Flipped Instruction as a Method of Teaching Science in Grade 10

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Abstract

This study aims to determine the effectiveness of flipped instruction in teaching science among Grade 10 students. A mixed-method is used to analyze the performance and attitude of the students between flipped instruction and the traditional instructions. An unpaired t-test determined the significant difference in the students' mean gain performances between the control and experimental groups. The findings showed a significant improvement in the students' performance and attitude in flipped instruction. The pre-test revealed that students had less prior knowledge of the science topic and got lower scores. However, after integrating flipped instruction in teaching science, the student's performance improved, and they gained a high post-test scores. Students became more confident and motivated during class activities and developed a sense of interest and readiness for the science lessons. Hence, students learn better in flipped instruction than in the traditional approach to teaching.

Keywords: Flipped Instruction; Teaching Method; Science; Grade 10

1. Introduction

The growing availability of media resources changes teaching and learning, as well as emphasizing the need to finding satisfactory and appropriate mode of materials and instruction. Indeed, the approach of teaching has shifted from traditional to the modern way of teaching in which the very thrust is the learner-centered approach and the integration of Information and Communication Technology (ICT) both for teachers and students' instructional activities. Hence, a teacher should utilize various approaches for the students to learn in the classroom (Casem, 2016).

One of the emerging teaching strategies that subscribes to the new paradigm in teaching that highlights the use of modern technology and programs is the Flipped Instruction in which students are introduced to pre-recorded concepts outside of the traditional instructional space (Bergmann & Sams, 2012; Fulton, 2012). The use of flipped instruction as an alternative to traditional learning environments has been increasingly attracting the attention of researchers and educators. Further, flipped instruction enables teachers to shift from teacher-driven to student-centered learning; hence, outcomes-based education is emphasized where students are responsible for their own learning and the teacher acts as guide-on-the-side. This complements the K-to-12 curriculum that promises to champion ICT among basic education students. Flipped instruction has been increasingly known due to the advancement in the technological tools: interactive videos, in-class activities and video conference systems (Cabi, 2018). It is even asserted that flipped instruction is the best model of using technology in education to create effective teaching environment at school (Hamdan et al., 2013). Studies about flipped instruction appear in different disciplines including information systems, engineering, sociology and humanities, mathematics education, and English composition (Cabi, 2018).

The researcher conducted the study in order to find other teaching strategies and assess the effectivity of flipped instruction in teaching Science 10 on the academic performance of students.

1.2 Objectives of the Study

This study focused on determining the effectiveness of flipped instruction as a teaching method among grade 10 science students. Specifically, it answers the following questions:

1. What is the performance in the pre-test and post-test of students subjected to traditional and flipped instruction?
2. Is there a significant difference in the mean gain between the students subjected to traditional and flipped instruction?
3. What is the students' attitude towards the utilization of flipped instruction?

2. REVIEW OF RELATED LITERATURE

2.1 The Flipped Instruction

Flipped instruction is a pedagogical approach in which the learning is student-centered rather than teacher-centered, mediated by technology (Reyna & Meier, 2015). It allows the transformation of transmissible lectures into a program of pre-class preparation, in-class tasks, and post-class work (Abeysekera & Dawson, 2015). Flipped instruction is another form of blended learning where students are introduced to an online presentation using new material outside of class. Students watch pre-recorded videos at home as instructed by the teacher and then come to school to do the homework armed with questions and at least some background knowledge (Bergmann & Sams, 2016).

The Flipped Learning Network defines flipped instruction as the pedagogical approach with direct instructions from group to individual learning space to make a dynamic and interactive learning environment. The teacher guides students to apply concepts and engage creatively in the subject matter. Similarly, Saunders (2014) cited in his study that flipped instruction involves flipping the traditional classroom instruction.

Ahmed and Ouda (2016) expanded that teacher-to-student and student-to-student interaction is the highly significant feature of flipped instruction. Furthermore, one-on-one contact with every student is the best advantage. It is a mixture of direct instruction with inquiry-based learning, which permits more time to develop 21st-century skills: critical thinking and problem solving, creativity and innovation, collaboration, and self-direction (Framework for 21st Century Learning, 2010).

In support, evidence has suggested that students, in most cases, have a preference for flipped instruction over the traditional lecture style. It was discovered that flipped classrooms have advanced and restored the fun in teaching students accomplishing academic gains, educators, and professors. Moreover, its advantage is using the language of today's students, who have become accustomed to using the web and social media for information and interaction (Bergmann & Sams, 2012). A pedagogical approach is direct instructions from group to individual learning space to make a dynamic and interactive learning environment.

2.2 Advantage of Flipped Instruction

Herreid and Schiller (2013), as cited by Camiling (2017), mentioned that flipped learning results in the achievement of the learning outcomes. Interestingly, flipped class inverts typical class content acquisition and application to gain necessary knowledge through the instructor's guide to actively, interactively clarify and apply the knowledge

during class. A similar note (Clark, 2013) that the students are more actively involved in the flipped classroom than in the traditional environment.

An inverted classroom means traditional events occur inside and outside the classroom and vice versa. This is the first study to introduce the idea of employing multimedia and the World Wide Web as a substitute for lectures (Ahmed & Ouda 2016). The idea behind the reverse classroom is to allow students to study the materials at home and do the homework assignments with the support of the educators in the classroom. Studies claim that this method is excellent for any individual learning style (Lage et al. 2000).

The flipped classroom is very effective in attaining the learning outcomes, as assured by many researchers. Every student in the class is necessary to integrate the pre-class and in-class to increase the understanding of the course matters, assessments, responses, or adjustments. The reason is for the students to be more responsible in their obligations and participate in the class more dynamically. The outcomes can be increased along with self-efficacy. Doing assignment as seat works provide educators better insight into student difficulties and learning styles (Ahmed & Ouda, 2016).

Teachers who use flipped classrooms have time to work individually with students (Steed, 2012) as cited by (Calamlam, 2016). In addition, various studies suggest that the benefits of flipped instruction, especially in the emergence of outline technology, could make e-learning possible (Calamlam, 2016). The approach promotes one-to-one interactions and discussions with students in classrooms. Another study suggests that classroom time will be spent working through problems, advancing concepts, and engaging in collaborative learning with flipped classrooms (Tucker, 2012). Furthermore, Flipped Learning Network suggests that in a flipped classroom, the teacher moves taxonomy lower levels outside of the class to work on mastering concepts, pause, rewind, and review the lessons at any time (Arfstrom, 2013).

A recent study suggested that flipped instruction offers students opportunities to leverage their prior knowledge and the new knowledge under investigation to generate multiple methods for solving a problem (Song and Kapur, 2017). Flipped instruction works because the videos can be paused, rewatched, or fast-forwarded (Rosiene, & Rosiene, (2015). Further, one study reported significant improvements in students' scores in flipped instruction compared to student scores in the traditional classroom. Hence, flipped instruction positively affects students' performance (Sahin, Zeytuncu, & Cavlazoglu, 2015). Further, students are more active in the classroom because they have gained the knowledge and understanding of the concepts and facts before learning (Paristiowati et al., 2017). Using flipped instruction increases students' motivation and improves students' learning in Science (Davies, Dean, & Ball, 2013).

Moreover, flipped classroom motivates collaborative work. Likewise, Evseeva & Solozhenko (2015) found that it improves students' academic performance. Similarly, Flumerfelt & Green (2013), cited by Farrah 2018 reported that flipped classrooms

created more instructional time overall by providing students with a task they enjoyed and could control, deciding when and where to listen to the daily lectures.

The potential influence of flipped instruction is directed at the consequences of preparing learners with direct instruction before taking delivery of in-class instruction. Ahmed (2016) stated that students are well-informed for active learning tasks before the class. Flipped classroom promotes more learner autonomy and self-direction. Moreover, participants have considered flipped classrooms exciting, motivating, and engaging (Farrah, 2018).

2.3 Attitude of students towards flipped instruction

The study by Malto et al. (2018) stated that exposure to flipped instruction developed a more positive attitude in students, resulting in a more robust understanding of concepts as reflected in their performances. Flipped instruction allowed the students to be participative in class and articulate their ideas during small group discussions. Hao (2014) factor analysis revealed that four types of attitudes in the flipped classroom had above-the-average levels considering the four factors: student engagement, learning strategies, learner control, and task orientation. Moreover, Nouri (2016) found that majority of the students had a positive attitude towards flipped classrooms which was strongly correlated to perceptions of increased motivation, engagement, increased learning, and practical learning. It was also found that students in flipped classrooms reported greater course satisfaction than those in lecture-based courses.

Chao et al. (2015) found that students learning attitudes, motivation, and self-evaluation were enhanced. Hence, flipped learning approach has a positive effect on the effect of learning. In their study, Lo and Hew (2017) revealed that the flipped classroom approach in K-12 Education yielded a neutral or positive impact on student achievement against traditional teaching. Further, only a few studies reported that students performed significantly better in the traditional classroom than in the flipped classroom in the published research.

3. METHODOLOGY

This study is a mixed-method using experimental and descriptive research design. The researcher wanted to know if there was an improvement in students' performance in the utilization of flipped instruction and if the students had a positive attitude towards the Flipped Instruction. Thirty (30) respondents in the experimental group and thirty (30) respondents in the control group were randomly selected with almost the same average grades.

For the first set of questionnaires, the researcher used the personally developed Pre-test/Post-test, which the three experts validated. A thirty (30) item test included

measuring the skills about chemical equations, balancing chemical equations, types of chemical reaction, the law of conservation of mass, and collision theory. The Adapted Cognitive Process Dimensions (Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating) format test was followed for the pre-test and post-test. The second set consisted of twelve (12) statements on the students' attitude towards flipped instruction strategy. In answering the survey questionnaires, the four-point Likert Scale anchored to the scale developed by Rensis Likert with corresponding descriptions was used, such as

4 – Strongly Agree, 3 – Agree, 2 – Disagree, 1 – Strongly Disagree.

The researcher used descriptive statistics, which include the mean, standard deviation, frequency distribution, and percentage, as statistical tools in determining the performances of the experimental and control group and determining the students' attitude toward the flipped instruction. The following scale and interpretation are used to identify the performance in the pre-test and post-test of students subjected to traditional and flipped instruction.

Score Range	Interpretation
25-30	Outstanding
19-24	Very satisfactory
13-18	Satisfactory
7-12	Fairly Satisfactory (Passed)
0-6	Did not meet Expectation (Failed)

On the students' attitude towards the utilization of flipped instruction, the following scale and interpretation was used:

Mean Range	Scale	Description	Interpretation
3.50 – 4.00	4	Strongly Agree	Strong Positive Attitude
2.50 – 3.49	3	Agree	Positive Attitude
1.50 – 2.49	2	Disagree	Negative Attitude
1.00 – 1.49	1	Strongly Disagree	Strong Negative Attitude

Finally, to answer the significant difference between the mean gain of the experimental and control group. An unpaired T-test is used at a 0.05 level of significance.

4. RESULTS AND DISCUSSIONS

4.1 Performance of Students in the Traditional Method (control group)

The pre-test and post-test performance in Science of the control group are presented in Tables 1 and 2. Each table shows the frequency, percentage distribution, mean and standard deviation.

Table 1 shows the frequency distribution of scores of the control group on the pre-test. The majority of the students' scores, 67%, ranged from 0-6 in their pre-test with failure description, and 33% with a score range 7-12 achieved fairly satisfactory. The average pre-test performance of students in Science under the Control Group is 5.70, with the standard deviation of 1.489 described as "did not meet expectation" or "failed." This result means that the students have less prior knowledge of chemical reactions.

Table 1 Pre-test Frequency Distribution of Scores of Students subjected to Traditional method

Score Range	f	f %	Description
25-30	0	0	
19-24	0	0	
13-18	0	0	
7-12	10	33	Fairly Satisfactory (Passed)
0-6	20	67	did not meet expectation (Failed)
Total	30	100.00	
Mean	5.70		
Sd	1.489		

Legend:

Score Range	**Description**	**Score Range**	**Description**
25 – 30	Outstanding	7 – 12	Fairly Satisfactory (Passed)
19 – 24	Very Satisfactory	0 – 6	Did not meet expectation (Failed)
13 – 18	Satisfactory		

Table 2 shows the frequency distribution of scores of the control group in the post-test. Results showed that 67% of the students' scores, range 7-12, were described as fairly satisfactory, and only 2 or 6% did not meet expectations or failed. Further, the average post-test performance of the students with a mean of 10.80 and a standard deviation of 2.905 is described as "fairly satisfactory" or "passed." This indicates that the students have quite improvements in their gained knowledge. Moreover, after the

group of students had been taught Science utilizing the traditional teaching method, they were found to improve and gain knowledge.

Table 2 Frequency Distribution of Scores of Control Group on Posttest

Score Range	f	f %	Description
25-30	0	0	
19-24	0	0	
13-18	8	27	
7-12	20	67	Fairly Satisfactory (Passed)
0-6	2	6	did not meet expectation (Failed)
Total	30	100.00	
Mean	10.8		
Sd	2.905		

Legend:

Score Range	**Description**	**Score Range**	**Description**
25 – 30	Outstanding	7 – 12	Fairly Satisfactory (Passed)
19 – 24	Very Satisfactory	0 – 6	Did not meet expectation (Failed)
13 – 18	Satisfactory		

4.2 Performance of Students Subjected to Flipped Instruction (experimental group)

The pre-test and post-test performances in Science of the students subjected to the flipped instruction are presented in Table 3 and Table 4 below. The tables illustrate the frequency, percentage distribution, mean (μ), and standard deviation.

Table 3 Frequency Distribution of Scores of Experimental Group on Pretest

Score Range	f	f %	Description
25-30	0	0	
19-24	0	0	
13-18	0	0	
7-12	6	20	Fairly Satisfactory (Passed)
0-6	24	80	did not meet expectation (Failed)
Total	30	100.00	
Mean	5.63		
Sd	1.520		

Legend:

Score Range	Description	Score Range	Description
25 – 30	Outstanding	7 – 12	Fairly Satisfactory (Passed)
19 – 24	Very Satisfactory	0 – 6	Did not meet expectation (Failed)
13 – 18	Satisfactory		

Table 3 above shows the frequency distribution of scores in pretest under experimental group where 80% of the students did not meet expectations or failed in their pretest and only 6 or 20% of the students passed the pretest with score range 0-6 with a description of fairly satisfactory. Moreover, the average pre-test performance of students in Science (flipped instruction) is 5.63 with the standard deviation of 1.520 and described as "did not meet expectation" or failed. This indicates that 80% of the students have retained/know less knowledge about the topic of chemical reaction; knowingly that the curriculum is a spiral progression process.

Table 4 Frequency Distribution of Scores of Experimental Group on Posttest

Score Range	f	f %	Description
25-30	0	0	
19-24	9	30	Very Satisfactory
13-18	17	57	Satisfactory
7-12	4	13	Fairly Satisfactory (Passed)
0-6	0	0	did not meet expectation (Failed)
Total	30	100.00	
Mean	16.80		
Sd	3.326		

Legend:

Score Range	Description	Score Range	Description
25 – 30	Outstanding	7 – 12	Fairly Satisfactory (Passed)
19 – 24	Very Satisfactory	0 – 6	Did not meet expectation (Failed)
13 – 18	Satisfactory		

Table 4 shows the frequency distribution of scores in the posttest where 17 or 57% of the students got a "satisfactory" with a score range of 13-18, and 4 or 13% of the students got a score range of 7-12 which is fairly satisfactory or passed. The students' post-test mean is 16.80 with standard deviation of 3.326 which is described as "satisfactory" or "passed". This means that after the intervention of flipped instruction

majority of the students in the experimental group have notable improvements in their gained knowledge.

This agrees with the findings of Song and Kapur in 2017 that flipped instruction offers students opportunities to leverage their prior knowledge and the new knowledge under investigation to generate multiple methods for solving a problem.

4.3 Difference in the Mean Gain between the Control and the Experimental Group

Table 5. Comparison of the Mean Gain between the Control and the Experimental Group

Compared Group	N	Mean	Mean Difference	sd	t-ratio	t-Prob.	Interpretation
Control	30	5.10		3.144			
			6.07		-6.888	.000*	Significant
Experimental	30	11.17		3.659			

**p < .05, Significant at .05 alpha*

Statistically, the test reveals a significant difference in the mean gain performance between the control group and the experimental group, t = -6.888, p = .000. This finding implies that the students under the experimental group used with flipped instruction have better performance in learning science than the control group with traditional method of teaching. This agrees with the study of Paristiowati et.al, 2017, that students with flipped instruction are more active in the discussion because they have gained the knowledge and understanding of the concepts and facts before the classroom learning process.

4.4 Attitudes of Students towards the Use of Flipped Instruction

Table 6. Mean Scores of Students' Attitudes towards the use of Flipped Instruction

Item	Mean	Description
1. I like the reverse instruction integration because it requires critical thinking.	3.37	Agree
2. I consider watching videos before the class is necessary for the subject.	3.47	Agree
3. I find watching videos before the class stimulating.	3.60	Strongly Agree
4. I find the reverse instruction is the latest trend in learning science.	3.10	Agree
5. I find the reverse instruction integration make learning science easier.	3.33	Agree
6. I like the subject because the knowledge derived can applied in daily life.	3.47	Agree
7. For me, studying with video lectures is worth the time and efforts required.	2.87	Agree
8. I find the traditional way of my teacher's teaching as the most effective way to learn science	2.93	Agree
9. Video lectures before the class makes me learn a lot about science.	3.63	Strongly Agree
10. I like having reverse instruction in learning science because my needs are answered.	3.36	Agree
11. I am confident that I can solve problems during the class hour because I gained much information about the science subject.	3.47	Agree
12. Reverse instruction integration in my learning of science encouraged me to actively involved in discussion during the class hours.	3.33	Agree
Overall Mean	**3.33**	**Agree**

Legend: **Interpretation**	**Scale**	**Description**
3.50 – 4.00	Strongly Agree	Strong Positive Attitude
2.50 – 3.49	Agree	Positive Attitude
1.50 – 2.49	Disagree	Negative Attitude
1.00 – 1.49	Strongly Disagree	Strong Negative attitude

The table above shows items 3 and 9 with a mean of 3.60 and 3.63 respectively which means that the students have a strong positive attitude towards flipped instruction. This means that the students strongly believed that "flipped instruction" gave them a stimulating factor which eventually result to more learning in Science.

Further, the rest of the items and the overall mean of 3.33 show that the respondents have a positive attitude towards "flipped instruction" that can provide and improve students' learning in Science. These results reinforce the idea of (Davies, et.al., 2013) which stressed that using flipped instruction increases students' motivation and improves students' learning in Science which revealed that flipped instruction motivates collaborative work and improves students' academic performance.

These findings were affirmed by the revelations of the students' comments:

R1: "This time, I liked my teachers' way of teaching because I can learn more about the topic. It is good that the given videos are related to our topic."

R2: "I like the reverse very much because I'm confident to solve problems."

R3: "I like the reverse instruction because my teacher's instruction is very clear, that's why I really understand."

R4: "I like reverse instruction because it makes me learn easier and it makes me understand the topic easily."

R5: "I like it because reverse instruction integration requires me to think and to study."

These quotes from students attest to the study of Ingram, et al. (2014) where the learners' interest and sense of readiness for the lesson are developed.

This also affirms the study of (Malto et.al, 2018), that exposure to flipped instruction developed a more positive attitude in students, which also resulted in a greater improvement of understanding of concepts as reflected in their performances. Flipped instruction provided avenues for the students to be participative in class, and to articulate their ideas during small group discussions.

Generally, this result confirmed the effectiveness of the flipped instruction method in teaching Science, especially for the kind of students this generation has, that is, *millennials.* A generation, within which gadgets and ICT tools are part and parcel of the life of people.

5. Conclusion

Based on the result, it can be concluded that there is a positive effect of flipped instruction on the performance of Grade 10 students in science as reflected in their performances. Students learned better in flipped instruction than the traditional one. Further, data shows that the respondents have a positive attitude towards "flipped instruction" that can provide and improve students' learning in Science. Flipped instruction increases students' motivation in learning and makes them more confident during class activities which means that learners' interest and sense of readiness for the lesson are developed.

The students liked this teaching strategy for it gives them autonomy, freedom and self-direction as to how, when, and where they will learn. It also gives them fun and that they learn better and easier because they have better prior knowledge prior before the class. Hence, flipped instruction is effective in teaching Science 10.

6. Recommendations

1. School administrators may impose and monitor frequently the creative conduct of classroom instruction by their science teachers to use flipped instruction as a teaching method.

2. Teachers may consider utilizing flipped instruction by incorporating technology into their teaching to achieve better learning outcomes and create better learning opportunities for their students.

3. Future researchers may conduct a similar study to determine the effectiveness of flipped instruction for different types of learners: high-performing students, low-performing students for other types of respondents, and experimental research.

4. The curriculum developer may utilize the findings on the students' attitude towards flipped instruction in enhancing/designing a flipped classroom with different types of learners.

References

Abeysekera, L. & Dawson, P. (2015) Motivation and Cognitive Load In The Flipped Classroom: Definition, Rationale And A Call For Research. *Higher Education Research & Development*. http://dx.doi.org/10.1080/07294360.2014.934336

Ahmed, K & Ouda H. (2016) *Flipped Learning As A New Educational Paradigm: An Analytical Critical Study*. 10.19044/esj.2016.v12n10p417

Arfstrom, K. (2013). How to Reach Struggling Students: Once You Flip, You'll never go Back - Flipped Learning Global Initiative: The Exchange (flglobal.org)

Bergmann, J. & Sams, A., (2012). Flip Our Classroom: Reach Every Student in Every Class Every Day. *International Society for Technology in Education*. https://www.amazon.co.uk/Flip-Your-Classroom-Reach-Student/dp/1564843157

Bergmann, J. & Sams, A., (2016). The Definition of the Flipped Classroom. https:// www.teachthought.com/learning/the-definition-of-the-flipped classroom/

Cabı, E. (2018). The impact of the flipped classroom model on students' academic achievement. *International Review of Research in Open and Distributed Learning*, *19*(3).

Calamlam, J. (2016). Effectiveness of Blended E-Learning Approach in a Flipped Classroom Environment. http://25qt511nsw fi49iayd31ch80-wpengine.netdna-ssl.com/wpcontent/uploads/papers/ acset2016/ ACSET2016_21431.pdf

Camiling M.K, (2017). The Flipped Classroom: Teaching the Basic Science Process Skills to High Performing 2nd Grade Students of Miriam College Lower School Miriam College, Philippines. *IAFOR Journal of Education* http://iafor.org/archives/journals/iafor-journal-of education/ 10.22492. ije.5. si.10.pdf

Casem R. Q. (2016). Effects of flipped instruction on the performance and attitude of high school students in mathematics. European Journal of STEM Education, v1 n2 p37-44 https://eric.ed.gov/?id=EJ1167409

Chao, C.Y., Chen Y.T. & Chuang K. Y. (2015). Exploring students' learning attitude and achievement in flipped learning supported computer aided design curriculum: A study in high school engineering education. *Computer Applications in Engineering Education 23(4)* DOI: 10.1002/cae.21622

Clark, K. (2013). The Effects of the Flipped Model of Instruction on Student Engagement and Performance in the Secondary Mathematics Classroom. Journal of Educators Online, v12 n1 p91-115 https://files.eric.ed.gov/fulltext/EJ1051042.pdf

Davies, R.S., Dean, D.L. & Ball, N. Flipping the classroom and instructional technology integration in a college-level information systems spreadsheet course. *Education Tech Research Dev 61,* 563-580 (2013). https://doi.org/10.1007/s11423-0113-9305-6

Evseeva, A. & Solozhenko, A. (2015). Use of Flipped Classroom Technology in Language Learning. Procedia - Social and Behavioral Sciences 206:205-209 https://www. researchgate.net/publication/283984133_Use_of_Flipped_Classroom_Technology_in_Language_Learning/download

Farrah, M. (2018). *English Students' Attitudes Towards Using Flipped Classrooms in Language Learning at Hebron University.* https://www.research gate.net/publication/330667474_English_Students'_Attitudes_Towards_Using_Flipped_Classrooms_in_Language_Learning_at_Hebron_University

Flumerfelt, S., & Green, G. (2013). Using Lean in the Flipped Classroom for At Risk Students. *Educational Technology & Society*. https://www.j-ets. net/ets/journals/16_1/31.pdf on Sept. 2018

Framework for 21st Century Learning, (2010). *The Partnership for 21st Century* http://www.p21.org/overview/ skills-framework

Fulton, K. (2012a). Upside down and inside out: flip your classroom to improve student learning. *Learning & Leading with Technology.* http://files.eric. ed.gov/ full text /EJ982840 .pdf.

Hamdan, N., McKnight, P., McKnight, K., & Arfstrom, K. M. (2013). A Review of flipped learning. http://www.flippedlearning.org/cms/ lib07/VA01923112/Centricity/ Domain/41/LitReview_FlippedLearning.pdf

Hao, Y. (2014). Students' Attitude towards a Flipped Classroom and its Relationship with Motivation Orientations in an Undergraduate Course. In M. Searson & M. Ochoa (Eds.), Proceedings of SITE 2014--Society for Information Technology & Teacher Education International Conference (pp. 2835-2840). Jacksonville, Florida, United States: Association for the Advancement of Computing in Education (AACE). http://sciencecases.lib.buffalo.edu/cs/pdfs/Cases_Flipped_Classroo

Herreid, C. & Schiller, N. (2013). Case studies and the flipped classroom. *Journal of College Science Teaching.* m.pdf

Ingram, D., Wiley, B., Miller, C., & Wyberg, T. (2014). A study of the flipped Math classroom in the elementary grades. Saint Paul, MN: University of Minnesota, College of Education and Human Development, Center for Applied Research and Educational Improvement. Retrieved July 27, 2017, from https://conference.iste.org/uploads/ISTE2015/HANDOUTS/KEY_94297144/ FlippedCla ssroomReportMarch212014.pdf

Lage, M. J., Platt, G., & Treglia, M. (2000). Inverting the classroom: A gateway to creating an inclusive learning environment. *Journal of Economic Education*. https://doi.org/10.1080/00220480009596759

Lo, C.K., & Hew, K. F. (2017). A critical review of flipped classroom challenges in K-12 education: Possible solutions and recommendations for future research. RPTEL 12,4. https://doi.org/10.1186/s41039-016-0044-2

Malto, G. A., Dalida, C.S. & Lagunzad C. G. (2018). Flipped Classroom Approach in Teaching Biology: Assessing students' Academic Achievement and Attitude Towards Biology. Doi:10.18502/kss.v3i6.2403

Nouri, J. (2016). The flipped classroom: for active, effective and increased learning-especially for low achievers. *International Journal of Educational Technology in Higher Education.* (13:33)

Paristiowati, M., Fitriani E. &Aldi N. H. (2017). The effect of inquiry-flipped classroom model toward students' achievement on chemical reaction rate https://aip.scitation.org/doi/pdf/10.1063/1.4995105

Reyna, J., Davila, Y.C. & Meier, P. (2016). Enhancing the Flipped Classroom Experience with the Aid of Inclusive Design. In *Proceedings of EdMedia 2016--World Conference on Educational Media and Technology* (pp. 1795-1807). Vancouver, BC, Canada: Association for the Advancement of Computing in Education (AACE). https://www.learntechlib.org/primary/p/173190/.

Rosiene, C. P., & Rosiene, J. A. (2015, October). Flipping a programming course: The good, the bad, and the ugly. In *2015 IEEE Frontiers in Education Conference (FIE)* (pp. 1-3). IEEE.

Roehling, P. & Carrie B. (2021). Flipped learning What is it, and when is it effective? (brookings.edu).

Sahin, A., Zeytuncu, Y. & Cavlazoglu, B. (2015). Flipping a College Calculus Course: A Case Study. https://www.researchgate.net/ publication/ 280945591_Flipping_a_College_Calculus_Course_A_ Case_ Study

Saunders J. (2014). The Flipped Classroom: Its Effect On Student Academic Achievement And Critical Thinking Skills In High School Mathematics. http://citeseerx.ist.psu.edu/viewdoc/ download? doi= 10.1.1.865.3516 &rep=rep1&type=pdf

Song, Y. & Kapur, M. (2017). How to flip the classroom- "Productive failure or traditional flipped classroom" pedagogical design? *Journal of Educational Technology & Society.* https://www.jstor.org/stable/pdf/jeductechsoci.20.1.292.pdf

Tucker, B. (2012). The Flipped Classroom Education https://www.educationnext.org/files/ednext_20121_B Tucker.pdf