IJAMS INTERNATIONAL JOURNAL OF ADVANCED MULTIDISCIPLINARY STUDIES
Volume II, Issue 5 May 2022, eISSN: 2799-0664

Flipped Classroom Approach in Learning Taxonomy

ANGEL LHI F. DELA CRUZ[1] & TESSIS E. LERIOS[2]
[1]Notre Dame of Midsayap College
[2]University of Southern Mindanao
ORCID Number: 0000-0003-4838-2741
delacruzangellhi@gmail.com

Abstract — Scientific literacy is one of the digital age skills. Personal decision-making requires a thorough understanding of scientific concepts and methodologies. Using spatial and temporal links in learning taxonomies is an example of a basic science process ability. This study used a quasi-experimental methodology and purposefully chose STEM students for the experimental (Flipped Classroom Approach) and control groups (lecture method). The results were t-tested and ANOVA'd. As a result, the flipped classroom emphasizes independent learning, constructivism, and student-centered teaching practices. The study found that both males in the control and experimental groups performed equally well in evolutionary relationships and systematics, but that females in the control group outperformed females in the experimental group. Gender is one of three demands that transcend other social biological factors, according to proponents of self-determination theory. To measure learning achievement, students in flipped classrooms and lecture groups must know the measures that inspire them to learn. So the researcher wanted to gauge student motivation. Using an improvised Motivation Learning Questionnaire, the theory's primary premise was that three psychological demands drive students' motivation: autonomy, competence, and possibly belongingness. However, the results showed that there was a highly significant difference in the scaled motivation of students in the lecture technique in intrinsic goal orientation, control of learning beliefs, and self-efficacy. Extrinsic goal orientation, task value, and teacher aid did not differ significantly. The flipped classroom approach excelled in learning performance, whereas the lecture technique excelled in extrinsic goal orientation, control of learning attitudes, and self-efficacy.

Keywords — Assessment, Flipped Classroom, Lecture Method, Performance, Motivation, Learning

I. Introduction

Education has been under pressure to adopt more adaptable, effective, active, and student-centered teaching practices that address the shortcomings of traditional transmittal models of education. Recently, the flipped classroom concept has been proposed to help with this shift. However, because the research is still in its early stages, little is known about how students learn in a flipped classroom.

The flipped classroom is gaining popularity in a growing number of educational institutions worldwide (Gundlach et al., 2015a). The flipped classroom approach is based on the principle of pre-delivering teacher lectures via online videos, freeing up in-class time for active learning and problem-solving tasks (Lo and Hew 2017).

The flipped classroom encouraged students to use technology in the classroom by exposing them to pre-recorded content (through the internet, films, or audio-visual recordings) outside of the typical educational environment (at home, in the library, or anywhere instructional material can be accessed) (Bergmann & Sams, 2012). After seeing the video, students are expected to return to class—typically during the following class meeting—and collaborate on the issue with their peers and teacher. Students may use this time to address any misconceptions regarding the subject. Where pupils can design their own learning (Okit, 2019).

In the flipped classroom approach, the teacher is the focal point of the lesson and the primary disseminator of knowledge during the class session. While the teacher responds to student inquiries, students look to the teacher for guidance and feedback. Individual instruction in a classroom setting employing a typical teaching style may also emphasize the rationalization of material information through the use of a lecture style. Student involvement may be limited in a traditional approach to activities in which students work independently or in small groups on a teacher-defined application task (Okit, 2019a).It is the obligation of the institution to equip learners with quality education to prepare them to tackle the challenges of change across the world. In light of the present challenges in science education, the formation of highly qualified science teachers is critical. These include problems for students to understand scientific concepts and recognize the utility of science in general (van Driel & Abell, 210 C.E.).

Recent study in science education reveals the systematic and intricate structure of science teaching and learning. Collaboration between classroom teachers, science educators, and technologists is fostering the development of a more robust perspective on science teaching and learning by designing innovative instruction, constantly refining it based on classroom studies, and fostering the development of a more robust perspective on science teaching and learning. Rather than absorbing information from the science subject, most scientists agree that science students engage in a process of knowledge integration in which they make sense of disparate pieces of information such as personal experiences, classroom instruction, and related concepts. Frameworks for science instruction assist students in integrating their knowledge by requiring materials and activities that are simple to grasp, make thinking visible, allow for peer learning, and promote self-monitoring (Linn, 2001a).

Lifelong science learners reflect actively on their views, seek novel viewpoints on scientific problems, and endeavor to continually improve their scientific knowledge. Allowing for independence requires designing instruction in such a way that students take ownership of science learning frameworks, standards, texts, and even recipe-driven hands-on experiences. However, the curriculum cannot possibly contain all of the necessary scientific information; rather, students require supervised practice analyzing their own development in order to take charge of their own education (Linn, 2001b).

Scientific knowledge is humanity's collective legacy. It is the only humankind's treasure that can provide a feasible remedy for overcoming inequality and bringing about an adequate quality of life and a sense of purpose for the vast majority of the world's people (Kaptan & Timurlenk, 2012).

To meet the difficulties of the twenty-first century in science and technology, students must be prepared with 21st-century abilities in order to compete in the globalization era. Students are required to acquire 21st-century talents in addition to achieving academically. As a result, including 21st-century skills in science education is critical. Digital age literacy, imaginative thinking, effective communication, and high productivity are the four primary domains of 21st-century abilities. One of the abilities required for digital age literacy is scientific literacy. It entails knowledge and comprehension of scientific concepts and processes necessary for personal decision-making, as well as engagement in civic and cultural issues. Basic science process abilities include seeing, categorizing, measuring, and manipulating numbers; forming inferences; and predicting, conveying, and using space and time relationships (Turiman et al., 2012).

There is a clear link between their gender, biological self-efficacy, learning style, and overall performance as a result of their biology research. Previous reviews imply that a flipped-classroom method can improve student performance or, at worst, do no harm to student learning when compared to traditional instruction. Only a few studies (Gundlach et al.2015b) found that students in traditional classrooms did significantly better than students in flipped classrooms in published research on flipped classrooms.

Literature Review

Social cognitive theorists recognize the importance of individual cognition in learning and performance, in contrast to behaviorists, who concentrated exclusively on stimulus or response conditioning. The triadic reciprocity model is used by social cognitive theorists to give a framework for the disentanglement of learning and performance, demonstrating that learned behavior may be disentangled from performance. Bandura and colleagues (Groenedijk, Rijlaarsdam, and van der Berg, 2013) proved that learning can occur without the production of actions, implying that learning and those behaviors will not occur unless the individual is driven to do so by the consequences of not doing so (Bandura & Jeffrey, 1973; Schunk & Usher, 2012).

Self-Determination Theory in Flipped Classroom Approached

Edward L. Deci and Richard M. Ryan pioneered self-determination theory, a subset of motivational theory. Self-determination theory, like social cognitive theory, recognizes the importance of the relationship between individual agency and environmental context in the construction and functioning of human psychology. The core premise of the theory is that human motivation is driven by three psychological needs: autonomy, competence, and relatedness (or belonging) (Ryan & Deci, 2000). According to proponents of self-determination theory, these three demands are fundamental to human psychology and transcend other social biological factors such as age, gender, and cultural background (Chirkov, Ryan, Kim & Kaplan, 2003). The extent to which these requirements are met is contingent upon an individual's motivation. By contrast, settings that undercut or defy these expectations result in either motivation or disaffection in those impacted (Deci & Ryan 2008).

Teacher Factor in Lecture Method

The modern classroom is built on the relationship between students and instructors. The instructor conveys knowledge to pupils through conversation and demonstration, which serves as the framework for the classroom. Students who are assisted by their teachers have a larger chance of success. According to self-determination theory, the instructor can either support or block motivation by creating an environment that simultaneously influences all three essential psychological demands. Instructors can help students feel more autonomous by engaging in autonomy-promoting actions such as providing alternate assignments and adapting classes or assignments to students' interests. Students who are taught in this manner are more likely to reject manipulative or controlled feedback, place a higher premium on effort than performance, and receive rewards that encourage an internal locus of causality over an external locus of causality, among other behaviors. Encouraging students to inquire providing feedback on assignments, and appraising student's efforts while responding to queries are all good strategies for influencing students' views of competence. Teachers can help students feel more connected to one another by connecting with them in the classroom. In the classroom, relatedness refers not only to the instructor's relationships with the students but also to the environment that the teacher creates for the students (Furrer & Skinner, 2003). They discovered that teacher-related parameters significantly influenced classroom engagement (both self-reported and instructor-reported), especially among boys. Furrer and Skinner discovered that relatedness was a more powerful predictor of engagement than self-control in the same study.

Participation has a huge impact on the relationship between the instructor and the student (Reeve 2012) a model that elucidates the link between classroom participation and motivation In the context of a learning environment, this model explores the relationship between motivation and classroom involvement. This paradigm encourages teachers to act in ways that add to student motivation. After that, participation occurs as a result of the inducement. When teachers and students acknowledge and accept engagement cues, motivation and, as a result, engagement increase. When teachers or peers disregard students' engagement, it erodes their motivation by eroding their sense of connectedness. Engaged students, according to Reeve (2012), fully explain and mediate the motivation-to-achievement mismatch. When students are actively involved in the learning process, teachers receive drive-feedback that they may utilize to alter the dynamics and character of a lesson. Teachers can use the information provided in this feedback to help maintain student engagement and ensure they get the best potential results. These signs of involvement are well-established in the traditional classroom setting. Teachers look for indicators of student attendance in the classroom, such as an attentive gaze, posture, tone of voice, and active questioning.

These metrics of student engagement are uncommon in an online classroom. The teacher is frequently compared to a singer performing in front of an empty room. The instructional support provided in online vs. traditional classes has the potential to have a substantial effect on student's motivation and academic success. Jaggars (2014) discovered that students in higher education prefer traditional over online courses.

II. Methodology

The study used the quasi-experimental design to examine the significant difference between the Flipped Classroom Approached against the Lecture Method. There were two groups purposely selected as the participants of the study and a total of 48 students from Science, Technology, Engineering, and Mathematics from Grade-11 in Notre Dame of Midsayap College for the school year 2019-2020. The selected topic in the TAXONOMY were Evolutionary relationships, Systematics, and Phylogeny. To assess the Flipped Classroom Approached the researcher measured the students' academic performance by obtaining the test scores pre-test and post-test. While the Lecture Method in the control group assessed the performance based on the result of pretest and post-test scores compared to Flipped Classroom Approached.

Data Analysis

There were several methods of analysis used in the study. Each research hypothesis was treated accordingly to the proper data analysis. To ensure the learning ability of the experiment group and control group the pretest scores were administered. To determine the differences between the performance of the test score. The researcher used analyzed the paired t-test of the experimental and control group. In the comparison of the performance of the Flipped Classroom Approached on the three learning topics for comparison, the study employed the ANOVA (Analysis of Variance).

Instrument

The study used research made a 30 items multiple-choice questionnaire to align the instrument and the topics of Evolutionary Relationships, Systematics, and Phylogeny. Using Google Classroom the research questionnaire was made available. The primary goal is to test the learning performance using the research questionnaire for the experimental and control groups.

The research survey questionnaire the Motivation to Learn Online Questionnaire (Fowler, 2007) was used to assess the motivation to learn Taxonomy and Classification of the students who are taught with Flipped Classroom Approached.

III. Results and Discussion

The table showed no significant difference in the paired sample of the pretest scores between the experimental (M = 11.50, SD = 0.74) and control group (M = 11.42, SD = 3.61). Based on the result (t = 0.74, P > 0.05), the null hypothesis needs to be accepted. No significant difference in the students' scores in the experimental and control group. The result showed that the two groups were on equal footing prior to the intervention given.

Table 1 t-test results in comparison between the pre-test scores of the control and experimental group.

Group	**N**	**Mean**	**SD**	**t-value**	**p-value**
Control	24	11.42	3.61	0.74^{ns}	0.05
Experimental	24	11.50	0.74		
Total	48				

The table showed a significant difference in the paired sample t-test of the post-test scores between the experimental (M = 26.83, SD = 1.84) and the control group (M = 25.00, SD = 1.84). Based on the result (t = 3.06, P < 0.05), the null hypothesis needs to be rejected. There was a significant difference in the students' scores in the experimental and control group.

Table 2 t-test results in comparison between the post-test scores of the control and experimental group.

Group	N	Mean	SD	t-value	p-value
Control	24	25.00	2.28	3.06^{*}	0.00
Experimental	24	26.83	1.84		
Total	48				

The table below showed a comparison between male and female post-test results with a significant difference between the experimental and control group. The female in the experimental group had significantly higher post-test scores (M = 28.57, SD = 1.22). While males in the experimental group had a low significant post-test score (M = 24.60, SD = 1.34).

Table 3 ANOVA results in comparison between the scores of males (experimental group) and females (control group).

Group	N	Mean	SD	Std. Error
Male (Experimental)	10	24.60	1.34	0.46
Female(Experimental)	14	28.57	1.22	0.32
Male (Control)	6	26.00	0.00	0.00
Female (control)	18	24.72	1.99	0.47
Total	48			

The table showed that there was a significant difference between groups (MS = 47.17) post-test scores of the students in the experimental group and the control group. The *f*-ratio value is 3.06, *p*-value is 0.00. Thus, the results needed to reject.

Table 4 ANOVA test results in comparison to the post-test scores between experimental and control groups.

Sources	DF	SS	MS	F-Stat	p-value
Between Groups	3	141.53	47.17	3.06*	0.00
Within Groups	44	103.44	2.35		
Total	47	244.98			

The result showed a comparison between male and female post-test results with a significant difference between the experimental and control group on the topic of Evolutionary relationships. The female in the experimental group had significantly higher post-test scores (M = 9.28, SD = 0.67). While females in the control group had a low significant post-test score (M = 24.60, SD = 0.87).

Table 5 ANOVA results in comparison between the scores of males (experimental group) and females (control group) in Evolutionary Relationships.

Group	N	Mean	SD	Std. Error
Male (Experimental)	10	7.30	0.67	0.21
Female(Experimental)	14	9.28	0.61	0.16
Male (Control)	6	8.00	0.00	0.00
Female (control)	18	7.94	0.87	0.20
Total	48			

The table showed that there was a significant difference between groups (MS = 47.17) post-test scores of the students in the experimental group and the control group. The *f*-ratio value is 17.42, *p*-value is 0.00. Thus, the null hypothesis needed to reject.

Table 6 ANOVA test results in comparison to the post-test scores between experimental and control groups in Evolutionary Relationships.

Sources	DF	SS	MS	F-Stat	p-value
Between Groups	3	26.01	8.67	17.42*	0.00
Within Groups	44	21.90	0.49		
Total	47	47.91			

The result showed a comparison between male and female post-test results with a significant difference between the experimental and control group on the topic of Systematic. The female in the experimental group had significantly higher post-test scores (M = 10.00, SD = 0.00). While males in the experimental group had a low significant post-test score (M = 7.30, SD = 0.67).

Table 7 ANOVA results in comparison between the scores of males (experimental group) and females (control group) Systematics.

Group	N	Mean	SD	Std. Error
Male (Experimental)	10	7.30	0.67	0.21
Female(Experimental)	14	10.00	0.00	0.00
Male (Control)	6	8.00	0.00	0.00
Female (control)	18	7.94	0.87	0.20
Total	48			

The table showed that there was a significant difference between groups (MS = 17.54) and within groups (MS = 0.38) post-test scores of the students in the experimental group and the control group. The *f*-ratio value is 45.28, *p*-value is 0.00. Thus, the null hypothesis needed to be rejected.

Table 8 ANOVA test results in comparison to the post-test scores between experimental and control groups in Systematics.

Sources	DF	SS	MS	F-Stat	p-value
Between Groups	3	26.01	17.54	45.28*	0.00
Within Groups	44	21.90	0.38		
Total	47	47.91			

The result showed a comparison between male and female post-test results with a significant difference between the experimental and control group on the topic of Phylogeny. The male in the experimental group had significantly higher post-test scores (M = 10.00, SD = 0.00). While females in the control group had a low significant post-test score (M = 8.83, SD = 0.85).

Table 9 ANOVA results in comparison between the scores of males (experimental group) and females (control group) Phylogeny.

Group	N	Mean	SD	Std. Error
Male (Experimental)	10	10.00	0.00	0.00
Female(Experimental)	14	9.28	0.61	0.16
Male (Control)	6	10.00	0.00	0.00
Female (control)	18	8.83	0.85	0.20
Total	48			

The table showed that there was a significant difference between groups (MS = 3.67) and within groups (MS = 0.38) post-test scores of the students in the experimental group and the control group. The *f*-ratio value is 9.82, the *p*-value is 0.00. Thus, the null hypothesis needed to be rejected.

Table 10 ANOVA test results in comparison to the post-test scores between experimental and control groups in Phylogeny.

Sources	DF	SS	MS	F-Stat	p-value
Between Groups	3	11.62	3.67	9.82*	0.00
Within Groups	44	17.35	0.49		
Total	47	28.97			

The result showed a comparison between the experimental and control group in their responses to the Motivation to Learn Questionnaire. The intrinsic goal-oriented had a higher mean in the controlled group (M = 22.40, SD = 1.82); the extrinsic goal-orientation had a close mean score among the control (M = 20.75, SD = 0.96) and experimental (M = 19.75, SD = 1.71) groups; a high mean score of control group (M = 20.75, SD = 0.50) compared to experimental (M = 1.50, SD = 0.58) in control of learning Beliefs; with the high efficacy in motivation a high mean score in control (M = 16.57; SD = 2.64) than the experimental group (M = 11.71; SD = 2.64); while the close mean scores between the control (M = 21.29, SD = 2.56) and experimental group (M = 19.86, SD = 4.60) in task value; and close mean scores of the control (M = 23.67; SD = 0.82) and experimental (M = 24.00, SD = 0.00) in the instructional support.

The table showed a highly significant difference between the control group in intrinsic-goal orientation (t =3.69 > p = 2.77), control of learning beliefs (t = 46.43 > p =3.18), and self-efficacy (t = 2.48 >2.44). It also showed a no significant difference in terms on the extrinsic goal-orientation (t = 2.83 < p = 3.18), task value (t = 1.25 < p = 2.45).

Table 11 scaled item mean and standard deviation between the experimental and control groups.

Scale	Mean		SD	
	Experimental Group	Control	Experimental Group	Control
Intrinsic Goal Orientation	19.20	22.40	2.39	1.82
Extrinsic Goal Orientation	19.75	20.75	1.71	0.96
Control of Learning Beliefs	1.50	20.75	0.58	0.50
Self-Efficacy	11.71	16.57	7.16	2.64
Task Value	19.86	21.29	4.60	2.56
Instructor Support	24.00	23.67	0.00	0.82

The table showed a significant difference between the experimental and control group. In scaled test the control group differed in intrinsic goal orientation (p = 2.77), control of learning beliefs (*p* = 3.18), and self-efficacy (*p* = 2.44). While no difference on the extrinsic (*p* = 3.18), task value (*p* = 1.25), and instructor (*p* = 2.57).

Table 12 paired sample t-test between the experimental and control group in the Motivation to Learn Questionnaire.

Test	t	p	Effect Size
Intrinsic Goal Orientation	3.69	2.77*	1.9
Extrinsic Goal Orientation	2.83	3.18ns	0.7
Control of Learning Beliefs	46.43	3.18*	0.83
Self-Efficacy	2.48	2.44*	5.16
Task Value	1.25	2.45ns	3.02
Instructor Support	1.1	2.57ns	0.76

The preferences of males and females in control and experimental groups varied based on the topics used in the flipped classroom and in the lecture approach. On the topic of evolutionary relationships, the comparison of male and female post-test results revealed a substantial difference between the flipped classroom and lecture methods. Females in the experimental group scored significantly higher on the post-test than females in the control group, while males in the flipped classroom approach scored significantly low on the post-test on the topic of systematic, the comparison of male and female post-test results revealed a significant difference between the experimental and control groups. Females in the experimental group scored significantly higher on the post-test than males in the experimental group, who scored significantly lower on the post-test. The comparison of male and female post-test results, on the other hand, revealed a substantial difference between the experimental and control groups on the topic of the phylogeny. Males in the experimental group had significantly higher post-test scores than women in the control group, who had significantly lower post-test scores.

The difference in responses to the Motivation to Learn Survey Questionnaire between the experimental and control groups. The intrinsic goal-oriented had a higher mean in the controlled group, while the extrinsic goal-oriented had a close mean score between the control and experimental groups, a high mean score of the control group compared to the experimental in control of learning beliefs, with high efficacy in motivation, a higher mean score in control than the experimental group, and close mean scores between the control and experimental groups in task value, and close mean scores between the control and experimental groups in task value.

The difference between the control group and the intrinsic-goal orientation, control of learning beliefs, and self-efficacy was highly significant. It also revealed no statistically significant differences in extrinsic goal orientation of task value.

IV. Conclusion

Learning can occur without resulting in behaviors that represent the acquired knowledge, and those behaviors will not occur unless the individual is driven to do so by the consequences. Females in the experimental group outperformed females in the control group on the post-test. There was a significant difference in male and female post-test findings between the experimental and control groups on a systematic level. Females did better on the post-test than males in the experimental group. However, when male and female post-test results were compared, a significant difference in phylogeny was observed between the experimental and control groups. Males in the experimental group outperformed females in the control group on the post-test.

The intrinsic-goal orientation, control of learning beliefs, and self-efficacy of the control group were all statistically significant. No statistically significant changes in task value were observed. According to the theory, human motivation is driven by three psychological needs: autonomy, competence, and relatedness. These three conditions, according to self-determination theorists, transcend age, gender, and culture. Individual motivation determines whether these requirements will be reached or not. Individuals who are impacted by circumstances that do not fit these requirements are more driven or unhappy. Teacher-student relationship was found to be a major predictor of classroom engagement (both self-reported and teacher-reported), especially among males. Relatedness outperformed self-control as a predictor of trial participation.

In the classroom, relatedness encompasses both teacher-student interaction and the teacher-created environment. Teacher-student relationships were found to have an effect on classroom involvement (both self-reported and teacher-reported), especially in males. Relatedness outperformed self-control as a predictor of the conducted experiment. Participation in the instructor-student relationship is critical and explains the relationship between motivation and classroom participation. This strategy explains why students are motivated and participate in class. Teachers employ this technique to assist students in developing motivation. The engagement follows motivation. When teachers and students notice indicators of interest, motivation, and, consequently, involvement increase. Engaging in activities that are not deemed socially valuable by teachers or classmates demotivates students because they lack a sense of belonging.

REFERENCES

[1] Bandura, A., & Jeffrey, R. W. (1973). Role of symbolic coding and rehearsal processes in observational learning. J. Journal of Personality and Social Psychology., 26, 122–130. https://doi.org/10.1037/h0034205

[2] Bandura, A., & Schunk, D. H. (1981). Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. Journal of Personality and Social Psychology, 41(3), 586–598. https://doi.org/10.1037/0022-3514.41.3.586

[3] Bergmann, J., & Sams, A. (2009). Remixing Chemistry Class: Two Colorado Teachers Make Vodcasts of Their Lectures to Free Up Class Time for Hands-On Activities. International Society for Technology in Education, 36(4), 22–27. http://www.iste.org

[4] Chirkov, V. I., Ryan, R. M., Kim, Y., & Kaplan, U. (2003). Differentiating autonomy from individualism and independence: A self-determination theory perspective on internalization of cultural orientations and well-being. Journal of Personality and Social Psychology, 84, 97–110. https://miami.pure.elsevier.com/en/publications/differentiating-autonomy-from-individualism-and-independence-a-se-2

[5] Deci, E. L., & Ryan, R. M. (2008). Facilitating optimal motivation and psychological well-being across life's domains. Canadian Psychology/Psychologie Canadienne, 49(1), 14. https://doi.org/10.1037/0708-5591.49.1.14

[6] Fowler, S. (2007). The Motivation to Learn Online Questionnaire (Unpublished master's thesis). University of Georgia, Athens, Georgia, 1--26. https://getd.libs.uga.edu/pdfs/fowler_kevin_s_201805_phd.pdf

[7] Furrer, C., & Skinner, E. (2003). Sense of relatedness as a factor in children's academic engagement and performance. Journal of Educational Psychology, 95(1), 148. https://getd.libs.uga.edu/pdfs/fowler_kevin_s_201805_phd.pdf

[8] Groenendijk, T, T., Janssen, T., Rijlaarsdam, G., & van den Bergh, H. (2013). The effect of observational learning on students' performance, processes, and motivation in two creative domains. British Journal of Educational Psychology, 83(1), 3–28. https://doi.org/10.1111/j.2044-8279.2011.02052

[9] Gundlach, E., Andrew, K., Richards, R., Nelson, D., & Bristol, C. L. (2015). A Comparison of Student Attitudes, Statistical Reasoning, Performance, and Perceptions for WebAugmented Traditional, Fully Online, and Flipped Sections of a Statistical Literacy Class. Journal of

Statistics Education, 23(1). https://www.tandfonline.com/doi/pdf/10.1080/10691898.2015.11889723?needAccess=true

[10] Jaggars, S. S. (2014). Choosing between Online and Face-to-Face Courses: Community College Student Voices. American Journal of Distance Education, 28(1), 27–38. https://doi.org/10.1080/08923647.2014.867697

[11] Kaptan, K., & Timurlenk, O. (2012). Challenges for Science Education. Procedia - Social and Behavioral Sciences, 51, 763–771. https://www.sciencedirect.com/science/article/pii/S1877042812033757

[12] Linn, M. C. (2001a). Science Education. International Encyclopedia of the Social & Behavioral Sciences, 13668–13673. https://doi.org/10.1016/B0-08-043076-7/02441-4

[13] Linn, M. C. (2001b). Science Education. International Encyclopedia of the Social & Behavioral Sciences, 13668–13673. https://doi.org/10.1016/B0-08-043076-7/02441-4

[14] 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. A Critical Review of Flipped Classroom Challenges in K-12 Education: Possible Solutions and Recommendations for Future Research, 12(4), 13–22. https://telrp.springeropen.com/track/pdf/10.1186/s41039-016-0044-2.pdf

[15] Okit, J. L. (2019). Flipped Classroom Approached. Enhancing the Academic Performance and Motivation of Senior High School Students. Https://Www.Grin.Com/De/. https://www.grin.com/de/

[16] Reeve, J. (2012). A Self-determination Theory Perspective on Student Engagement. In Handbook of Research on Student Engagement, January, 149–172. https://doi.org/10.1007/978-1-4614-2018-7_7

[17] Robins, J. (2012). A self-determination theory perspective on student engagement. In Handbook of research on student engagement. Springer US, January, 149–172. https://www.researchgate.net/publication/278716228_A_Self-determination_Theory_Perspective_on_Student_Engagement

[18] Ryan, R. M., & Deci, E. L. (2000). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. Contemporary Educational Psychology, 57, 54–67. https://www.sciencedirect.com/science/article/pii/S0361476X99910202

[19] Schunk, D. H., & Usher, E. L. (2012). Social cognitive theory and motivation. APA Educational Psychology Handbook, 1, 13–27. https://psycnet.apa.org/record/2012-03687-002

[20] Turiman, P., Daud, A. M., & Osman, K. (2012). Fostering the 21st Century Skills through Scientific Literacy and Science Process Skills. Procedia - Social and Behavioral Sciences, 59(October), 110–116. https://www.sciencedirect.com/science/article/pii/S1877042812036944

[21] van Driel, J. H., & Abell, S. K. (210 C.E.). Science Teacher Education. International Encyclopedia of Education (Third Edition), 712–718. https://www.sciencedirect.com/science/article/pii/B9780080448947006825

AUTHOR'S PROFILE

ANGEL LHI F. DELA CRUZ

Ms. Angel Lhi F. Dela Cruz is taking a Doctor of Philosophy in Education major in Biology at the University of Southern Mindanao in Kabacan, North Cotabato, and an instructor in the College of Arts and Sciences at Notre Dame of Midsayap College. In 2016, she earned a Bachelor of Secondary Education with a major in Biology from Notre Dame of Midsayap College in Midsayap, North Cotabato (NDMC). In 2020, she completed her Master of Science in Teaching Biology at the University of Southern Mindanao (USM). She is a certified professional teacher and a student coach for research and biology.