacher's guidance and control over their performance (student-centered student principle).
- Learning activities should reduce anxiety and increase students' self-confidence (principle of expert teacher).
- Learning activities should be designed based on the principles of constructivism and modern teaching methods (the principle of lifelong learning).
- The problem that most math teachers face is the lack of time to take full advantage of the power of handicrafts. Sine flipped classroom raises the issue of serious reconsideration of class time, teachers can make more use of hand structures.

### D. Teaching strategies

The active and pivotal role of the teacher is diminished traditionally in the teaching and learning process from the 1970s. In fact, the teacher role was introduced as a supporter, facilitator, an active member of the learners' group in collaborative learning, understanding the learners' world, paying attention to learners as a discoverer and analyst, helping students to manage their learning, helping students to interpret the input, creating an intimate atmosphere without anxiety [23]. Therefore, it is suggested:

- Teaching strategies should be designed to facilitate learning, not just knowledge transfer (principle of learning facilitation)
- Teaching strategies should be designed to stimulate metacognitively to learn management skills in students (lifelong learning).
- Designing teaching strategies should pay attention to emotional variables such as anxiety and self-confidence (expert teacher principle).

**Study of teachers' opinion:** This study showed that teachers are introduced to new teaching methods during their service, and more attention is paid to teaching methods in teaching education. They cannot adopt the learned methods in the real classroom environment and often have to adapt traditional methods in their teaching.

Teachers cite educational conditions and a lack of coordination between textbook content and other elements as influential factors in teaching methods. Accordingly, it is recommended:

- Teaching strategies should be designed in real classrooms in accordance with teaching methods in the field of methods (principle of coordination).
- Necessary coordination should be anticipated between content, activities, time, and teaching methods based on the principles of flipped approach and constructivist learning (principle of coordination).

### E. Evaluation methods

Alternative methods focus more on the learning process, student-centered strategies, guiding learning activities, as well as emotional variables such as reducing anxiety and boosting self-confidence in learning and helping students manage learning and adopting group activities since the 1970s [23]. These methods affect the way of evaluation and also puts more emphasis on formative evaluation that evaluates the learning process. Based on this study, it is recommended:

- Evaluation methods should be designed with an emphasis on the learning process (principle of coordination).
- Attention should be paid to individual differences and students' interests in adopting assessment methods (principle of attention to students' interests and needs; the principle of attention to individual differences).
- Evaluation methods should reduce anxiety and increase learners' confidence (expert teacher principle).

- Evaluation methods should be designed to encourage students to learn more (expert teacher principle).

Teachers' complaints about their compulsion to use traditional methods instead of modern teaching methods based on the principles of constructivism and communication indicate the acceptance of new methods and communication as superior methods to traditional methods by teachers. Therefore, more importance should be given to the formative evaluation, and group self-evaluation and evaluation should be considered as part of formative evaluation, along with the final evaluation, which assesses the standards and skills predicted in the goal (Principle of coordination; principle of expert teacher).

**F. Learning resources and instruments**

Alternative methods, from the 1970s, refer to the textbook as a source of learning, give the teacher the freedom to choose teaching materials appropriate to the intended educational objectives, and place more emphasis on real-world educational materials, students' interests, and needs to achieve educational goals.

Considering the centralized educational system and the importance of a common educational resource, it is recommended to supplementary resources based on the real world and the needs and interests of students along with the textbook as a common resource for all. Teachers can make the textbook content lessons attractive to the students by using new technologies. For example, they can use communication channels in cyberspace to post instructional videos or provide students with files that are relevant to the course so that they can always access them (The principle of attractiveness and matching with the real world; the principle of paying attention to the needs and interests of students).

Audio-visual learning resources, the Internet, and various texts emphasizing students' interests and needs should be considered. In fact, the fundamental concepts should be taken to the students' homes so that students, who are mostly in cyberspace and the Internet these days, can also view part of their course content through their devices and interact through out-of-class technology (The principle of attractiveness and matching with the real world; the principle of paying attention to the needs and interests of students). Considering the tendency and interest of teachers in using new methods in education and mentioning factors such as inadequate facilities and lack of coordination between content and other elements, especially time as factors influencing the distance between ideal methods for teachers and traditional methods that have to be adopted in the real classroom environment, it is recommended:

- To design learning resources such as textbooks and supplementary resources based on modern teaching methods.

- To design learning resources such as textbooks and complementary resources such as the Internet, educational videos, and communication tools to strengthen communication skills in accordance with the allocated time (principle of coordination; principle of interaction and active communication)

- To prepare video files of the concepts of each lesson to prevent long teacher lectures in the classroom, make available to students to watch and prepare themselves for group work and interaction in the classroom.

### G. Space and location

In alternative methods with student-centered education and process- and experience-based learning since the 1970s, the learning space is not limited to the classroom and under the teacher's supervision but also includes the space outside the classroom and the real world around the student. According to the designed model, parts of the content of textbooks and learning activities should be designed so that students automatically need to use the space outside the classroom to use learning experiences or gain new experiences. The teacher must provide the content of each lesson in advance in the form of videos and PowerPoint or educational games online or via CD to be prepared for homework and practice in the classroom and apply these skills in the learning environment after class (Principle of Lifelong Learning).

According to the interests and needs of learners, the content of education should be designed separately for learning in cyberspace in such a way that students can understand the basic principles and concepts of the lesson by observing them, summarize the desired content, and discuss the presented content in cyberspace or on the Internet with the teacher and other students, and prepare themselves for individual and group exercises in the classroom. Teachers' interest in using new methods and compulsion to use traditional methods due to inappropriate facilities and educational conditions and inconsistent content, as well as the difference in the real atmosphere of class in teacher education, indicate that they tend to use new methods if the educational conditions are appropriate and the negative factors affecting the teaching method are eliminated. As mentioned, the learning space is not limited to the classroom space in modern methods. Therefore, the use of out-class space, especially available technologies such as Internet sites, telegram, and WhatsApp groups, and other communication software in the design of textbook content and learning activities are suggested.

**Student grouping:** Educational methods tended towards student-centered education in alternative methods from the 1970s, which were formed against traditional methods and influenced by communication approaches. Therefore, students were directed to learn communication skills that require group interaction in the learning process.

Thus, it is recommended to use group or two-person interaction in performing activities. Group interaction in activities should be designed from simple to complex. Group interaction in performing activities should be designed in accordance with the time allocated to the subject. In the latest research, students are even helped make educational material that actually needs the opportunity to talk about math scientifically. It is the teacher's task to provide the necessary and appropriate guidance to discuss mathematics in their groups. Moreover, students can solve each other's problems, help each other learn more, and complete the training these groups.

### H. Time

In alternative methods from the 1970s, which emerged with the advent of communication education versus traditional education, education is often student-centered. In these approaches, especially since the 1990s, more attention has been paid to student interests and needs of students, individual differences, group interaction, and emotional variables in the learning process. It is inferred that a fixed time is not recommended for all learners in the learning process in methods and approaches based on communication principles such as the flipped approach, and individual differences and different learning speeds among students play a role in this decision. The minimum and maximum time can be managed for all schools in the country due to the centralized education system and prescribing a curriculum throughout the country concerning time and its close relationship with individual differences in the learning process and left it to the schools and teachers to decide between the minimum and maximum specified time.

Thus, it is recommended to give teacher lectures to students in audio or video files for 10 to 20 minutes to avoid wasting valuable time in the classroom to explain the basic concepts in the flipped method and rather interact, discuss, and exchange the golden classroom time. The lack of time was mentioned in the analysis of influential factors as a barrier in the grouping, used to analyze the element of time in the existing model. The main classroom time is devoted to group work and student interaction in small groups in the flipped method by presenting video files or any electronic file to students and viewing them before entering the classroom. In fact, flipped learning and teaching recovers class time and gives students more power to control their learning because it allows them to flexibly plan their learning schedule based on their specific learning needs and style. Therefore, high-level cognitive activities can be included in the classroom, and the teacher can be present in the classroom as a master of content.

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