

In this context, the flipped learning is proposed as a methodology aimed at improving higher-order thinking skills [4] and arouses greater interest in students by promoting active learning and integrating a different training process with ICT technologies for the provision of training content. "Flipping the classroom establishes a framework that ensures students receive a personalized education tailored to their individual needs" [5].

"Flipped learning is a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter" [6].

The flipped approach is user-centered as it puts students in the condition of being protagonists of their own learning. In fact, outside the school environment and before the formal lesson on a topic, students study the multimedia content prepared ad hoc by the teacher. Everyone does it with its rhythms and with the technology that he prefers, which is typically the same that is normally used for entertainment and the most diverse communications; it certainly has a better grip on the students. Therefore, they may feel more active and participatory and less bored and discouraged. They will be able to suspend their studies when they deem it necessary and review some steps that are not yet clear.

For this reason, in the Flipped Learning it is necessary for students to have to carry out research, observe tutorials and videos of various kinds and read texts on the subject that will be dealt with in the classroom.

However, it is not the simple use of technology and educational resources to innovate the learning process, what makes the difference is the way in which their use is integrated into the process itself [7].

Obviously this approach must find full integration with e-learning web technologies: therefore, for example, each individual content can be included in a Learning Management System (LMS) that will allow, if necessary, to use other digital social services such as forums and chat to interact, collaborate or ask support from classmates or from others.

The rest of this paper is organized as follows: Literature review in Flipped Learning is addressed in section 2; in section 3 the experiment is presented. Section 4 illustrates the results of the experiment and a discussion. Conclusions, as well as directions for future research work, are pointed out in section 5.

2. Literature Review

The teaching model of the Flipped Learning is based on an approach to teaching whose purpose is to renew

the classic frontal lesson by placing the pupil at the center of the learning process.

The significant features of this model and the origin of the Flipped Classroom concept can also be traced back to past experiences.

The theoretical foundations of this model in fact draws inspiration from ideas that are certainly not new, such as, for example, Dewey's pedagogical activism [8].

The Dewey model provides a wide range of activities centered on students and their needs, directing them towards more practical and experimental concepts.

In these terms, the Flipped Classroom can also be considered as a review of Dewey's active school.

Also Celestin Freinet [9], father of the Educational Cooperation Movement, posed the problem of promoting knowledge and skills capable of adequately equipping students with respect to the social and technological transformations under way, identifying a posterior lesson as one of the three main elements of his method.

Subsequently the idea of the Flipped Classroom was focused in the early 90's by Eric Mazur, a professor at Harvard University, [10]. The concept was taken up by several authors who declined it in various ways but maintaining the basic idea of reversing the classical moments of teaching, introducing a kind of pre-learning [5] [11].

Bergmann and Sams were pioneers of the application of this teaching method, initially adopting this idea to allow absent students to recover the lessons they had missed; consequently, they realized that this method was strongly appreciated also by the students who had not lost the lessons [5].

Similarly, the authors are almost all in agreement with the following statement: allocate about 70% of class time to the teachers explaining, while students listen, sometimes and passively, is the basis of the lack of attractiveness of the frequency of lessons by the majority of them. The idea of the reversal starts from this assumption and plans to free up class time to do other things with the students.

This teaching method is also of great interest for a university environment.

A survey conducted in 2013 shows that flipped learning has been adopted in many universities, achieving good results in the implementation of university teaching. It has been noted that this modality can effectively mobilize students, encouraging them, as well as offering teachers a greater "opportunity to improve the degree of student participation in class teaching." [12] [13]

Furthermore, various experiences conducted in different disciplinary fields, both at higher education and university level [14] [15] [16], show positive signs in terms of involvement and motivation of students

engaged in educational activities thanks to the use of the flipped learning approach.

This approach is born with the necessity to help students meet the growing need to have skills and knowledge to use in the workplace after graduation; specifically, in our experimentation, this requisite was in the area of software development.

As we have already said, the process to give life to this approach considers the new technologies a necessary support. In fact, through a LMS, students become aware of the contents to be studied and dealt with in class in advance. In the classroom they work in groups or individually with the teacher who supports them and can collaborate or intervene in the activities of the various groups, can immediately clarify any doubts about the contents and processes or add new concepts for a profitable training. Pragmatically, the students out of school collect information and topics and then, at school, work on the material collected.

The teacher is no longer the sole possessor of knowledge but has the role of teaching/educating students about the use of knowledge now present in the global network and at hand at all times.

3. The Experimentation

Each experiment needs an initial design phase; in this step, the teachers selected and published the educational material useful to the students in the anticipatory and in the operational steps, illustrated below. Moreover, they redesigned the contents of each lesson taking into account the times of use that the research group had established for itself.

Before, during and after the lesson, the lecturer was assisted by the classroom tutors with the task of making available the digital teaching material and to check that the students involved benefited from them correctly.

This phase is very important and requires a significant workload that is probably higher than that required in the traditional teaching methodology.

In the experimentation object of the research, in order to guarantee the success of the same in the estimated times during the design phase, the topic to be treated has been appropriately fragmented, trying to face only one aspect of the problem and then choosing cases of applicability of size adequate for experimentation.

In order to verify the effectiveness of the flipped methodology also in the university field, between November and December 2018 an experiment was conducted on the field in which the topic being taught, the teacher, the number and the type of students in the class remains constant, what changes is the teaching methodology.

The experiment involved two groups of students:

1. the *FlippedGroup*, to which training was provided according to the flipped classroom;

2. the *LectureGroup*, to which training was provided according to the traditional approach.

At the end of the training step the two groups were given a test for the assessment of learning as well as a satisfaction survey to express the opinion of the students on the activity carried out.

As a sample for the experiment, the class of the 'Programming' course, delivered in the first semester of the first academic year, was selected in the degree course in Computer Science and Technology for the Production of Software at the University of Bari "Aldo Moro" in the academic year 2018/2019.

The sample was divided in such a way as to maintain uniformity in the composition of the two groups, compared to previous knowledge and skills.

To this end the students were previously invited to fill out a web form on the e-learning platform of the Department (<https://elearning.di.uniba.it/>) specifying ID number, typology of school diploma and diploma vote.

In defining the organization of the flipped classroom, reference was made to the structure of the EAS of which in Italian stands for "Episodi di Apprendimento Situato" (Episodes of Situated Learning) illustrated by Rivoltella [11] that set three steps:

1. the anticipatory step, individual study of the contents of the lesson;
2. the operative step, for the resolution of the problems;
3. the restructuring step, for the re-elaboration of the contents and reflection on what has been learned.

The two lessons (flipped and traditional) were carried out in parallel following the scheme of table 1 and lasted three hours, including the breaks between the various activities.

Table 1: Process Scheme

Duration	Activities LectureGroup	Activities FlippedGroup
40 min	Frontal Lesson	Individual Study (Anticipatory Step)
40 min	Individual Study	Contents Production (Operative Step)
40 min	Contents Production	Flipped Lesson (Restructuring Step)
30 min	Test	Test
10 min	Satisfaction Survey	Satisfaction Survey

The division of training times has respected the proportion regulated in our University of Bari, where for each hour of lectures with the teacher, the student engages individually for two hours.

Both for the content production phase (performance of a task) and for the learning assessment, materials prepared specifically by the teacher were used. The

multimedia and hypertext materials made available to the students accredited on the e-learning platform of the Computer Science Department have been chosen and/or prepared by the teacher. On the same platform, didactic support services have been implemented, such as chat rooms and forums.

The satisfaction survey has been created making reference to some examples reported in the literature adapting them to the specific situation [17]. In particular, the satisfaction survey provided the following three questions, in which the value 5 represents the highest rating, while the value 1 represents the lowest rating. In addition, an open-ended question was expected to collect the suggestions and feelings of the students about the experience carried out.

Table 2: First Question of Satisfaction Survey

1. How do you consider the activity carried out? (the methodology used during the lesson)

	5	4	3	2	1	
Clear						Confused
Interesting						Boring
Useful						Useless
Concrete						Abstract
Easy						Difficult
Effective						Ineffective
I learned a lot						I learned little

Table 3: Second Question of Satisfaction Survey

2. Do you think you have achieved the objectives of the educational module?

	5	4	3	2	1	
Achieved						Not Achieved

Table 4: Third Question of Satisfaction Survey

3. Overall how do you consider the activity carried out?

	5	4	3	2	1	
Positive						Negative

Specifically, the activities of the LectureGroup included the following steps:

- Frontal lesson in the classroom.
- Individual study in the study hall; the material delivered to the students was the same as the one made available to the students of the 'flipped' group during the anticipatory step.
- Content production (performance of a task) carried out individually, or more frequently as a spontaneous group, as each individual student prefers.
- Carrying out an anonymous assessment test on the subject studied.
- Carrying out an anonymous satisfaction survey to evaluate the proposed methodology.

The activities of the FlippedGroup included the following steps:

- Individual study (anticipatory step) in the study room.
- Production of contents (operative step): carrying out a task in an individual way, or more frequently as a spontaneous group, as each individual student prefers; in this phase the students were engaged in project activities, research activities, and cooperative activities with the aim of stimulating their interest in the topic.
- Flipped lesson (restructuring step) in the classroom; it consisted of an activity, conducted by the teacher, of elaboration, reflection and comparison on what has been learned, with the aim of clarifying and consolidating the knowledge obtained. Starting from the problems encountered by the students during the anticipatory step and the moment of individual/group production, the teacher develops a reflection to allow the systematization of the knowledge object of the study to the students. This is the moment of problem solving during which the teacher listens to the problems highlighted by the students and solves them.
- Carrying out an anonymous assessment test on the subject studied.
- Carrying out an anonymous satisfaction survey to evaluate the proposed methodology.

Finally, the answers to the open-ended question, present at the end of the satisfaction survey, essentially highlight the need on the part of the students to have more time available both for the anticipatory step and for the restructuring step.

4. Results and Discussion

Figure 1 shows the results of the learning assessment obtained by the students of the flipped class and those of the traditional lecture class.

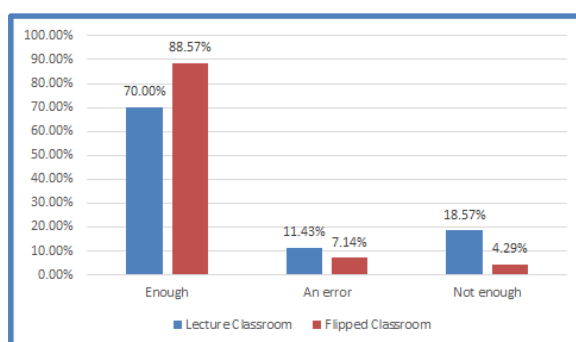


Figure 1: Evaluation Test Results

By analyzing Figure 1 you can see that 88.57% of the students in the flipped class performed the learning verification test with 0 errors, 7.14% committed only one error while only 4.29% committed more than one error. These results are better than those achieved by the

students of the LectureGroup, show a clear improvement in the performance of the students and confirm the effectiveness of the flipped methodology. Moreover, it can be noted that in the FlippedGroup the number of students who commit more than 1 error is drastically reduced, which confirms the effectiveness of flipped learning especially in the involvement of almost all students.

The first question of the satisfaction survey presented both to the students of FlippedGroup and to those of the LectureGroup was aimed at assessing the degree of satisfaction of the students with regard to clarity, interest, usefulness, concreteness, easy, effectiveness and perception of students to having

learned the concepts of the task entrusted to them (see Figures 2 and 3). The data emerged from the FlippedGroup students' answers highlight the very positive opinions expressed by the students who should encourage the use of the flipped approach also in the university context. The results obtained, on the other hand, by the answers given by the LectureGroup students highlight, once again, that the traditional approach has fewer favors from the student component, especially regarding the ease of use and the effectiveness of the teaching method.

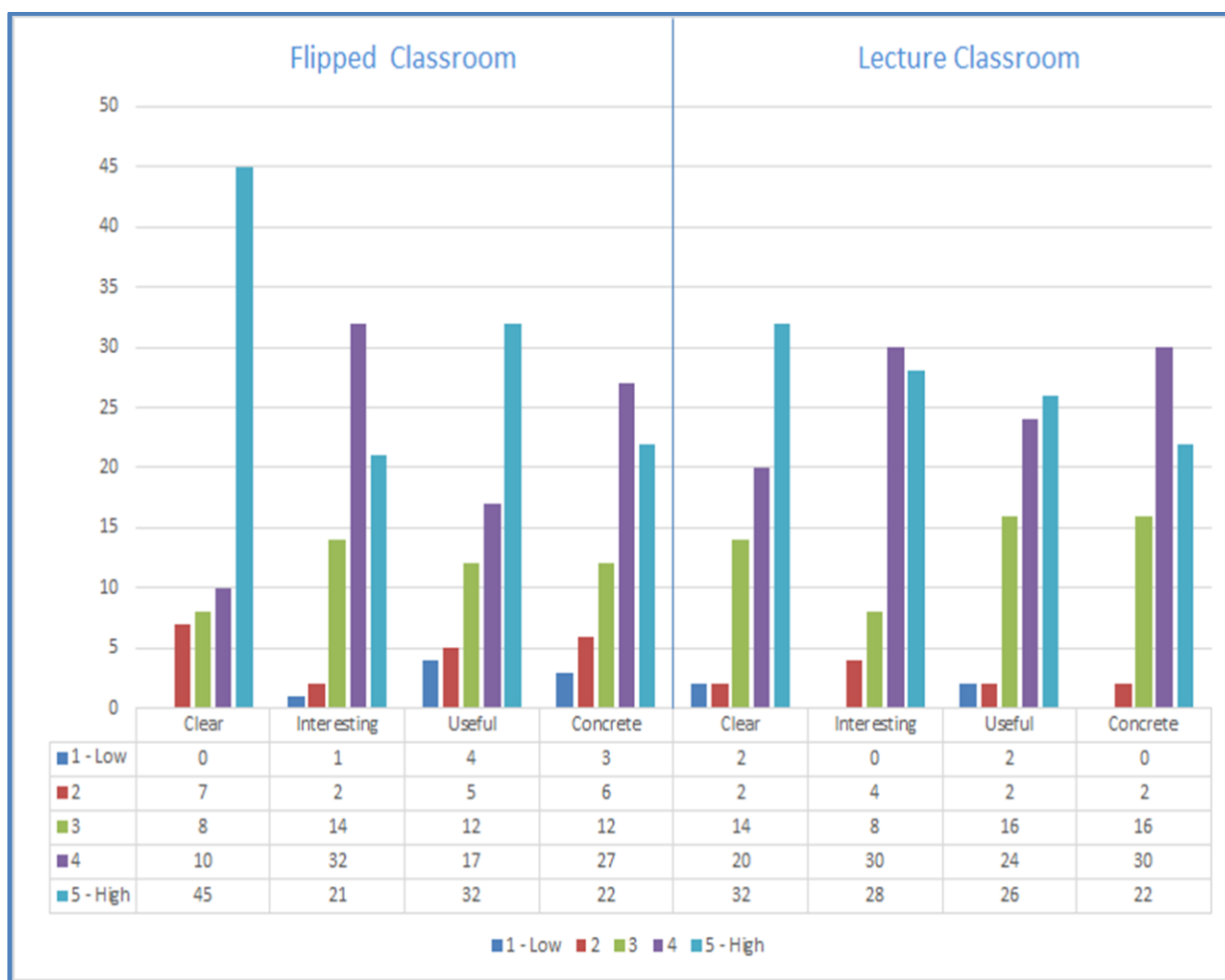


Figure 2: First Question Results of the Satisfaction Survey of the FlippedGroup and Lecture Classroom – Part One

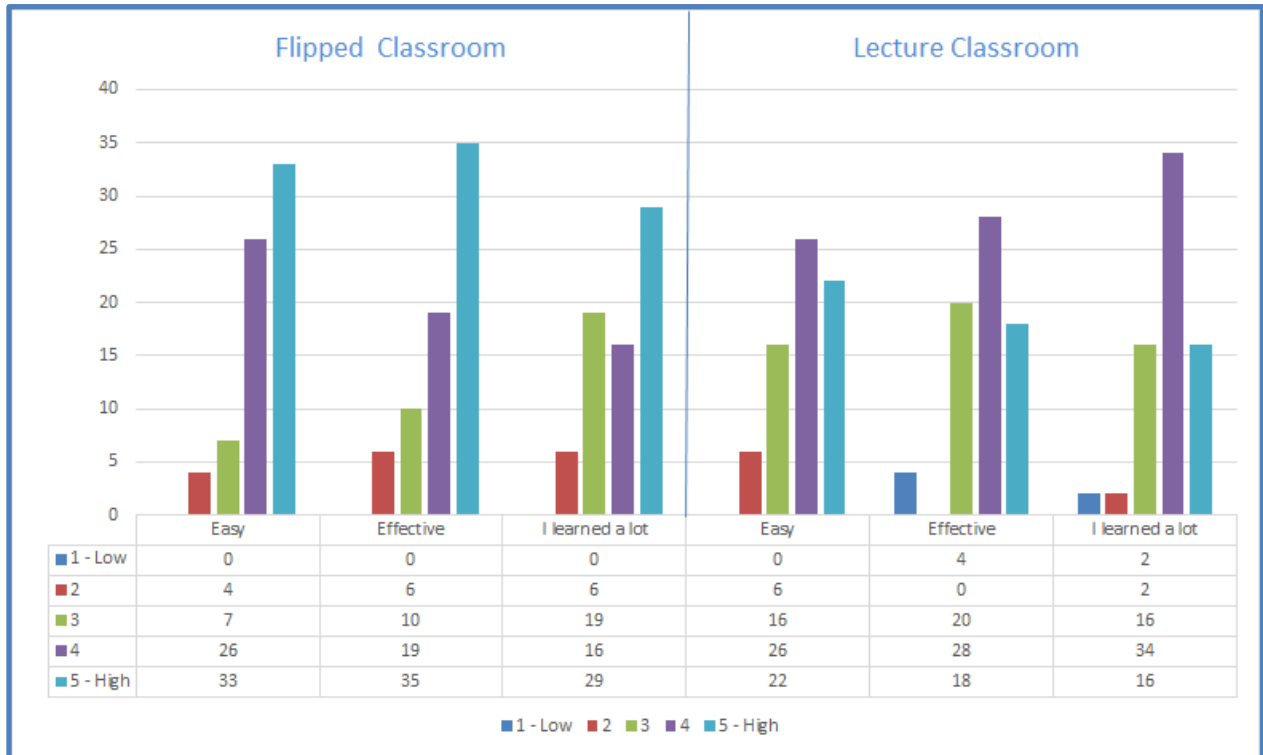


Figure 3: First Question Results of the Satisfaction Survey of the FlippedGroup and Lecture Classroom – Part Two

The high score attributed to the ease and usefulness of the flipped approach, shown in Figures 2 and 3, most likely can be related to the familiarity of the digital natives in the use of information technology. Despite the absence of experimental data, it is the authors' opinion that the high values assumed by the various satisfaction survey indexes could not have been obtained without the indispensable support of internet and multimedia technologies. It is evident that the flipped approach finds fertile ground in ICT tools that allow its application.

Figure 4, on the other hand, shows that more than 80% of students acknowledge that they have reached the goal of the training unit and are very satisfied with the skills acquired.

Lastly, Figure 5 shows that more than 50% of students said they were very satisfied with the experience. This data, together with those who declared themselves satisfied (enough or slightly), reaches 95% of the participants in the flipped classroom. It should be noted that no student of the FlippedGroup has declared that he is not at all satisfied with the training process followed.

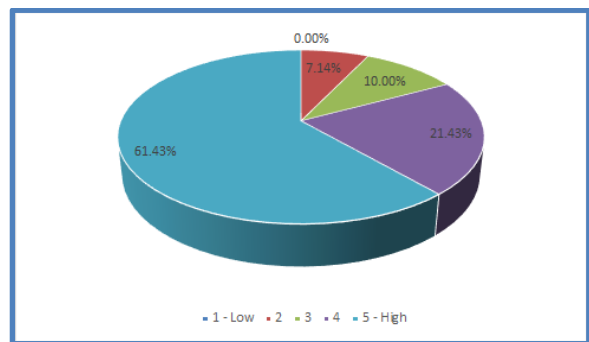


Figure 4: Second Question Results of the Satisfaction Survey of the FlippedGroup

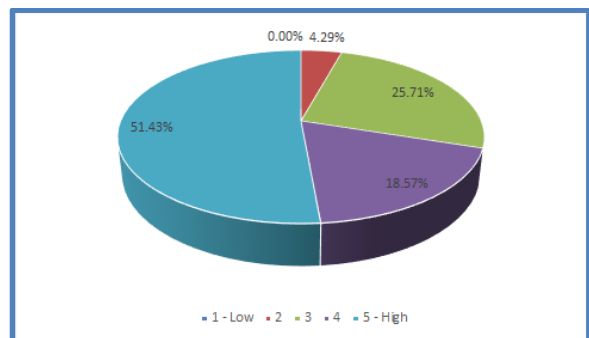


Figure 5: Third Question Results of the Satisfaction Survey of the FlippedGroup

Most of the students commented positively on the participation in the FlippedGroup because they felt more

stimulated, involved and committed as they felt responsible for their own training.

The analysis of the results so far made must not hide some weaknesses of the flipped learning that emerged in the experimentation.

In fact, in line with what was found in the literature [18] and in similar experiences [19] [20], the flipped learning has presented critical issues in particular as it regards the workload of the teacher in the preliminary phase. In fact, as already mentioned, the teachers must make a great effort to identify, design and implement the materials for the anticipatory and operative steps. Furthermore, the subdivision of the course teaching units with self-consistent contents to be delivered in a single cycle of lessons further aggravates this workload load.

The timing of the various phases of flipped learning deserves special attention. In the experimentation object of the present research work, the times of the various phases (see Table 1) have been identified previously according to a logic tending to verify the compatibility of the learning times between the two groups, LectureGroup and FlippedGroup. This explains the 40 minutes of the Frontal Lesson of the LectureGoup and of the Flipped Lesson of the Restructuring Step of the Flipped Group. It also explains the 40 minutes of the Individual Study and Contents Production phases.

The experiment revealed several times that the time reserved for the Operative Step was inadequate, given that the group activities in the laboratory require moments of cooperation among the students.

Furthermore, the vitality of the students who, enthusiastic about trying what they have learned in the anticipatory step, try to involve the teacher in multiple discussions is important but also needs a longer time than that required in traditional lessons.

5. Conclusions

The experiment conducted is a starting point for the introduction of the Flipped Learning methodology in the university field. It is a positive contribution that deserves, as is the intent of the research group, replicas to validate or refute the results.

The results achieved suggest that the flipped approach, thanks to the collaborative and active modality, encourages group learning focused on students and problem-solving activities.

In the same way it allows to increase the level of interactivity among the students as well as to improve the learning and performance of the students. It should be noted that at the same time the flipped methodology allows to optimize the work of the teacher allowing him to support the students in solving problems rather than simply transferring contents.

The results highlighted the effectiveness of the proposed methodology as 88.57% of the chosen sample achieved a very positive result at the proposed learning verification. The satisfaction ratings also highlight the interest and appreciation of the proposed methodology.

The experiment showed that the flipped classroom has high ratings of appreciation and effectiveness even at the university level. In the positive evaluation of the indexes used in the experiment, the implementation of the training process certainly influences the information technology normally used by the students in their daily life.

The students expressed their positive perception which reflects their acceptance of this method.

Our research has shown that flipped learning requires a significant effort for university professors who are called to "turn over" their role as "knowledge bearers" to become tutors, coaching and mentoring students.

A teacher is very busy in the design phase since he has to search, select and produce the multimedia educational material to be provided to the students. In flipped learning the teaching material of which the students will study takes on an even more important role than the traditional methodology. Making material available to students without proper selection would be giving them a huge struggle that would probably discourage most.

The correct timing of the various scheduled activities is fundamental to the success of flipped learning, as is the creation of appropriate and atomic teaching units to be delivered.

It is evident that the success of this method depends on the correct planning and implementation of the resources and services made available to the students as well as the evaluation strategy adopted.

In the future the authors of this research will establish the process to share with the community the guidelines to properly organize the correct environment for flipped lessons.

6. References

- [1] M. Maglioni, *La classe capovolta*. Edizioni Centro Studi Erickson, 2014.
- [2] S. A. Becker, M. Cummins, A. Davis, A. Freeman, C. G. Hall, and V. Ananthanarayanan, "NMC horizon report: 2017 higher education edition," 2017.
- [3] H. Jenkins, "Convergence culture: where old and new media collide New York University Press," New York, 2006.
- [4] A. M. Al-Zahrani, "From passive to active: The impact of the flipped classroom through social learning

platforms on higher education students' creative thinking," *Br. J. Educ. Technol.*, vol. 46, no. 6, pp. 1133–1148, 2015.

[5] J. Bergmann and A. Sams, *Flip your classroom: Reach every student in every class every day*. International society for technology in education, 2012.

[6] J. Bergmann and A. Sams, "Flipped learning: Maximizing face time," *T+ D*, vol. 68, no. 2, 2014.

[7] B. Tucker, "The flipped classroom," *EducationNext*, vol. 12, no. Winter 2012 / NO. 1, 2012.

[8] J. Dewey, "Experience and Education," *Educ. Forum*, vol. 50, no. 3, pp. 241–252, 1986.

[9] C. Freinet, "Cooperative learning for social change. Selected writings of Célestin Freinet," *Our Sch. Selves Educ. Found.*, 1990.

[10] E. Mazur, "Can We Teach Computers to Teach? Computers have Yet to Cause the Revolution in Physics Education That has Long Been Expected," *Comput. Phys.*, vol. 5, no. 1, pp. 31–38, 1991.

[11] P. C. Rivoltella, "Episodes of situated learning. A new way to teaching and learning," *REM--Research Educ. Media*, vol. 6, no. 2, pp. 79–88, 2014.

[12] J. Morris and S. Brown, "The up side of upside down: National CDE study shows flipped classrooms are on the rise." 2013.

[13] J. Yarbrow, K. M. Arfstrom, K. McKnight, and P. McKnight, "Extension of a Review of Flipped Learning," *Flip. Learn. Network/Pearson/George Mason Univ.*, 2014.

[14] Z. Zainuddin, H. Habiburrahim, S. Muluk, and C. M. Keumala, "How do students become self-directed learners in the EFL flipped-class pedagogy? A study in higher education," *Indones. J. Appl. Linguist.*, vol. 8, no. 3, pp. 678–690, 2019.

[15] W. S. Tse, L. Y. A. Choi, and W. S. Tang, "Effects of video-based flipped class instruction on subject reading motivation," *Br. J. Educ. Technol.*, vol. 50, no. 1, pp. 385–398, 2019.

[16] F. Chen, A. M. Lui, and S. M. Martinelli, "A systematic review of the effectiveness of flipped classrooms in medical education," *Med. Educ.*, vol. 51, no. 6, pp. 585–597, 2017.

[17] G. P. Quaglino and G. P. Carrozzi, *Il processo di formazione: dall'analisi dei bisogni alla valutazione dei risultati*. Franco Angeli, 1995.

[18] M. Li, "Research on the Innovative Practice of 'The Flipped Classroom' in the Basic Management Course of Chinese Universities," pp. 2155–2163, 2017.

[19] S. Alhazbi, "Using flipped classroom approach to teach computer programming," in *2016 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE)*, 2016, pp. 441–444.

[20] W.-C. Hsu and H.-C. K. Lin, "Impact of applying WebGL technology to develop a web digital game-based learning system for computer programming course in flipped classroom," in *2016 International Conference on Educational Innovation through Technology (EITT)*, 2016, pp. 64–69.