Journal of Turkish Science Education, 2023, *20*(2), 333-355.
DOI no: 10.36681/tused.2023.019

Journal of Turkish Science Education
http://www.tused.org
© ISSN: 1304-6020

Impact of formative assessment based on feedback loop model on high school students' conceptual understanding and engagement with physics

Faith Celeste B. Ole[1], Marilou R. Gallos[2]

[1]*Carlos Hilado Memorial State University, Philippines, faith.celeste.ole@chmsc.edu.ph, ORCID ID: 0000-0001-6248-4168*
[2]*University of San Carlos, Philippines, ORCID ID: 0000-0002-5259-634X*

**Part of a Dissertation Paper*

ABSTRACT
This study examined the effects of using the Feedback Loop Model (FLM) in Grade 12 Senior High School (SHS) Physics classes. Using a one-group pretest-posttest design, 58 students identified from a simple random sampling method were tested for their conceptual understanding and engagement with in kinematics. The results showed that students' engagement had been significantly affected when their physics teachers practised formative assessment (FA) using the Feedback Loop Model in their synchronous classes. These implications were supported by both quantitative and qualitative data in the study. With the use of Wilcoxon Signed-rank Test, statistical differences were obtained in the four dimensions of the engagement tool in terms of agentic engagement ($Z = 3.37$, $p < .001$), behavioural engagement ($Z = 4.82$, $p < .001$), emotional engagement ($Z = 4.06$, $p < .001$), and cognitive engagement ($Z = 4.40$, $p < .001$). Meanwhile, for students' conceptual understanding, the difference between their pre-and posttests mean scores in kinematics revealed a significant difference ($t (57) = 17.76$, $p < .001$), suggesting that teachers' classroom practices towards FA using FLM affected students' level of conceptual understanding in Kinematics. Employing Cohen's d to measure its practical significance also showed a large effect ($d = 2.83$). Thus, it is recommended that implementing FA based on FLM could significantly impact the engagement and learning process of high school physics students.

RESEARCH ARTICLE

ARTICLE INFORMATION
Received: 14.09.2022
Accepted: 15.03.2023

KEYWORDS:
Conceptual understanding, engagements, feedback loop model, formative assessment, physics.

To cite this article: Ole, F. C. B., & Gallos, M. R. (2023). Impact of formative assessment based on feedback loop model on high school students' conceptual understanding and engagement with physics. *Journal of Turkish Science Education, 20*(2), 333-355.

Introduction

Several studies on formative assessment (FA) practices have shown significant increases in school, such as students' academic achievement and attitudes toward classroom performance (Ozan & Kincal, 2018; Yan et al., 2021). This type of assessment has been recognised as a beneficial strategy to enhance learning (Andersson, 2015), cognitive engagement, and understanding of learning contents (Pellegrino & Sloan, 2021). Although the effects of FA may vary among different implementations and student populations, it is manifested in studies of how FA is an essential agenda in educational reform worldwide (Bennett, 2011; Birenbaum et al., 2015; Yan et al., 2021).

Despite its underlying merits on the students' performance, teachers, who have an integral role in shaping the teaching and learning approach, are still reluctant to change their conceptions and practices towards conducting FA (Yan et al., 2022). Teachers' knowledge and skills to design and implement FA in the classrooms (Rashid & Jaidin, 2014; Heitink et al., 2016; Yan et al., 2021) are some of the factors that could impede the FA practice and therefore, to enact this reluctance, teachers through attending teacher development programmes on FA should be given tangible ways to strengthen the skills of assessing formatively.

The proponent of this study designed the *Feedback Loop Model Professional Development Program (FLMPDP)* to orient and train physics teachers by logically explaining multiple elements of the Feedback Loop Model (FLM) by Furtak et al. (2016) – a new approach to maximising formative assessment data. FLM involves four steps– setting the goals, designing and selecting tools, collecting data, and making an inference–to explain and determine students' current knowledge. The piece not represented as a stand-alone step in the Feedback Loop is the final element of formative assessment, which provides helpful feedback to move students toward learning goals. This step has the final arrow connecting inferences and learning objectives. The feedback connects what has been inferred from what students know and can do with the goals for student learning – a process that identifies the gaps. This gap consequently paved the way for the study to use the FLM in helping science teachers to go beyond thinking about the pieces of data in isolation into reorienting them as part of a more extensive system that teachers can design and act on.

Moreover, the FLMPDP webinar programme, a timely avenue for conducting teacher professional growth during the COVID-19 pandemic of 2020-2, used formative assessment data to guide their instructions. This FLMPDP that helped science teachers to efficiently and systematically sort through the data, extract meaningful information, and determine teaching and student learning steps is one of the tangible ways to strengthen teachers' skills in implementing FA in the classroom. With this FLM, students' motivation to participate could be revitalised, especially when teachers are flexible in creating formative assessment situations (Rodgríguez et al., 2021).

The four elements of the FLM - *goal, tool, data, inference* - were brought to bear on formative assessment data, which focuses on what teachers can do when working together to set learning *goals*, design *tools* iteratively, collect *data* and *make inferences* based on that data to guide their instruction. This method that advises them on implementing the intended framework of FLM is essential for better science teaching and meaningful learning of students in their physics classes.

The current educational system in the Philippines has found that teachers' high claim of understanding and applying the FA in their classes is somewhat inconsistent with their actual practices inside the classroom. It was found that only a few indications of FA practices were observed (Griffin et al., 2016) because teachers' teaching sequences showed little flexibility in adapting lessons corresponding to student progress, an expectation from FA practices.

With the pandemic affecting schools worldwide, the use of online distance learning (ODL) became widespread. This ODL setting, an alternative delivery of instruction between the teacher and learners who are geographically remote from each other, uses open educational resources and different technologies, which can be accessed online during instruction (DepEd, 2020). Because of this ODL, students' engagement in an online set-up could also affect their learning progress. Different findings have revealed how online formative assessment could effectively promote learner engagement (Rakoczy et al., 2019), while others opposed it, indicating students' disengagement (Avsar et al., 2021, Bergdahl et al., 2020; Lu & Cutumisu, 2022)

As one of the fundamental topics in physics, kinematics is the most commonly covered area by the teachers teaching the subject. This branch of mechanics, a prerequisite to other branches in physics, is a difficult area for students in the country. In a recent study conducted by Miraňa, as cited by Ole and Gallos (2021), the conceptual knowledge in Physics of most students was found to be deficient when compared to the standards determined by the Department of Education (DepEd). This

result is different from what is expected in the Spiral Progression scheme intended by the K to 12 curriculum, which aims to deepen students' understanding as they progress to a higher level.
This study sought to investigate the effects of FLM on Grade 12 students' conceptual understanding of kinematics as well as their engagement during online classes.

Literature Review

Feedback Loop Model

The assessment model of Furtak et al. (2016) utilises formative assessment data to improve science teaching and learning. This approach is designed to help science teachers efficiently and systematically sort through the data, obtain meaningful information, and decide on the next teaching and student learning steps. As shown in Figure 1, four elements are used in the model: *goal, tool, data,* and *inference.*

The *goal* of the Feedback Loop as the cornerstone is the first step in this guiding principle as teachers build their plans based on what teachers require their students to do. The second element in the loop is the *tool,* which refers to teachers' instruments used to collect student learning data. This can be through worksheets, classroom assessments such as tests or quizzes, or an unwritten condition of actions or expressions that elicit students' ideas. However, this must align with the objectives teachers plan to assess. The third element in the loop is called *data*. In this element, all bits of information indicate students' knowledge. Any form of data (e.g., quantitative, qualitative, formal, or informal) created from the tools teachers used can interpret students' prior knowledge. Formal types of data resulting from tools planned are different from the informal ones. Informal data includes students' responses to questions asked on the fly, including their expressions and involvement in the class.

Finally, the most crucial element in the loop is making sense of the data collected by the teachers-- the process of making *inferences*. However, this does not suggest that a stepwise order must be purely followed because what is significant and highlighted is the synchronisation of one element with other elements of the FLM. When teachers have gone through the four steps in the process, the idea is to connect inferences made back to their goals. Closing the loop is often called feedback in the formative assessment literature (Black & William, 1998 as cited by Furtak et al., 2016) or simply using the information gained through the loop to move students' learning forward.

Figure 1

Feedback Loop Model

Engagement

Engagement as a broad construct of motivation and a component of action (Pavlin-Bernardić, 2017) has been a predominant research topic in education because of its essential role in attaining educational expectations. Although there are conflicts of interchangeably using either motivation or engagement (Reschly & Christenson, 2012), more literature accepts that engagement occurs after motivation (Bond et al., 2020). Student engagement manifests effort (Skinner & Pitzer, 2012).

According to Hake (as cited in Cahyadi, 2004), the Interactive Engagement (IE) method involves promoting conceptual understanding by actively engaging students in activities that yield immediate feedback from their peers or teachers. Students exposed to IE elements gained better conceptual understanding than those who received the traditional teaching approach during their introductory physics classes. Fernandez (2017) posited that when teachers and students apply Vygotsky's theory (1978), a deep-seated conceptual understanding can be obtained through conversing, questioning, explaining, and negotiating.

Jiao's paper (2015) arrived at similar findings, utilising a formative e-assessment tool that encourages students to correct errors. Immediate feedback provided by the programme enhanced student engagement and improved understanding. Biggs and Tang (as cited in Jiao, 2015) explained that actively engaging students in learning activities motivates them to learn the best. This usually depends on teachers' encouragement and creativity when designing activities to attain intended learning goals.

Studies on student engagement could explain how students are involved in the learning process, especially during learning activities (Reeve & Tseng, 2011). When students put time, effort, energy, thought, and feelings into their learning (Dixson, 2015), students' varied engagements (agentic, behavioural, emotional and cognitive) could connect to their positive functioning and motivation (Ladd & Dinella, 2009) that in turn, influence academic progress and achievement. Due to the impact of the pandemic, the shift to the online distance learning (ODL) modality in education has become inevitable. However, students' level of engagement as a sign of online learning effectiveness (Hu & Li, 2017) was challenged and analysed to gauge how students effect their learning outcomes (Cleofas, 2021) in this ODL setup. In this connection, assessing the four aspects of student engagement (agentic, behavioural, emotional and cognitive engagement) as teachers apply FLM on FA could shed light on this study.

Agentic Engagement

Reeve and Tseng (2011) added this construct as the fourth aspect of students' engagement because it focuses on their constructive contribution to instruction flow. This aspect generally involves the proactive participation of the student to express their preference, opinions, and suggestions or offer inputs and recommendations for additional relevance to the lesson. To this extent, students act intelligently as they initiate a process that increases their strong motivation (autonomy and self-efficacy) and meaningful learning by expanding their freedom of action.

Behavioural Engagement

According to Hu and Li (2017), this observable form of engagement describes students' specific behaviours in the learning process. This aspect of engagement expresses students' on-task attention or their task involvement and efforts during the lessons (Reeve & Tseng, 2011). Pilotti et al. (2017) cited that students' involvement or active participation in an online class, such as their response rates during discussions, could also be used to indicate this behavioural engagement.

Emotional Engagement

For the emotional engagement items, five-item measures reflecting the emotional states like enjoyment, interest, curiosity and fun, were primarily measured in this scale instead of the academic emotions experienced by students during task engagement (Reeve & Tseng, 2011).

Cognitive Engagement

The eight-item statements that describe cognitive engagement generally support learning strategies and metacognitive self-regulation strategies (planning, monitoring, and revising the work), which students could apply to improve their learning process.

This study further explored how these constructs affect academic success, assuming that student engagement and conceptual understanding are interrelated. As Reeve and Tseng (2011) pointed out, student engagement depends on the learning activities that teachers provide. Hence, utilising the Feedback Loop as formative assessment data for teaching and learning, this study investigated how these changes in teachers' classroom practices affect the formative assessment of the effect of PDP on the level of students' engagement during online instruction.

Conceptual Understanding in Kinematics

Based on the learning competencies provided by the curriculum, kinematics, as an inevitable subtopic of physics, is connected to all other areas, such as electricity, magnetism, waves, optics, thermodynamics, nuclear physics, and solid-state physics (Syuhendri, 2021). Hence, learning its basic concepts is essential to master the subsequent topics.

In the Philippines, before students can advance to senior high school (SHS), they were taught integrated sciences, including different physics topics, during their junior high school (JHS). Therefore, SHS students are expected to have prior knowledge of physics concepts which could be used to measure their pre-conceptual understanding of kinematics. This prior knowledge from their JHS could be used to obtain their pretest results. With this notion, any significant change (posttest result) in their conceptual understanding of kinematics as affected by implementing the FLM approach could be used to determine its relevance in the students' learning process.

Objectives of the Study

Given the underlying benefits of FA and how FLM could be of aid in enhancing the science teaching and meaningful learning of students in their Physics classes, this study aimed to determine the effects of formative assessment based on the Feedback Loop Model on Grade 12 SHS students' conceptual understanding of kinematics and their engagement. Specifically, it addressed the following questions, "What are the students' engagements (agentic, behavioural, emotional, cognitive) and conceptual understanding in kinematics before and after implementing the FLM?"

Methods

Research Design and Environment

A mixed-method design was utilised in this study. Data from the adopted instruments (quantitative) were analysed and backed by qualitative data for in-depth analysis and interpretation of findings. In particular, a one-group pretest-posttest design was employed for the 58 SHS students who answered the instruments concerning their engagements and conceptual understanding in kinematics. Since distance learning is a new normal in education, this research focused on the different private schools that offer Online Distance Learning (ODL) in the province of Negros Occidental, Philippines.

The province is the second most populous province in the Visayas after Cebu City and is known as the "Sugar Bowl of the Philippines" as the place produces more than half of the nation's sugar production.

Research Participants

Presented in Table 1 is the distribution of Grade 12 students' profiles from the 3 physics teachers who agreed to participate in the implementation process of the Feedback Loop. Teacher 1, who had the most significant number of students, composed almost 90% of the data sets. This number of respondents doing an online class could be attributed to the large school population handled by Teacher 1 and the students' economic status, located in the province's capital city. This school is also one of the city's prestigious schools, which entailed many students opting for online classes.
Meanwhile, Teachers 2 and 3, who came from the same small school situated outside the capital city, had fewer students to handle because many of their Grade 12 students opted to do modular distance learning. In this pandemic, private schools in the country may have options for their students to choose online or modular learning modes. Hence, few attendances registered for them. Consequently, this study reported the quantitative data under Teacher's 1 class, while those under Teachers 2 and 3 were only presented qualitatively in a manner that showed supplementary information.

Table 1

Students' Profile

Teacher	Number of students per class	
	Female	Male
1	45	13
2	3	2
3	3	0

The 58 students from Teacher 1 were chosen to be the focus of the statistical analysis using a convenience sampling method. Inclusion criteria included that they were attending the synchronous class in physics for the AY 2021-2022 and must have completed the pre- and post-surveys.

Research Instrument

A tool developed by Reeve and Tseng (2011) called *Agentic Engagement Scale (AES)* was employed to measure the four aspects: agentic engagement, behavioural engagement, emotional engagement, and cognitive engagement. With a strong and acceptable level of reliability value (α = 0.81), this instrument that used a 1 to 7 bipolar response scale ranging from "strongly disagree" to "strongly agree" with "agree and disagree equally" serving as the midpoint (4) was accessed by the students for the pre-and post-surveys. Using a Google form, this instrument was given as an initial undertaking before teachers could implement FA based on the Feedback Loop. After their teachers discussed all the topics in kinematics, a post-survey was re-administered to assess any changes in their engagement during class.
Another instrument utilised in this study is the *Physics Concept Test in Kinematics for Senior High School Students* (Ole & Gallos, 2021), which consisted of a 30-item conceptual test in kinematics designed from the K-12 Most Essential Learning Competencies (MELCs) determined by the Department of Education (DepEd). With a reliability value (α = 0.758) and content validation coefficient (V = 0.94),

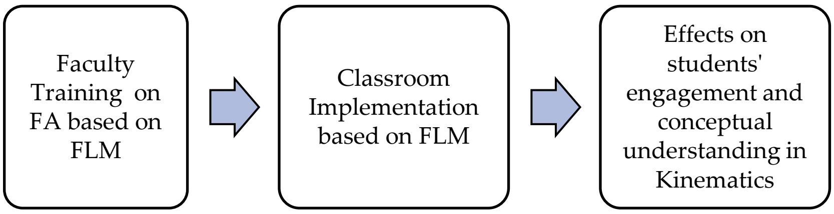
this test indicated an acceptable measurement standard for the conceptual understanding of kinematics of the SHS students.

Research Procedures

The Department of Education's (DepEd) webpage identified the province's various private schools offering Senior High School (SHS) programs. These schools were sent an invitation letter through their official emails addressed to the principals, heads, and directors of their institution about the free webinar series entitled "Feedback Loop Model Professional Development Program (FLMPDP)." This webinar also included free e-certificates and e-copies of the speakers' presentations. Following the framework presented in Figure 2, the first two phases of this study were conducted in order to determine the effects of FLM on the aforementioned variables.

Figure 2

Phases of the Study



Instructor training on FA based on FLM

For the first part of the study, 23 SHS physics teachers attended and actively participated in the webinar series held every Saturday in July, specifically on July 10, 17, 24, and 31, 2021. An action plan of the FLMPDP, which served as the training blueprint, was prepared to guide the proponent. In the duration of the conduct of the FLMPDP, an email was sent to each registered teacher two to three days before the next scheduled webinar. This reminded them of the schedule and the link they needed to click to join the webinar. While waiting for the programme to start, teacher-participants followed the house rules indicating the webinar's instructions and flow. This included the privacy act (purpose and confidentiality), expected outcomes, and reflective details. Suffice it to say teachers underwent a programme of training called FLMPDP to optimize their skills in formative assessment.

Classroom Implementation Based on FLM

Before examining the effects of FLM on the target Physics classes, students were first asked to answer the pre-survey questionnaire on students' engagement scale using the "Agentic Engagement Scale." After the teachers implemented the FA based on FLM, a post-survey was re-administered to examine any significant change in their levels of engagement (agentic, behavioural, emotional, cognitive). Moreover, teachers’ narratives from their journals or reflections were utilised to support the statistics, and valuable feedback from the different cross-examiners (CE) were also tapped to support the data triangulation results. This study employed cross-examiners (CE) or experts who would notably observe how teachers utilized the FLM in their Physics classes. The purpose of utilizing

cross-examiners or experts was to facilitate deeper understanding and shed light on how teachers practice FA in their classes without bias. They were chosen based on their familiarity with the FLM.
Meanwhile, a pre-and post-test using the Physics Concept Test in Kinematics for Senior High School (SHS) Students (Ole & Gallos, 2021) was administered to measure changes in students' conceptual understanding of Kinematics.

Ethical Consideration

All students who accessed the Google forms were presented with a letter of consent informing them of the purpose of the engagement survey and how it can provide information for the analysis. They were also told in advance by their teachers for ethical reasons. Records acquired from this study were treated with confidentiality, and their identities were not disclosed. Codes were provided to all recordings, transcripts, and documentation, and all gathered information was kept in locked files at all times.

Results and Discussion

Agentic Engagement

As shown in Table 2, students' agentic engagement before being exposed to the implementation of Feedback Loop reported a mean value of 3.01 (*SD* = 1.24), indicating their *slight disagreement* with all five-item measures in the tool. The results suggested that students in Teacher 1's class do not particularly agree with doing these undertakings during their learning activities, such as *(1) asking questions during class, (2) telling the teacher what they like or don't, (3) letting the teacher know what they are interested in, (4) expressing their preferences and opinions, and (5) offering suggestions on how to make the class better.*

Table 2

Wilcoxon Signed-rank Test of Agentic Engagement before and after FLM

Agentic Engagement	Before (n= 58)			After (n = 58)			Test		
	M	SD	Interpretation	M	SD	Interpretation	Z	p-value	Interpretation
1	3.29	1.53	SLD	3.79	1.86	NU	3.80	< .001	S
2	2.71	1.38	D	2.83	1.59	SLD	1.81	.071	NS
3	3.00	1.50	SLD	3.22	1.80	SLD	2.42	< .05	S
4	3.26	1.54	SLD	3.59	1.89	NU	2.83	< .05	S
5	2.79	1.32	SLD	2.93	1.54	SLD	2.13	< .05	S
Overall Mean	3.01	1.24	SLD	3.27	1.50	SLD	3.37	<.001	S

Note. Slightly Disagree = SLD, Neutral = NU, S = Significant, NS = Not Significant

Then, when Teacher 1 practiced the Feedback Loop Model (FLM) in the class, Grade 12 students' overall mean scores (M = 3.27; *SD* = 1.50) increased. To test its statistical significance, a non-parametric tool called Wilcoxon signed-rank test was performed to measure how these changes in the teachers' classroom practices on FA affected the students' agentic engagement before and after FLM. This statistical test was chosen because the data sets were not normally distributed upon checking the assumption of normality.

As a result, it was observed that at a significance level of 0.05, there was a significant difference ($Z = 3.37$, $p < .001$) in the overall perspectives of students after Teacher 1 implemented the FLM. This denotes students' change of agentic engagements as the teacher practiced formative assessment anchored in the Feedback Loop during their online classes. But then, for item # 2, which states, *"I tell the teacher what I like and what I don't like,"* there was no significant difference in its measure ($Z = 1.81$, $p = 0.71$). This implies students' apprehension about expressing this kind of agentic freedom.

According to Ahmad (2021), one of the possible factors that may inhibit a student's participation in the class could be associated with one's personality, individual character or cultural values (Ahmad, 2021). Hesitancy from the students to make suggestions or speak out about what they like or do not like could be attributed to a Filipino trait called group harmony. According to Schrier et al. (2010), as cited by Espinosa (2018), Filipinos generally value relationships and may set expectations for themselves and the opinions of others. Hence, when associated with classroom settings, students would avoid negative impressions of their teachers in a classroom and would love to follow their directives.

Due to the lack of valuable information from the students directly, these apprehensions on this aspect of the agentic engagement have limitations, however, despite students not expansively agreeing with the agentic engagements' items in general, the acquired significant differences ($p < .001$) due to the classroom practices on FA have affected them. This suggests that Teacher 1 could encourage students to speak up and share their thinking during discussions.

Based on the gathered information from Teacher 1's journal and cross-examinations of experts, the following extracts could support these engagements related to agentic constructs, such as how Teacher 1 emphasised students' involvement in the learning process.

> *"I find it nice that they are also trying to answer and participate in our discussion. I am glad that my students try their best to answer every question I pose. They participate well in the discussion and are not shy to ask for questions or clarifications."* **(T – 1)**

In the context of Feedback Loop, the teacher used this whole group discussion *(tool)* to make students answer the question *(goal)* and exhibited the different elements of the model. The *data* she could collect from their active participation could help her decide *(inference)* on the next step of the discussion. These shared experiences of Teacher 1 were supported by the cross-examination of external validators, as stated in the extracts. (Note: CE stands for Cross-examiner and T stands for Teacher)

> *"Collaboration was seen as a dialogue between teacher and students."* **(CE 1 on T -1)**
> *"There was ample time for students to digest the lesson by giving questions and answers, addressing students' difficulties, and providing more sample exercises for mastery."*
> *"Students' questions are also entertained…"* **(CE 3 on T-1)**

Teacher 2 and Teacher 3 also claimed these agentic engagements of their students, and based on their extracts,

> *"… In the introduction of our lesson, the students share their insights…"* **(T-2)**
> *"Students are engaged in the simulating activity, and they provide the ideas, meaning, and information related to the topic based on their own observations."* **(T -3)**

As highlighted in the teachers' narratives, these phrases, "*trying to answer and participate in our discussion," "trying their best to answer every question I pose," "not shy to ask for questions or clarifications," "students share their insights,"* and *"the one who provides the ideas, meaning and information related to the topic based on their own observations,"* revealed students' constructive contribution to the flow of discussion. Their engagement to proactively participate and express their views was pieces of evidence of the students' agentic change. According to Espejo (2018), if students perceived that a learning or classroom environment was designed in a more encouraging and inspiring atmosphere, their perceptions could influence their academic engagement by getting more involved in the teaching and learning process.

Furthermore, data gathered from the observations of cross-examiners also showed how this proactive participation of students reflected a classroom environment that promotes formative assessment, and these were manifested in their remarks: (Note: CE stands for Cross-examiner and T stands for Teacher)

"*… After short discussions, the teacher constantly checks students' understanding by giving them questions related to the discussed topics…*" **(CE-3 on T-2)**

"*He welcomes students' responses or ideas politely and gives proper feedback.*" **(CE-2 on T-3)**

According to Reeve and Tseng (2011), these characteristics of agentic engagement could serve as an open-ended formative assessment that could be used to elicit and gather student feedback. In this way, students have the opportunity to engage in an agentic form. This further supports Fernandez's (2017) study explaining that when teachers and students apply Vygotsky's theory (1978) such that they "converse, question, explain and negotiate" could obtain a deep-seated conceptual understanding.

Behavioural Engagement

In this study, due to the limited information from the students (viz, interview, focus group discussion), teachers' reflections and cross-examiners' observations were used in supporting students' underlying behavioural engagement.

Upon checking Table 3, students' pre-reported behavioural engagement showed an overall mean of 4.75 (*SD* = 0.72), denoting a *slight agreement* in all five items under the scale. This reveals students' behavioural engagement attributes that enable them to *(1) listen carefully in class*, (*2) try very hard in school*, *(3) listen very carefully if the lesson is discussed for the first time by a teacher*, *(4) work hard when they start something new in class*, and (5) *pay attention in the class.*

Table 3

Wilcoxon Signed-rank Test of Behavioural Engagement before and after FLM

Behavioral Engagement	Before (n= 58)			After (n = 58)			Test		
	M	SD	Inter-pretation	M	SD	Interpre-tation	Z	p-value	Inter-pre-tation
1	4.67	0.85	SLA	5.10	1.25	SLA	4.63	< .001	S
2	4.90	0.87	SLA	5.47	1.27	A	5.26	< .001	S
3	4.86	0.87	SLA	5.36	1.28	A	4.67	< .001	S
4	4.74	0.85	SLA	5.21	1.25	SLA	4.73	< .001	S
5	4.59	0.92	SLA	4.93	1.24	SLA	3.91	< .001	S
Overall Mean	4.75	0.72	SLA	5.21	1.09	SLA	4.82	< .001	S

Note. Slightly Agree = SLA, Agree = A, S = Significant, NS = Not Significant

After students were exposed to Teacher 1's application of the FLM approach on FA, their behavioural engagement levels were affected (M = 5.21, *SD* = 1.09), and so to determine if this change was significant or not, the Wilcoxon signed-rank test was carried out. It could be observed that there was a significant difference (Z = 4.82, p < .001) in the overall perspectives of students' behavioural engagement before and after the teacher conducted the FLM approach.

Hence, it can be inferred that the changes in the classroom practices on formative assessment significantly affected their behaviours inside the class. But, because of the challenges in measuring this dimension in an ODL and the underlying difficulty of fully reflecting the students' efforts (Hu & Li, 2017), Louwrens and Hartnett's (2015) perspectives in justifying students' online behavioural engagement (e.g., regular attendance to online classes and doing what was required of them by the teacher) were used as additional support to the engagement.

As shown in the extract, Teacher 1 mentioned that students' behavior in her classes were observed, stating,

> *"… They participate well in the discussion and are not shy to ask questions or clarifications..."*

For Teachers 2 and 3, such changes were observed in the reflections they have shared, stating the following context,

> *"… In our previous discussion, they are just passive learners even I initiate high-order thinking skills questions… utilizing the FLM model in my physics class discussion enables my students to be involved and simulate the concept of kinematics…"* **(T – 2)**
> *"… students tend to develop higher-order thinking skills because teachers do not spoon-feed them with all the topics they need to learn, but they were guided in learning process…"* **(T – 3)**

Aside from this information, details to support such changes in their behavioral engagement can be attested by the following extracts from the cross-examiners, as shown: (Note: CE stands for Cross-examiner, T stands for Teacher)

> *"The classroom shows the* ***students' responses to the teacher's questions****."* **(CE 3 on T-2)**
> *"The video* ***showed students answering an assessment task****. Individually, students' answered an assessment task."* **(CE 1 on T-1)**
> *"****Students were asked to give examples*** *of projectile motion to assess their understanding of the concept."* **(CE 3 on T-1)**
> *"… He made* ***students participation visible through short reporting*** *to measure the depth of learning."* **(CE 2 on -T-3)**

These pieces of information supported how students followed what was required of them by the teacher. According to Louwrens and Hartnett (2015), completing their tasks or activities in class because it was needed reflected an example of a behavioural engagement.

Moreover, all elements of the Feedback Loop could also be reflected in the extracts, such as students' answering and responding to teachers' questions or tasks and reporting collected *data* from the *tool(s)* given to them. Teachers could assess their understanding of the concepts *(make inferences)* based on the learning *objectives* set for the students.

Emotional Engagement

As reflected in Table 4, students' pre-emotional engagement showed a *neutral* emotion (M = 4.08, *SD* = 1.08), implying their impartial perceptions of the four items of the dimension. The following items declare *(1) "I enjoy learning new things in class," (2) "When we work on something in class, I feel interested," and (3) "When I am in class, I feel curious about what we are learning, and (4) "Class is fun,"* received *neutral* opinions from the students. This could imply their unsure emotions towards the class, especially in this synchronous learning setup.

Table 4

Wilcoxon Signed-rank Test of Emotional Engagement before and after FLM

Emotional Engagement	Before (n= 58)			After (n = 58)			Test		
	M	SD	Interpretation	M	SD	Interpretation	Z	p-value	Interpre-tation
1	4.24	1.11	NU	4.69	1.55	SLA	4.13	< .001	S

2	4.21	1.18	NU	4.59	1.55	SLA	3.70	< .001	S
3	4.19	1.16	NU	4.60	1.60	SLA	3.81	< .001	S
4	3.71	1.33	NU	3.97	1.67	NU	2.95	< .01	S
Overall Mean	4.08	1.08	NU	4.46	1.45	SLA	4.06	< .001	S

Note. Neutral = NU, Slightly Agree = SLA, S = Significant

Despite students' neutral emotional engagements, in the beginning, these perceptions shifted when Teacher 1 incorporated a change in the classroom practices on FA. Table 4 showed that the overall mean increased to 4.46 (*SD* = 1.45). Based on Wilcoxon signed-rank test, this change was statistically significant (Z = 4.06, p < .001) at a significance level of 5%. Therefore, it could be suggested that the changes applied by Teacher 1 in practicing FA affected students' emotional engagement significantly.

This emotional engagement happens when students react positively to their class environment. Fanshawe et al. (2020) explained that teachers' support in their online classes by helping students feel connected is vital to students' emotional engagement. When students are given feedback and well-guided in their learning progress, they tend to be more emotionally connected and engage meaningfully in their learning.

With the classroom practices on formative assessment (FA) anchored in Feedback Loop Model (FLM), a classroom environment that supports FA plays a critical role in contributing to the emotional engagements of the students (Louwrens & Hartnett, 2015; Meyer & Turner, 2006). When students are emotionally engaged (i.e., feeling comfortable and connected), this positive emotion could stimulate their enthusiasm and interest in completing the learning task (Hu & Li, 2017). Thus, developing an online class environment where students feel safe contributing their thoughts and ideas is necessary to increase emotional engagement.

Furthermore, these changes are supported by the data collected from the teachers' journals and reflections, indicating students' emotional engagement. These details are shown in the following extracts:

> *"… During this activity, I have seen that my students are actively participating because there* ***are a number of them who always raise their hand to answer each item****."* **(T- 1)**
>
> *"...* ***They anticipate*** *how an object sustains a uniform motion."* **(T-2)**
>
> *"… Students are engaged in the simulating activity, and they are the one who provides the ideas, meaning, and information related to the topic based on their observations. And my only role during the discussion is to guide their answers by throwing them questions…"* **(T -3)**

The evidence of how students were engaged could be attributed to their eagerness to participate in the activity. The phrases expressing "a *number of them who always raise their hand to answer"* and *"they anticipate,"* which reflect a process *(tool)* of collecting informal *data* from students, revealed their enthusiasm and interest in being involved. The statements provided by Teacher 3 guiding students (reach the *goals)* proved how learning progressions transpired in the class led to increased engagement. These positive reactions to their learning environment were characteristic of being emotionally engaged in the learning process (Louwrens & Hartnett, 2015).

Likewise, when students feel comfortable in class, this positive emotion could stimulate their enthusiasm and interest in completing the learning task (Hu & Li, 2017). These implications could also be shown through the cross-examiners' observations of the teachers.

> *"Teaching and learning is a two-way process. The teacher provided a classroom where rapport, interaction, and collaboration were present. This classroom environment made* ***every student feel comfortable; thus, learning is captured easily****."* **(CE 2 on T-1)**
>
> *"Teacher 2* ***delivers her lesson in a way that is somehow easily understood*** *because of the language that she used. She maintains a positive disposition in the duration of her entire class."* **(CE 2 on T-2)**

> *"… The teacher is always* ***in control of himself at all times; he sets a very good example of speech habits, voice very pleasant, and uses effectively to stimulate interest among students.*** *These factors are important to* ***make students engaged and interested in the topic and as well as in reaching the set goals intended for the topic****."* **(CE 2 on T-3)**

This essence of establishing a connection *(making inferences)* could boost students' confidence and promote an effective classroom experience (Pellegrino & Sloan, 2021). Students are more likely to be engaged and feel more positive about their learning experience when they perceive that their teachers care about them (Gallup, 2020, as cited by Pellegrino & Sloan, 2021).

Cognitive Engagement

As shown in Table 5, students' pre-surveyed cognitive engagement showed an overall mean of 4.69 (*SD* = 0.80), representing a *slight agreement* with all eight items. Some of the items include "Item 4: I make up my own examples to help me understand the important concepts I study," which registered a neutral scale among students, and "Item 5: Before I begin to study, I think about what I want to get done", which had the highest mean among the items.

However, these initial findings changed when Teacher 1 implemented the FLM approach to FA in their synchronous classes. Though the new overall mean (M = 4.98, *SD* = 1.12) was still in the *slightly agreed* scale, its mean value improved after FLM was practiced. Thus, a Wilcoxon signed-rank test was performed to affirm its statistical significance.

Table 5

Wilcoxon Signed-rank Test of Cognitive Engagement before and after FLM

Cognitive Engagement	Before (n= 58)			After (n = 58)			Test		
	M	SD	Inter-pretation	M	SD	Inter-pretation	Z	p-value	Interpretation
1	4.79	1.01	SLA	5.21	1.39	SLA	4.37	< .001	S
2	4.67	1.11	SLA	5.02	1.48	SLA	3.75	< .001	S
3	4.67	0.94	SLA	5.00	1.27	SLA	3.63	< .001	S
4	4.40	1.18	NU	4.71	1.55	SLA	2.98	< .01	S
5	4.88	1.16	SLA	5.31	1.50	A	3.90	< .001	S
6	4.66	1.07	SLA	5.03	1.43	SLA	3.70	< .001	S
7	4.60	1.06	SLA	4.90	1.39	SLA	3.05	< .01	S
8	4.36	1.07	NU	4.66	1.38	SLA	3.90	< .001	S
Overall Mean	4.69	0.80	SLA	4.98	1.12	SLA	4.40	< .001	S

Note. Neutral = NU, Slightly Agree = SLA, A = Agree, S = Significant

Based on the results, it was found that there was a statistical difference in their mean scores ($Z = 4.40$, $p < .001$), indicating Teacher 1's classroom practices affected the students' cognitive engagement. Aside from the evidence of statistical results, affirming it through other data sources such as the journal and observation tool could be used to confirm qualitatively.

Similar evidences were observed from the classes of Teachers 2 and 3, and these are seen in the extracts shown.

> *"Utilizing the FLM model in my physics class discussion enables my students to be involved and simulate the concept of kinematics. The students are not only listening to the class discussion, but they*

also simulate the concept of uniform motion… They anticipate how an object sustains a uniform motion." **(T -2)**

"… The students' engagement increases and develops their higher-order thinking skills during the discussion after applying the FLM…" **(T – 3)**

Experts also supported that these improvements enhanced cognitive engagements, as shown in the following extracts.

"As in the course of the lesson, ***students' level of learning was increasing as evident in their oral and written responses****."* **(CE 2 on T – 1)**

"Students' ***knowledge about the topic was constantly assessed****.* ***A review*** *of the symbols was provided. This is* ***a very crucial assessment*** *so that the teacher will have an idea if the students really understood the variables involved in the formula."* **(CE 3 on T – 1)**

If one is to assess the cross-examiners' remarks carefully, it could be noted how the elements of Feedback Loop were reflected in the instruction. The increasing level of oral and written responses, which could be utilized as either a *tool or data* by the teacher, manifested strong indications of applying *inferences* by the teacher. Teacher 1, who could be observed to implement several formative evaluations based on FLM, has already shown well-established practices based on the comments observed in the class.

The improved classroom practices which led to **an enhanced level of engagement among students** are observed from the online classes of Teachers 2 and 3, respectively.

"The teacher ***asked checkpoint questions prior to introducing another term/concept to ascertain students' progress****."* **(CE 1 on T – 2)**

"He utilizes some approaches for evaluation results; results returned, and some feedback is given. He made ***students participation visible through short reporting to measure the depth of learning****."* **(CE 2 on T – 3)**

Cognitive engagement, which refers to students' understanding and mental effort, could lead to different levels of thinking when exposed to various learning strategies (Hu & Li, 2017). As emphasized in the phrases above, the highlighted texts like "a review," "checkpoint questions," and "short reporting" observed in the teachers' classes suggested different strategies that could activate or grasp the mental efforts of the students. One of the many factors that affected students' engagement was the teacher factor (McNaught et al. 2012), which could be attributed to how teachers designed the learning tasks, planned the learning content, and provided feedback during the learning activities. Feedback Loop Model (FLM), as a data-driven approach to teaching, gathered the students' ideas or thinking to guide teachers when considering setting goals, developing tools to collect data, and analysing those data to determine the next steps for instruction.

Conceptual Understanding

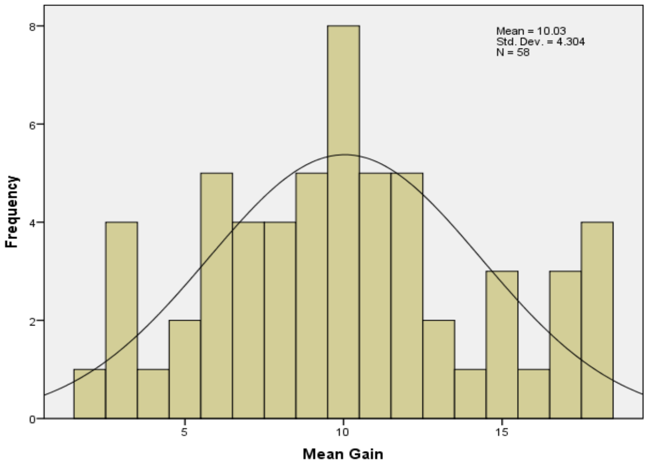
This section used descriptive statistics such as mean and standard deviations and likewise, inferential statistics (paired *t*-tests) to analyse the data. These explored the changes in Teacher 1's classroom practices on a formative assessment by comparing the pre-and posttests mean scores in kinematics.

As shown in Table 6, a mean gain of 10.03 (*SD* = 4.30) was obtained from the difference between the average pretest scores of 4.16 (*SD* = 1.79) and average posttest scores of 14.19 (*SD* = 4.68) of the Grade-12 students. With the given values, it was essential to determine how the data sets could affect the level of conceptual understanding of the students in Kinematics.

In this aspect, the researcher utilized the paired t-tests to understand better if the set of values was significant or not. However, checking for its normality test must be satisfied before applying the statistical tool. Upon checking on the Shapiro-Wilk test, the p-value of .086 implied a higher value than the alpha level of significance (0.05), indicating that the value was normally distributed, as shown in Figure 3. This signified that a paired t-test was suitable for determining the statistical significance.

Figure 3

Frequency Distribution of Mean Gain Values



Looking into the results of Table 6, it can be inferred that there was a significant difference between the pretest and posttest scores of the SHS students, and this was reflected in the computed p-value (< .001) with t (57) = 17.76, showing a lesser value than the alpha level of significance (0.05).

Table 6

Descriptive Statistics and t-test results in the pre-and posttests

Pretest		Posttest		Gain					
M	SD	M	SD	M	SD	n	*t*	df	p-value
4.16	1.79	14.19	4.68	10.03	4.30	58	17.76	57	< .001

In this case, it can be implied that the changes in the teacher's classroom practices towards FA affected the students' level of conceptual understanding in Kinematics significantly. According to Teacher 1, Feedback Loop guided her discussions, and through feedbacking, the teacher and students gained substantially in the teaching-learning process. Based on the gathered extract,

> *"After all our discussion in kinematics, I can summarize the insights that I have gained by the following: different types of activities increase student engagement in class; guided discussion helps them learn better; clear statement of the objectives is important in achieving the goal for the discussion; practice enhances learning, and feedbacking guides students and teachers on the teaching-learning process."* **(T-1)**

In addition to Teacher 1's learning experiences, Teachers 2 and 3 also gained insights that significantly impacted students' learning. To wit,

> *"In our previous discussion, they are just passive learners even I initiate high-order thinking skills questions… I learned that students would understand the concept thoroughly if they were performing it." **(T -2)***
>
> *"With the application of FLM, it is easy for us to go through our lessons. It gives us teachers the new teaching techniques and strategies that we could use as we deliver the topics online..." **(T-3)***

These reports were supported by the classroom observations examined by the cross-examiners. According to them, students were observed interacting with their teachers, which could be a factor in guided discussions leading to improved learning. These were reflected in the following comments:

> *"The teacher was very welcoming with questions from the students." **(CE 1 on T-2)***
>
> *"Though the class size is small, the teacher made sure to have an interaction with the students through Quescussion – Question, and Discussion." **(CE 2 on T – 3)***
>
> *"Students' questions are entertained by the teacher. The students are also given immediate feedback about their answers to the questions presented along with the discussions."*
> ***(CE 3 on T-1)***

These collected data exhibiting the effects of applying FLM could be used as solid support for the enhanced learning acquired by students as teachers implement it in their Physics classes.
Another aspect explored was the effect size measurement. This effect size was employed to measure the practical significance of the teacher's FA practices based on the Feedback Loop. This effect size measurement was often reported in educational research to show how much the experimental results affect the variables in the study. One of the commonly used metrics was Cohen's d. According to Mcleod (2019), it is an appropriate effect size measure when comparing two means that could accompany the reporting results of *t*-tests. This could be categorised in the following descriptions in Table 7, defined by Cohen (1988).

Table 7

Description of Effect Size

Effect Size (d)	Description
d > 0.80	Large effect
d = (around) 0.50	Medium Effect
d = (around) 0.20	Small Effect

Based on the results in Table 8, the significant effect size (d = 2.83) revealed how it affected students' conceptual understanding of Kinematics. This showed the impacts of the changes applied by the teacher upon practicing the FLM towards FA. With the value of providing students with informational feedback on their learning (Snowball & Sayigh, 2007), significant impacts on their performance improvement were inevitable.

Table 8

Cohen's d Effect Size

Variables	Mean Difference	SD	N	Cohen's d effect size	Interpretation
Pretest	4.16	1.79	58	2.83	Large effect
Posttest	14.19	4.68	58		

The essence of the Feedback Loop is to make *inferences* from the *data* collected from the selected, adapted, or designed *tools* to meet the learning *goals,* providing a fundamental approach to teachers in conducting formative assessments in a class. Furtak et al. (2016) have clearly emphasised that while teachers can make many different inferences based on the collected information using specific tools, each inference in the feedback loop should connect to the initial goal. Although it can reach many outcomes from the data generated from students' engagement with a tool, the particular inferences made through this process should be the ones that inform about the goal.

Conclusion and Recommendation

This study aimed to determine the effects of FLM on the Grade-12 SHS students' conceptual understanding of Kinematics and their engagements. It exhibited positive and valuable changes to teachers' classroom practices on FA, creating beneficial impacts on the learning and engagement of the students.

Based on the findings, students' engagements (*agentic, behavioral, emotional, and cognitive*) as teachers implemented FLM towards FA showed active participation during their online Physics class, implicating positive impacts on their learning. Likewise, students' conceptual understanding also revealed enhanced knowledge of Kinematics. This could be supported by the high impact of its practical significance (effect size) when teachers' FA practices are based on the Feedback Loop. Thus, it can be inferred that the effect of the FA based on FLM has implications for the engagement and learning process of the students.

This further reinforced the idea that immediate feedback could enhance student engagement and improve conceptual understanding (Biggs & Tang, 2015; Jiao, 2015). The concept of FLM enabled teachers' encouragement and creativity when designing activities to reach the intended learning goals.

However, this study had several limitations, and one could be attributed to the few students of Teacher 1 who responded to the statistical analysis. Increasing the number of students may add sufficient support to the data. Also, an increase of respondents to the other teachers like Teachers 2 and 3 could have been a better point of statistical analysis as to the impact of the FLM. Another aspect that could be used to substantiate the results is conducting interviews with some students.

Since the results of this study supported the effects of utilising "digital pedagogies" in this new norm, it is recommended that the delivery of online formative assessments guided by Feedback Loop be reinforced by teachers for students' active participation and improved learning in the class.

Acknowledgement

The primary author wishes to thank the Department of Science and Technology - Science Education Institute (DOST-SEI), Republic of the Philippines, notably the Capacity Building Program in Science and Mathematics Education (CBPSME) scholarship program, for the bequeathed opportunity and support of her studies at the University of San Carlos, Talamban, Cebu City.

References

Abdullah, M. Y., Abu Bakara, N. R. & Mahboba. M. H. (2012). Student's participation in classroom: What motivates them to speak up? *Procedia - Social and Behavioral Sciences*, *51*, 516 – 522.

Ahmad, C. (2021). Causes of students' reluctance to participate in classroom discussions. *ASEAN Journal of Science and Engineering Education, 1*(1), 47-62. https://doi.org/10.17509/ajsee.v1i1.32407

Andersson, C. (2015). *Professional development in formative assessment: Effects on teacher classroom practice and student achievement*. Dean of the Science/Technology Faculty, Swedish Copyright Legislation (Act 1960:729)

Ash, D., & Levitt, K. (2003). Working within the zone of proximal development: Formative assessment as professional development. *Journal of Science Teacher Education, 14*, 23–48.

Avsar Erumit, B., Ozcelik, A., Yuksel, T. & Tekbiyik, A. (2021). Examining the views of preservice teachers about online science education during the Covid-19 lockdown: Expectations, Opportunities, Threats, Motivations, and Beliefs. *Journal of Turkish Science Education, Covid-19 Special Issue*, 2 -25. DOI no:10.36681/tused.2021.69

Bergdahl, N., Nouri, J., Fors, U., & Knutsson, O. (2020). Engagement, disengagement, and performance when learning with technologies in upper secondary school. *Computers & Education, 149*, 103783.

Borko, H. (2004). Professional Development and Teacher Learning: Mapping the Terrain. *Educational Researcher, 33*(8), 3-15.

Cahyadi, V. (2004) The effect of interactive engagement teaching on student understanding of introductory physics at the faculty of engineering. *Higher Education Research & Development, 23*(4), 455-464, DOI: 10.1080/0729436042000276468

Cleofas, J.V. (2021). Self-care practices and online student engagement during Covid-19 in the Philippines: A mixed methods study. *Issues in Educational Research, 31*(3), 699-717. http://www.iier.org.au/iier31/cleofas.pdf

Darling-Hammond, L., Wei, R.C., Andree, A., Richardson, N., & Orphanos, S. (2009). Professional Learning in the Learning Profession: A Status Report on Teacher Development in the United States and Abroad (PDF). Stanford, CA: National Staff Development Council and the School Redesign Network at Stanford University.

Dong, Y. & Liu, S. (2020). An investigation into students' agentic engagement in online English listening learning. *Journal of Language Teaching and Research, 11*(3), 409-417, DOI: http://dx.doi.org/10.17507/jltr.1103.09

Dixson, M.D. (2015). Measuring Student Engagement in the Online Course: The Online Student Engagement Scale (OSE). *Online Learning 19*(4). 10.24059/olj.v19i4.561.

Espejo, N. N. D. (2018, June 20 – 22). *Difference in Academic Engagement among College Students as a function of Learning Environment.* DLSU Research Congress, Philippines.

Fanshawe, M., Burke, K., Tualaulelei, E. & Cameron, C. (2020, August 31). *Creating Emotional Engagement in Online Learning*. https://er.educause.edu/blogs/2020/8/creating-emotional-engagement-in-online-learning

Fernandez, F. B. (2017). Action research in the physics classroom: the impact of authentic, inquiry-based learning or instruction on the learning of thermal physics. *Asia-Pacific Science Education*, *3*(1), 1-20.

Furtak, E. M., Glasser, H. M. & Wolfe, Z. M. (2016). *The Feedback Loop: Using formative assessment. Data for Science Teaching and Learning*. National Science Teachers Association.

Hu, M. & Li, H. (2017). Student Engagement in Online Learning: A Review. *2017 International Symposium on Educational Technology (ISET),* 39-43, doi: 10.1109/ISET.2017.17.

Jiao, H. (2015). Enhancing students' engagement in learning through a formative e-assessment tool that motivates students to take action on feedback, *Australasian Journal of Engineering Education, 20*(1), 9-18. DOI: 10.7158/D13-002.2015.20.1

Ladd, G. W., & Dinella, L. M. (2009). Continuity and change in early school engagement: Predictive children's achievement trajectories from first to eighth grade? *Journal of Educational Psychology, 101*, 190–206.

Louwrens, N., & Hartnett, M. (2015). Student and teacher perceptions of online student engagement in an online middle school. *Journal of Open, Flexible and Distance Learning, 19*(1), 27 - 44.

Lu, C., & Cutumisu, M. (2022). Online engagement and performance on formative assessments mediate the relationship between attendance and course performance. *International Journal of Educational Technology in Higher Education 19*(2), 1-23. https://doi.org/10.1186/s41239-021-00307-5.

McLeod, S. (2019). *What does effect size tell you?* Retrieved January 24, 2022, from https://www.simplypsychology.org/effect-size.html

McNaught, C., Lam, P. & Cheng, K.F. (2012). Investigating relationships between features of learning designs and student learning outcomes. *Educational Technology Research Development, 60*, 271–286. https://doi.org/10.1007/s11423-011-9226-1

Meyer, D. K., & Turner, J. C. (2006). Re-conceptualizing emotion and motivation to learn in classroom contexts. *Educational Psychology Review, 18*(4), 377-390. doi: 10.1007/s10648- 006-9032-1

Ole, F.C.B. & Gallos, M. R. (2021). Development and Validation of a Physics Concept Test in Kinematics for Senior High School Students. *IOER International Multidisciplinary Research Journal*, *3*(2), 95 – 104. DOI: 10.5281/zenodo.5090065

Pellegrino, M. A. & Sloan, A. (2021, September 15). *How to Improve and Promote Student Engagement in the Online Classroom.* Retrieved January 29, 2022 from https://www.facultyfocus.com/articles/online-education/online-student-engagement/how-to-improve-and-promote-student-engagement-in-the-online-classroom/

Pilotti, M., Anderson, S., Hardy, P., Murphy, P. & Vincent, P. (2017). Factors Related to Cognitive, Emotional, and Behavioral Engagement in the Online Asynchronous Classroom. *International Journal of Teaching and Learning in Higher Education, 29*(1), 145 – 153.

Rakoczy, K. & Pinger, P. & Hochweber, J. & Klieme, E. & Schütze, B. & Besser, M. (2019). Formative assessment in mathematics: Mediated by feedback's perceived usefulness and students' self-efficacy. *Learning and Instruction, 60* 154-165. 10.1016/j.learninstruc.2018.01.004.

Reeve, J. (2013). How Students Create Motivationally Supportive Learning Environments for Themselves: The Concept of Agentic Engagement. *Journal of Educational Psychology, 105*(3), 579 – 595.

Reeve, J. & Tseng, C. (2011). Agency as a fourth aspect of students' engagement during learning activities. *Contemporary Educational Psychology, 36*, 257–267.

Reschly, A. L., & Christenson, S. L. (2012). Jingle, jangle, and conceptual haziness: Evolution and future directions of the engagement construct. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement*, (pp. 3–19). Boston: Springer US Retrieved from http://link.springer.com/10.1007/978-1-4614-2018-7_1.

Rodgríguez, C. L., Mula-Falcón, J., Jesús Domingo Segovia, J. D., & Cruz-González, C. (2021). The effects of Covid-19 on science education: A thematic review of international research. *Journal of Turkish Science Education, Covid-19 Special Issue*, 26 - 45. DOI no:10.36681/tused.2021.70

Roth, K.J., Garnier, H.E., Chen, C., Lemmens, M., Schwille, K., and Wickler, N.I.Z. (2011). Video-based Lesson Analysis: Effective Science PD for Teacher and Student Learning [Abstract]. *Journal of Research in Science Teaching, 48*(2), 117-148.

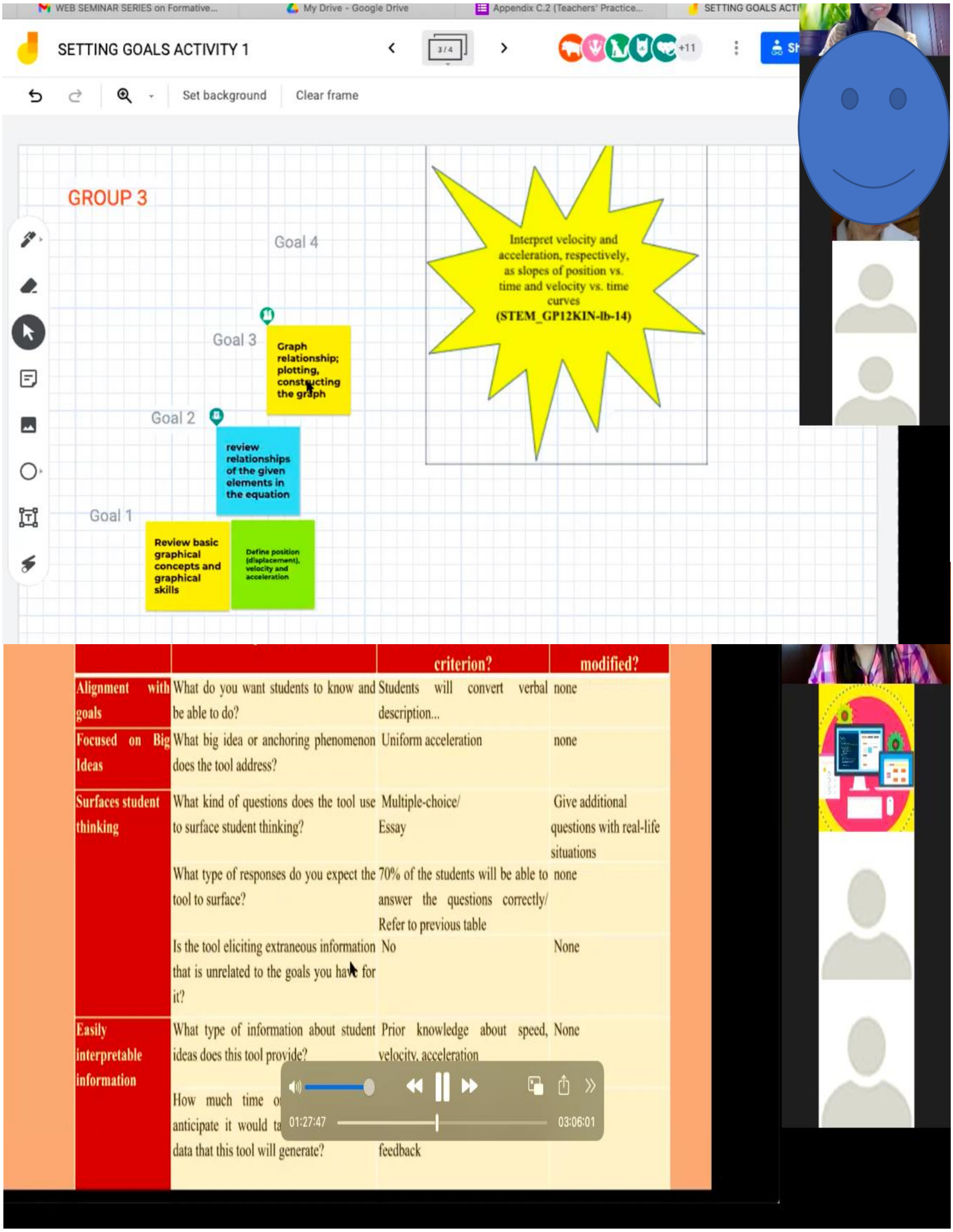
Snowball, J. D., & Sayigh, E. (2007). Using the tutorial system to improve the quality of feedback to students in large class teaching. *South African Journal of Higher Education*, *21*(2), 321-333.

Stoll, L., Bolam, R., McMahon, A., Wallace, M., and Thomas, S. (2006). Professional Learning Communities: A Review of the Literature. *Journal of Educational Change, 7*(4), 221-258.

Syuhendri, S. (2020, September 3-4). *Effect of conceptual change texts on physics education students' conceptual understanding in kinematics.* Journal of Physics: Conference Series, Padang, Indonesia. doi:10.1088/1742-6596/1876/1/012090.

APPENDIX A

Evidence of the Conduct of the FLMPDP Webinar Series

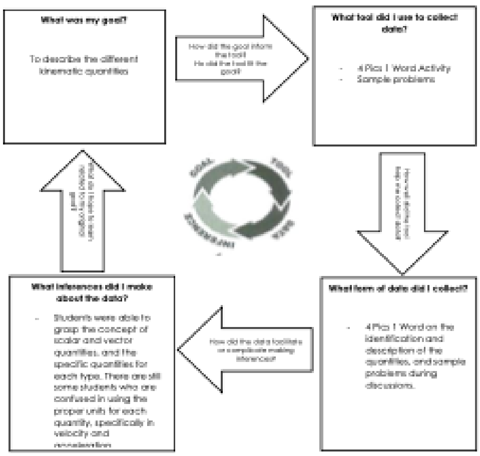


APPENDIX B

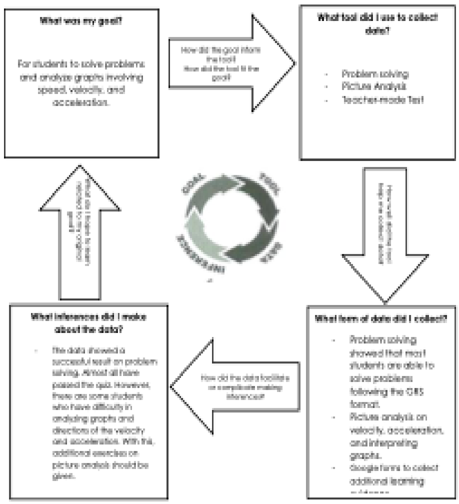
Teachers' Journals/Reflections

Teacher 1

WEEK 1 – FEEDBACK LOOP MODEL



WEEK 2 – FEEDBACK LOOP MODEL



WEEK 1 – JOURNAL

This is our first meeting for the introduction of the different kinematic quantities - time, distance, displacement, speed, velocity, and acceleration. First, I have presented the calendar of the module that this week is intended for our discussions, and that the following week is for the learning activities and assessments. This is to give them a heads up on how we will process their learning.

Before properly digging in to the discussion, I have presented a 4 Pics 1 Word activity for the students, where they were presented of several pictures related to our topic. After identifying the word being described in the picture, they need to give a short description for each. During this activity, I have seen that my students are actively participating because there are a number of them who always raise their hand to answer each item.

For the discussion, students find it easy to differentiate each quantity since they had these lessons in their Junior High School science classes. One thing that I have focused on is that students should be able to differentiate scalar and vector quantities. I have also prepared sample problems for each quantity that we are tackling. The students are prompt in submitting their answers in our Zoom chat box. With the given problems together with the students' responses, I can infer that the students grasp the concept of the different quantities. They are able to analyze the quantity needed in a problem, but there are some who are quite confused with the units, especially for velocity and acceleration. And I have decided that I need to clarify this with them, and show them the step-by-step method to cancel units, and end up with the remaining units for the problem.

The summary of our discussion is given in the figure above (WEEK 1 – FEEDBACK LOOP MODEL).

WEEK 2 – JOURNAL

I am satisfied with my student's learning for this week because I have seen that most of them are already proficient in solving problems on their own. They know how to analyze the problem, identify the required quantity, and properly show the solution together with the correct unit.

Through our Google Classroom, I was able to post their learning activities and assessment, while we are having our Zoom meeting. With this, students will be given an opportunity to ask questions regarding the activities. I have made sure that we have our review before posting the activities. This is to refresh students' minds before taking the quiz.

During the discussion on graphs, at first, students seem to be quite confused and cannot interpret the graphs on velocity and acceleration. I have realized that in order for them to master the discussion, constant exercises should be given and they should also have enough time to process their learning. Guide questions should be provided in order for them to get to the correct answer. I find it nice that they are also trying to answer and participate in our discussion.

To sum it all up, I have learned that follow up discussions and different types of assessment tools that challenge students' critical thinking skills are helpful to achieve the intended goal for a lesson.

Teacher 2

Reflection

Teachers have a significant role in the learning process of the students. The teachers need to prepare themselves for technology-based learning. Teachers enhance the methods of teaching by being exposed to training and seminars. Most students in the 21st century is knowledgeable about modern technology. In this era, the teacher serves as the facilitator.

The presentation of the Feedback Loop Model is great succor to teachers in assessing the learning of their students. The Feedbacking to the students is frequent since teachers ask what they have learned, what they need to learn, and how they learn.

Utilizing the FLM model in my physics class discussion enables my students to be involved and simulate the concept of kinematics. In the introduction of our lesson, the students share their insights. The students are not only listening to the class discussion, but they also simulate the concept of uniform motion. They differentiate the object's position, velocity, and acceleration with different time intervals. The students during the simulation activity can understand the concept and predict what will be the result if there is a change in position, velocity, and acceleration in different time intervals. They anticipate how an object sustains a uniform motion.

In our previous discussion, they are just passive learners even I initiate high-order thinking skills questions. I learned that students would understand the concept thoroughly if they were performing it. My principal also gave her feedback about how the class went through if the FLM model was applied. According to her, it is a student center class discussion. She added that having a tool or simulator during the class discussion can initiate and gather feedback from the students.

Teacher 3

The usage of the Feedback Looping Model (FLM) has a notable impact on my Physics teaching, mainly because most of my students were used to spoon-feeding process in education. The interaction between me as the teacher and my students are limited. The students' engagement increases and develops their higher-order thinking skills during the discussion after applying the FLM. I learned a lot of things on my experience in applying the FLM on the teaching-learning process. With the application of FLM, it is easy for us to go through our lessons. It gives us teachers the new teaching techniques and strategies that we could use as we deliver the topics online. I also learned in my experience that the FLM could be both beneficial to the teachers and the students. First, the teacher can easily identify which part of the topics which the students do not understand and needs a thorough explanation. Not just that but also it emphasizes the role of a 21st Century teachers which serve as a guide and facilitator, not just a mere provider or dispenser of knowledge. And for the students tends to develop higher-order thinking skills because teachers do not spoon-feed them with all the topics they need to learn but they were guided in learning process. Students are engaged in the simulating activity and they are the one who provides the ideas, meaning and information related to the topic based on their own observations. And my only role during the discussion is to guide their answers by throwing them questions. The use of formative assessment provides an advantage, like for example it can provide me data about the prior knowledge of my students and not just that but I can easily identify if the students really understand the lessons very well. Through this, I will also know if the students met the objectives provided or introduced to them. Overall I must say that FLM brought a huge difference on the teaching- learning process especially we had this new setup in new normal.

APPENDIX C

Sample of Cross-Examiners' Feedback on Teacher 1

Teacher – Participant # 1			
Key Elements	**Cross-examiner 1**	**Cross-examiner 2**	**Cross-examiner 3**
1. *The classroom is set up for a range of instructional approaches.* There is adequate space for: 1.1 Whole group teaching 1.2 Small group work	The teacher led the whole class teaching, as observed in the video. (Day 1) Students had an individual and graded written performance task. (Day 2) Individually, students' answered an assessment task. (Day 3) The video showed a whole class discussion led by the teacher. (Day 4) The video showed a synchronous class resembling whole group teaching. (Day 5)	Though the class is held online, the teacher provided a variety of instructional approaches, teaching pedagogy and different students' collaboration and interactions. It allows every student to proper learning and assimilation of knowledge.	The use of zoom portal allows the teacher to use different instructional approaches such as whole group teaching, small group work (via breakout rooms), individual and reflective work.
2. *The classroom displays include information about current learning targets.* Displays include evidence of: 2.1 Big ideas 2.2 Standards 2.3 Learning goals	Only big ideas were visualized hence, presented in the slides. Learning goals, standards were only verbally spoken/articulated by the teacher. (Day 1)	The deductive method of approach is being used to facilitate major ideas flowing down to more specific concepts through giving essential understanding and overarching questions to target the desired learning competencies for the lesson.	Big ideas were presented. However standards, learning goals , success criteria was not shown in the screen of the teacher.