AROW (AUGMENTED REALITY OVERLAID WORKSHEETS): STRENGTHENING ENGAGEMENT OF SCIENCE LEARNERS IN MODULAR DISTANCE LEARNING MODALITY

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AROW (AUGMENTED REALITY OVERLAID WORKSHEETS): STRENGTHENING ENGAGEMENT OF SCIENCE LEARNERS IN MODULAR DISTANCE LEARNING MODALITY

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By

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Abstract

In this time of threat, challenges, and ambiguities, learners involve themselves in learning the lessons presented in the self-learning modules that promote independent learning. ICT-based learning materials play a vital part in the learner's engagement. This study employed an action research aimed to gauge the learner's engagement using an augmented reality-laden worksheet in a modular distance learning modality setting. A total of 30 purposively selected Grade 5 science learners participated in this study. Data were collected in a mixed-method approach, done in two cycles using a survey questionnaire, focus group discussion, and interview. Results from the pre-post survey showed a substantial improvement from "High" to "Very High" extent of perceived engagement of the learners after some modifications and changes to the materials were made. It was affirmed that using augmented reality technology is a compelling factor linking to strengthening the learners' engagement in performing their tasks in a modular distance learning modality.

Keywords: Augmented Reality, engagement, ICT-based learning, modular, distance learning

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Student engagement is associated with the learner's feeling of individual motivation in a particular field as implied from the study of (Czerkawski & Lyman, 2016). Motivation is a prerequisite element for student engagement in learning (Saeed S. & Zyngier ,2012). Positive learner's motivation is essential for success in distance learning environments (Artino ,2008) but not without challenges.

The main challenges that learners have encountered in distance learning modality are a self-studying, inadequate internet connection, shortage of sleep and time to answer all the modules due to the significant number of activities, distractions, and the lack of focus among the learners (Dangle & Sumaoang, 2020).

A similar study by (Barrot, 2021) shows that the extent of challenges among learners during online learning is more related to the learning environment. Distractions at home, limitations in completing the requirements for certain subjects, and difficulties in selecting the learning areas and study schedule are significant findings of existing literature.

The conduct of 1st quarter SMEA/DMEA (School/District Monitoring, Evaluation, and Adjustment) for the academic year 2021-2022 of South district schools in Cagayan de Oro City showed 1.08% of 2,580 total number of

enrollees of South City Central School in the current school year were unable to perform and submit their learning activity sheets. The learners' inability to conform is regarded as potential LARDO (Learners at Risk of Dropping out). The seeming lack of engagement in the learning task of some pupils is one of the concerns that need action and intervention. This prompted issues and concern to investigate the level of learners' engagement of Grade 5 learners of South City Central School in performing their task in the Modular Learning Modality setting.

To bridge this dilemma, efforts must be made to create an innovative technology-based learning package that needs to be tested in this setting. A material that possesses potential for intrinsic motivation to foster.

In the study of Raja and Nagasubramani (2018), stressed that the use of technology has made the process of teaching and learning more enjoyable. Learners are normally more 'on task' and convey more positive emotions when they use computer aided technology moreover than any other given task Becker, H.J.(2000) Moreover, the role that technology plays in the learner's engagement is a specific area of interest, as it has become a main feature within the learners' educational involvement. Selwyn, N. (2016). Moreover, Integrating technology into the curriculum allows teachers to improve learners' engagement. D'Angelo, G. (2018).

The core objective of this study is to investigate the potential of Augmented Reality technology utilizing Augmented Reality Overlaid Worksheet (AROW) as materials in strengthening learners' engagement in performing their tasks in the modular learning modality.

Incorporating Augmented Reality (AR) technology to a contextualized virtual and interactive learning activity worksheet anchored on Grade 5 Science Most Essential Learning Competencies (MELC) will be utilized as supplemental material during home-based modular learning.

The outcome of this study in investigating the potential effectiveness of the Augmented Reality Overlaid Worksheet (AROW) will provide vital information for the current researcher in developing various instruction delivery strategies utilizing augmented reality technology to support the modular distance learning needs and strengthens learners' engagement in the process. These will also set off opportunities for other researchers to further research in the future.

II. Intervention, Innovation, or Strategy

The core idea is to produce a supplemental learning material that contains interactive learning activity worksheets anchored on the Most Essential Learning Competencies (MELC) for Grade 5 Science. Each worksheet contains engaging interactive and virtual activities with

Augmented Reality (AR) supported images that allow learners to be immersed in real experiences. The self-guided AROW learning activity sheet is laden with interactive online and offline features supported with Augmented Reality (AR) that can be best viewed by downloading free applications for android devices. *(i.e. phone, tablet)*. The interactivity of the worksheets is best utilized when a learner is connected to the internet and is made possible by utilizing free mobile applications such as Eyejack, and QR code reader applications.

The AR application used in this study are free of charge downloadable app that can be installed on any modern Android and iOS platforms smartphone or tablets.

The learner orientation on the procedure using the materials was conducted through virtual meetings and instructional sheets that can be distributed in a limited face-to-face setting. Dissemination of learning activity worksheet was done but not limited to the weekly schedule of module distribution (online) and Google Drive Link (Online)

A pre and post intervention test survey was conducted to gauge and track the difference between two participants' engagement conditions. Their scores during pretest and posttest will be compared and statistically analyzed. Focus group discussion (FGD) and a semi-structured interview with the participant was conducted after the intervention to gather qualitative data

that describes the learners' experiences when exposed to AROW supplemental worksheets.

Augmented Reality Overlaid Worksheet (AROW)
Action Research Process

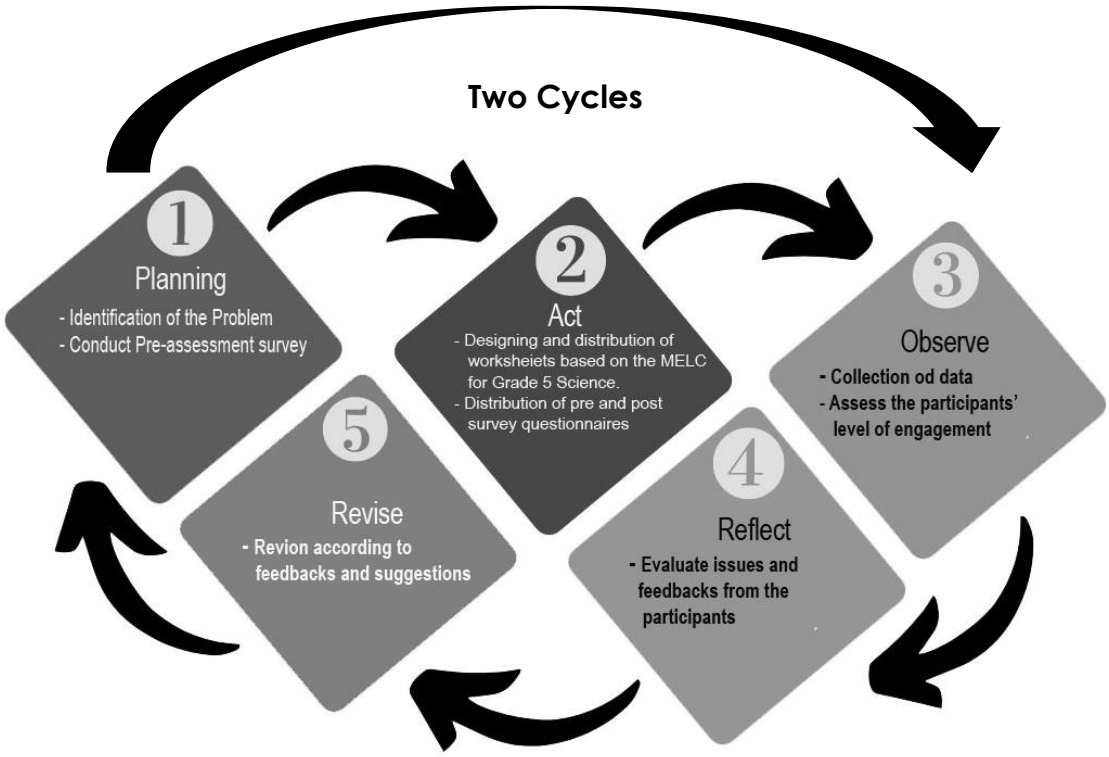


Figure 1: Action Research Cycle

III. Action Research Questions

This study aims to investigate the effectiveness of Augmented Reality (AR) using Augmented Reality Overlaid Worksheet (AROW) in strengthening the

learner's engagement to perform their task in modular distance learning modality. It sought to answer the research question:

1. How do the Augmented Reality Overlaid Worksheet (AROW) leaning activity sheets improve the level of engagement among learners before and after the intervention?
2. What is the participants' perception on the AROW learning worksheets in terms of its effectiveness in strengthening their engagement to perform task in modular distance learning modality?

IV. Research Methods

IV. a Research Design

This study utilized a practical research action research design conducted in two research cycles. It adopted a mixed-method approach, combining both qualitative and quantitative data using pretest – posttest survey, semi-structured interview, and focus group discussion (FGD).

IV. b. Sample

This study involved a group of purposively selected 30 Grade 5 pupils of South City Central School. The researcher made certain that the selected participants have their own Android devices either smartphone or tablet that can access the Internet as primary tools for the study.

A copy of the Self Learning Module (SLM) and AROW (Augmented Reality Overlaid Worksheet) for science are provided to the participants. The participants are using the AROW worksheet thru an online platform.

IV c. Data Collection

Survey Questionnaire

The data was collected using a 5-point Likert scale ten (10) items teacher-made survey questionnaire using Google Form to consolidate the results. The link to the online questionnaire is individually given through private messages such as E-mail or social media private messenger.

The survey questions were derived from the widely accepted concept of dimension and indicators including cognitive, affective, and behavioral engagement(Fredricks et al. 2004; Fredricks, Filsecker and Lawson, 2016: Rotgans, and Schmidt 2011).

The term "indicators" is used to indicate student engagement and is expressed, observed and quantifiable through cognitive, affective, or behavioral action or reaction. Bond and Bedenlier (2019). The teacher-made questionnaire is obtained and derived from various literature that acknowledges the dimensions of learners' engagement. The

questionnaire was subjected to validity and reliability using Cronbach's Alpha test and has obtained 0.702 over all internal consistency during the pilot test among 31 learner-participants.

Table 1: Results of reliability test during pilot test of questionnaires

Survey questions (indicators)	Cronbach's Alpha	No. of Questions
Cognitive	0.691	3
Emotional/Affective	0.716	3
Behavioral	0.709	4
Total Questions		**10**

Overall Cronbach's Alpha=0.702 (Acceptable)

To establish its validity, the questions on the survey questionnaire were reviewed and verified by three(3) teacher colleagues and utilized related literature for references to ensure high content validity. Various research was used as a guide in creating the questionnaire.

Table 2: Various related literature as based for survey questionnaire.

Engagement	Indications	Literature
Cognitive (Thought)	• will • deep understanding • self-regulation • studying strategies	• Rotgans, J., & Schmidt, H. (2011) • (Solis A. 2008) • Pietarinen, J., Soini, T., & Pyhältö, K. (2014). • Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004)

Emotional (Feeling)	• enjoyment • Interest • excitement	• Bond, M., et al. (2020) • Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004) • Pagan J. (2018)
Behavioral (Action)	• concentration • on task • persistence • attention	• Pagan J. (2018) • Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004)

Focus Group Discussion (FGD)

Focus group discussions (FGD) using Google Meet among the participants was conducted to gain an in-depth understanding of the research question. The questions were presented in both Sinugbohanong Binisaya and in English. The participants were allowed to respond to the questions English or Binisaya to ensure that the respondents can freely express their thoughts and avoid social desirability biases. Bergen, N., & Labonté, R. (2020).

In this situation, the researcher serves as a moderator to the group discussion between participants. Qualitative data were gathered to validate the perceived learner engagement in performing their task. The transcribed FGD data gathered are evaluated and thematized.

Semi-structured Interview

A semi-structured interview was conducted to randomly selected respondents via phone call was conducted after the intervention was

made. Interviews were done prior to setting of appointments with the concerned participants. Open-ended follow-up questions were asked based on the answers given by the participants during the focus group discussion (FGD): Example, "*How would you describe your experience in using AROW Worksheet?*", "*What part/feature of the AROW worksheet you like or dislike the most?*", and "*What suggestion can you give to improve this kind of learning material?*" The interview was done in Binisaya then translated and transcribed in English. In this manner, it allows the researcher to gather open-ended data to outline the areas that are being investigated in the topic of interest.

VI d. Ethical Issues

This research is conducted with its full adherence on observing research ethics. A teacher-made online survey commenced by asking for the participants' permission through a consent letter stressing that their involvement in this study is not compulsory. Moreover, the researcher was fully aware that data privacy was given utmost considerations following information privacy regulation assuring that their identity will remain anonymous and protected during online sessions to meet the data privacy standards.

VI e. Data Analysis

The quantitative data of this study are encoded into a spreadsheet program using MS Excel and online statistics calculator www.statskingdom.com to get the mean scores and standard deviation to track the substantial development of the level of engagement of the participants.

Qualitative data from the unstructured interview and Focus Group Discussion (FGD) were transcribed and closely examined employing thematic analysis to identify common ideas, opinions, and topics.

V. Research Results & Discussions

This section comprises the presentation, analysis, interpretation, and discussion of the data gathered from this study's instruments. The data are presented according to the action research questions the researchers intends to answer.

Action Research Cycle

Table 3: Main tasks of the action research cycle

Cycle	Stages	Task
Cycle 1 (April To May)	**Plan**	• Explore the use of augmented reality technology as instructional material • Conduct Pre-assessment survey.
	Action	• Design of worksheets based on the MELC for Grade 5 Science • Distribution of Self-learning Modules for Grade 5 Science

		• Implementation and distribution of AROW learning activity sheets • Distribution of pre and post survey questionnaires
	Observation and Reflection	• Collection of data • Assess the findings of pre and post survey questionnaire • Evaluate issues and feedbacks from the participants
Cycle 2 (June To July)	**Revision**	• Revision of AROW worksheet based on the feedbacks from cycle 1
	Action	• Revision and Preparation of AROW learning activity sheets • Implementation and distribution of revised AROW learning activity sheets • Distribution of survey questionnaire
	Observation and Reflection	• Collection of data • Assess the findings of the survey questionnaire

Cycle 1

Plan and Act

The use of augmented reality or AR were explored together with the possible application to be used in the design of the worksheets. Several applications were tested and explored to suit the needs in the development of an interactive worksheet based on the 4th Quarter Most Essential Learning Competencies or MELC for Grade 5 Science learners. The researcher used Eyejack app downloaded from https://creator.eyejackapp.com/ for online and offline augmented reality effects and web applications such as, http://appsgeyser.com,

http://www.quizz.com and http://qr-code-generator.com to develop interactive content of the worksheets.

Distribution of Science 5 Self-Learning Module (SLM)for the 4th grading was done by the class adviser via online or limited face to face schedule. The researcher distributed pre-survey questionnaire to gather data on the perceived learning engagement of the participants towards the existing Self-Learning Module (SLM's).

The Augmented Reality Overlaid Worksheet (AROW) were distributed after two weeks and utilized as supplemental material in aid of the Self-Learning Modules. The participants went on an orientation on how to use the features of the module and utilize the required application both online and offline.

To allow the researcher to gather data on the perceived learning engagement of the participants using the AROW worksheet, a post-survey questionnaire was distributed. A focus group discussion was organized via online discussion forum using Google Meet to gather feedbacks and suggestions from the participants. Qualitative data were gathered utilizing open-ended questions which are vital information in answering the research question of this study. A follow up semi-structure interview was done among randomly selected

participants via Google Meet or phone call to gather the individual voice of the respondents.

Observe and Reflect

Pre-Post Survey

The data collected from the pre-survey before the intervention shows a "High" extent of perceived engagement of the learners with an overall mean score of 3.85 and Standard deviation of 1.16 respectively. Therefore, the participants are highly engaged with the current module that they are using in their modular class. These can be associated to participant's prior knowledge that self-learning modules are the primary guides through the lesson content and basis for grades assessment.

The data collected from the post-survey results of the perceived level of engagement after the Augmented Reality Overlaid Worksheet (AROW) initiative was implemented, indicated an improvement to the engagement level. An overall mean score of 4.45 with a Standard deviation of 0.67 making it 0.59 mean difference indicating "Very High" extent of leaning engagement among the participants as reflected on

Table 4 below making them extremely engaged with the worksheets that contains Augmented Reality features and interactive content.

It can be noted on that integration of a technology-based and interactive features to the activity worksheet, captures the attention and interest of the participants as it has recorded a pre-survey average mean of 3.63 with a standard deviation of 1.33 increasing to an average mean of 4.70 and standard deviation of 0.47 in the post-survey, making it the highest mean difference of 1.07. The connection between learners' affective or emotional engagement and the usage of ICT implies a positive attitude and feelings regarding the use of technology in learning similar to the findings of (Chenoby, 2014). Thus, the results can be attributed to the fact that learners nowadays are more acquainted with technology, and they will learn better within a technology-based environment congruent to the study (Ghavifekr, S., & Rosdy, W., 2015).

The data also shows that the behavioral aspect of engagement has posted the lowest mean difference, particularly on focus and concentration towards getting the answers correctly within an allotted time which scored an average mean of 4.17 and a standard deviation of 1.18 in the pre-survey. Post-survey revealed an increase to 4.40 average mean and a standard deviation of 0.67 resulting to 0.23 mean difference. On the other hand, technology can be a distraction

resulting to lack of focus to academic learning, and it is clear that technology must be appropriately controlled and regulated to lessen the negative aspects consistent to the study of DeHondt, G., Kulesza, J. and Nezlek, G., (2022).

Table 4 Pre and Post survey results of the participants' perceived level of engagement on Augmented Reality (AR) using AROW worksheet. Cycle 1 (April-May)

	Before the intervention			After the intervention			
Indicators	Mean	SD	Description	Mean	SD	Description	Mean Difference
1. *Akong nasabtan ang leksyon pinaagi sa paggamit niini nga modyul.* **I can understand the lesson by using this module *(Cognitive)***	4.03	1.07	Very High	4.57	0.57	Very High	0.54
2. *Gipaniguro nako nga naa koy panahon para makompleto ang tanang bukuhaton niini nga module* **I make sure that I find time to complete all activities in this module. *(Cognitive)***	3.87	1.07	High	4.37	0.72	Very High	0.50
3. *Gi kompleto nako ang tanang mga buluhaton niini nga modyul* **I completed all the activities in this module *(Cognitive)***	3.87	1.22	High	4.53	0.73	Very High	0.66
4. *Naghinam-hinam ko sa mga butang nga akong nakat-unan niini nga modyul* **I feel excited about the things I am learning**	3.87	1.2	High	4.40	0.67	Very High	0.53

with this module. ***(Affective)***							
5. *Nakahatag kanako ug interes kini nga klase sa modyul.* **I find this kind of module interesting.** ***(Affective)***	3.63	1.33	High	4.70	0.47	Very High	1.07
6. *Nalingaw ko sa pagbuhat sa mga buluhaton dinhi sa modyul.* **I enjoyed doing the activities in the module.** ***(Affective)***	3.77	1.14	High	4.30	0.75	Very High	0.53
7. *Naghinamhinam ko sa pagbuhat niini nga matang sa buluhaton.* **I look forward to doing this kind of task in the future.** ***(Behavioral)***	3.67	1.18	High	4.30	0.60	Very High	0.63
8. *Nahuman nako ang tanang buluhaton niini nga module sa dili pa ang deadline sa pag pasa niini.* **I can accomplish all the task in this module before the deadline of submission** ***(Behavioral)***	3.87	0.94	High	4.40	0.62	Very High	0.53
9. *Ga concentrate ko aron makuha ang saktong tubag ug ang paghuman sa mga buluhaton.* **I concentrate on getting the correct answer and finish the activities.** ***(Behavioral)***	4.17	1.18	High	4.40	0.67	Very High	0.23
10. *Gusto ko nga kanunay naa kini nga matang sa module aron makatabang*	3.80	1.24	High	4.50	0.86	Very High	0.70

kanako sa pagkat-on sa akong mga leksyon.							
I will always want this kind of module to help me learn my lessons. *(Behavioral)*							
Over-all	**3.85**	**1.16**	**High**	**4.45**	**0.67**	**Very High**	**0.60**

The data presented in Figure 2 shows the combined outcomes of the perceived level of engagement to the Augmented Reality Worksheet among the participants in terms of its cognitive, affective, and behavioral engagement. The data collected from the pre-survey for cognitive level shows an average mean of 3.92 and while the post-survey shows 4.49 making a mean difference of 0.57 indicating from "High" to "Very High" extent of engagement. Thus, pre-survey results for emotional level reveals a mean average of 3.76 and increased to 4.47 in the post-survey resulting to a 0.71 mean difference indicating from "High" to "Very High" extent of engagement. Furthermore, behavioral engagement indicates an average mean of 3.88 from the pre-survey to 4.40 in the post-survey showing a mean difference of 0.52 from "High" to "Very High" extent of engagement.

The increase in the level of engagement revealed that the participants are not just paying attention to the features of the material but also interacting with the content of the lesson in a sincere manner

which is also in line with the study of (Solis A. 2008). The participants were responsive to the task and sees it as responding to the purposes and values of the work. Thus, finding meaning and value in their task is similar to the study of Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004) and Schlechty P. (2011).

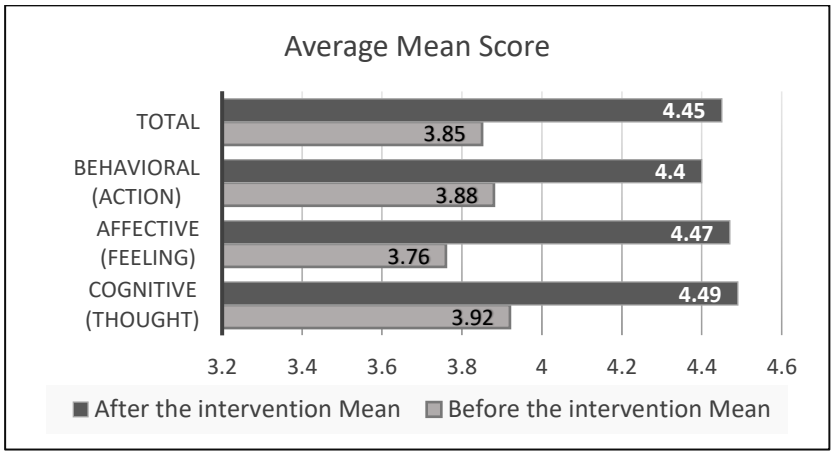
The participants were keen to exert time in learning the processes and activities, including self-regulation, bringing enjoyment, interest, and take on any challenges in the task at hand, corresponding to the findings of Pietarinen, J., Soini, T., & Pyhältö, K. (2014), Rotgans, J., & Schmidt, H.(2011), and Bond, M., et al. (2020). Thus, involving the display of emotions and the ability to find worth in doing their task corresponds with the findings of Harper & Quaye, et. al,(2019).

The manifestation of interest on the task on hand , implies actual behavioral actions to show their commitment and desire to overcome any challenges. It is an aspect related to learners' attention, participation, focus, effort, risk, and participation corresponding to the study of Pagan J. (2018).

The results also revealed that the learners' engagement is more visible from the affective aspect displaying the highest score of 0.71 mean difference before and after intervention. Learners who are engaged emotionally responded with feelings, such as interest,

enjoyment, satisfaction, or an appreciation similar to the findings of Pagan (2018).

Figure 2: Average mean score of before and after intervention in terms of its Cognitive, Affective, and Behavioral engagement. Cycle 1 (April-May)



Focus Group Discussion (FGD)

Focus group discussions (FGD) using open-ended guide questions with the participants disclosed how they describe their experiences in using the AROW worksheet were transcribed and thematized accordingly.

The response of the feedbacks shows the recurring thematized perception of the participants towards integration of Augmented Reality technology laden learning worksheet. The participants experienced feelings of fun and enjoyment while using it, uttering words such as: " *Ganahan ko ani na module kay maka-ligaw kaayo" (I like this*

module because it's really fun)and "Maka-amaze ug maka lingaw kaayo" (It's fun and amazing.). The outcomes of the material have also captured the interest to perform their task on hand and manifesting feelings of excitement when using the material. The participants also considered these material as a new mode of learning especially during modular distance learning modality which contributed to their noticeable act of engagement.

The experiences of the learner-participants imply positive attitude towards the use of ICT-based learning materials, interacting between the time and effort to optimize their learning outcomes with much fun and enjoyment in doing their task specifically, the use of augmented reality technology (AR).

Augmented Reality (AR) technology supports a new and interactive ways of learning a particular lesson or concept. It has an advantage over the traditional styles of teaching. Its impact on the learners' engagement is significant in performing a particular task which affirms the findings of Kaur, D., Mantri, A. and Horan, B., 2020

Table 5.1: Recurring themes for FGD question 1 (Cycle 1)

1. How would you describe your experience in using AROW Worksheet?	
Theme	**Sample Responses/Quotations**
	1. Ganahan ko ani na module kay maka-ligaw kaayo"

Enjoyable	*(I like this module because it's really fun)*
	2. *"Lahi siya kay makalingaw"* *(It's fun and its different)*
	3. *"Maka-amaze ug maka lingaw kaayo"* *(It's fun and amazing.)*
	4. *"Ligaw kung ani ang modules."* (Its fun having modules like this."
New way of learning	1. *Karon pa ko nakakita ug ingon-ani."* *(It's my first time seeing this.)*
	2. *"Bag-o ni nga style."* *(It's a new style),*
	3. *"Bag-o nga klasi sa pag-tuon"* *(New way of learning)*
	4. *"Bag-o na klasi nga module, haytek."* (New kind of module, Hi-tech!)
Interesting	1. *" Excited ko mo gamit sa module"* (I'm excited to use this module)

The data presented in Table 5.2 indicates that integrating multimedia capabilities including augmented reality features substantially impacts to the participants' engagement. The participants also perceived gamification and interactive online-offline educational games to be a positive and engaging aspect in learning and in performing their task.

The data from this study indicates various positive benefits of incorporating multimedia and interactive educational games into the material, which they perceived to help them understand a concept and determination to finish their task. It supported previous studies cited by Yueh, H.P.(2012) that learners are more likely to perceive the value of

ICT-based instructional materials as their curiosity increases and engaged them to learn.

Table 5.2: Recurring themes for FGD question 2 (Cycle 1)

2. What part /feature of the AROW worksheet you like the most?	
Theme	**Sample Responses/Quotations**
Multimedia Capabilities	1. "Ganahan ko na mo lihok ang mga picture." *(I like the way the pictures are moving)*
	2. "Abi nako picture lang, pwede diay ug video" *(I thought It's just a picture, there's also a video.)*
	3. "Ganahan ko kay nay video" *(I like that it has videos)*
	4. "Ganahan ko kay nay sound effects" (I like the sound effects)
	5. " Colored and mga pictures" (Colored images)
Interactive and gamified activities	1. "Tsada kay naay games nga quiz" (I like the gamified quizzes)
	2. "Mag online aron mag answer sa quiz" (Answering quizzes online)

The findings implied that the a few of participants were challenged about technical issues, and slow internet connection which confirms the findings of Cabual, R. and Cabual, M., 2022 that internet connectivity impedes to the momentum of engagement and inability to fully enjoy the features of the materials. It was also revealed that a few of the participants were having minor issues following a few of the instructions regarding certain activities and in utilizing the materials. This can be attributed to the clarity of the sentence on how it has been constructed and some visual content supporting alongside it. The data

that were revealed during this study are vital facts in considering certain revisions for the next research cycle.

Table 5.3: Recurring themes for FGD question 3 (Cycle 1)

What part /feature of the AROW worksheet that you dislike?	
Theme	**Sample Responses/Quotations**
Poor internet connection	1. *"Dilli nako ma download deretso kay lag kaayo ang internet"* (Slow internet unable me to download quickly)
	2. *"Dili nako makita kay hinay among signal"* *(I can't see it because of poor signal))*
	3. *"Usahay taud-taud pa aron ma download"* "It takes time to download"
Problems with instructions	1. "Nag lisod ko follow sa instruction unsaon ug download" (I find it hard to follow instruction on how to download files")

Semi-structured Interview

All interviews were carried out prior to setting of appointments to randomly selected participants. The participants undergone some follow up semi-structured interviews pertaining to questions such as *"What do you like or don't like about the material? "and "What suggestion can you give to improve this kind of material? "*. The interview was done via phone call or online via google meet. It was undertaken using the mother tongue dialect which is Binisaya and then transcribe and translate into English language for research purposes.

Learner 1:

" Para sa akoa, na amazed ko sa mga pictures na mo lihok ug mo tingog. Makaligaw kaayo ug ganahan ko mag gamit ani. Pero usahay hinay maka-download kung mo hinay among internet signal sa balay pero ganahan ko ani ug gamit."

(For me, I am amazed by the moving images and audio, but sometimes it takes time to download at times when the internet signal is slow. But it's fine, I like using it.)

Learner 8

"Ganahan ko mag answer sa mga activities kay nay mga games like puzzle. Maayo unta i-apil ang tingog sa teacher or video para makakita siya nako."

(I like answering the activities that are gamified. It would be good to include the audio or video clip of the teacher for me to see him/her)

Learner 21

"Apil unta powerpoint slide ug video ni teacher, kanang murag ga lecture. Mas makasabot ko unsay buhaton"

(PowerPoint slides of the teacher or video lectures should be included, I can understand more on what to do.)

Learner 4

"Tsada kay magamit nako akong cellphone ug maka answer ko sa online. Ang mga picture kay mo lihok pero walay audio ang uban, mayo unta kung naa tanan"

(It's good that I can use my phone and answer questions online. The images are moving but some don't audio. It would be nice if all has audio)

Learner 16

"Interesting kaayo ang module ug lahi ra sa daan nga gagamiton namo, wala na man ko mahuna-huna na suggestion. OK na ni para sa akoa"

(The module is interesting and different from the old one we are using. I can't think of anything more to suggest. This is OK for me.)

The integration of Augmented Reality technology and interactive activities has induced a consistently positive impact on the learners' engagement. Elements of curiosity, the desire to experience fun, and excitement have stimulated a positive attitude to sustain their motivation in performing the task at hand.

The inclusion of online-offline multimedia and educational games has captured their interest in the materials which they find interesting and enjoyable. The responses of the participants suggest that gamification can be very effective and helpful in promoting dynamic participation in the learning process.

Additionally, a few of the participants mentioned slow internet connection is always a challenge as cited by Cabual, R. and Cabual, M., 2022. Downloading files from the eyejack app and accessing online interactive activities became the reason that they were unable to use the full features of the materials. Hence, learners should have a stable internet connection to experience the full potential of the worksheet.

Cycle 2:

Plan and Act

In line with the outcome of first research cycle, certain modifications were made to address issues and incorporate suggestions made by the participants. Some of the revisions included the insertion of more audio media including the actual voice-over of the teacher giving instructions and explanations. Inclusion of actual video clips of

the teacher as part of the overlaying media for the augmented reality effects of the worksheet.

The revised learning activity sheets were re-printed and re-distributed to the participants. It was re-evaluated using the teacher-made survey questionnaire to gather important facts needed to assess the material.

Observe and Reflect

The data collected from the post-survey in cycle 2 shows an overall mean score of 4.53 with a Standard deviation of 0.65 making it a 0.08 mean difference indicating a "Very High" extent of learning engagement among the participants as compared to the post-survey results in cycle 1 as shown on Table 6 below.

Moreover, the data also shows that the participants are more highly engaged with the worksheet than in cycle 1 and their perception regarding the effectiveness worksheet also improved.

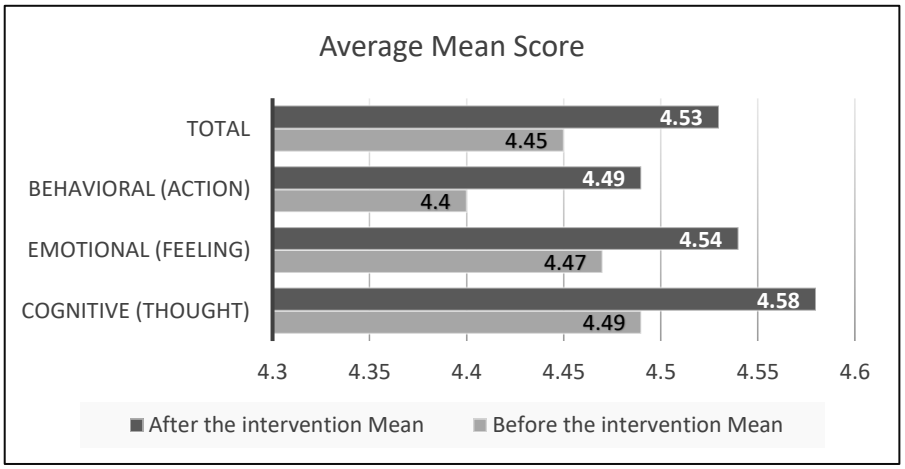
Table 6: Pre and Post intervention results of the participants' perceived level of engagement on Augmented Reality (AR) using AROW worksheet in terms of its Cognitive, Affective, and Behavioral engagement. (Cycle 2: June-July)

CYCLE 2	**Before the intervention**			**After the intervention**			
Indicators	Mean	SD	Description	Mean	SD	Description	Mean Difference
1. . *Akong nasabtan ang leksyon pinaagi sa paggamit niini nga modyul.* **I can understand the lesson by using this module *(Cognitive)***	4.57	0.57	Very High	4.60	0.61	Very High	0.03
2. *Gipaniguro nako nga naa koy panahon para makompleto ang tanang bukuhaton niini nga module* **I make sure that I find time to complete all activities in this module. *(Cognitive)***	4.37	0.72	Very High	4.57	0.67	Very High	0.20
3. *Gi kompleto nako ang tanang mga buluhaton niini nga modyul* **I completed all the activities in this module (*Cognitive)***	4.53	0.73	Very High	4.57	0.72	Very High	0.04
4. . *Nalingaw ko sa pagbuhat sa mga buluhaton dinhi sa modyul.* **I enjoyed doing the activities in the module. *(Affective)***	4.40	0.67	Very High	4.50	0.67	Very High	0.10
5. . *Nakahatag kanako ug interes kini nga klase sa modyul.* **I find this kind of module interesting. *(Affective)***	4.70	0.47	Very High	4.70	0.46	Very High	0.00
6 *Nalingaw ko sa pagbuhat sa mga*	4.30	0.75	Very High	4.43	0.76	Very High	0.13

buluhaton dinhi sa modyul. **I enjoyed doing the activities in the module. *(Affective)***							
7. *Naghinamhinam ko sa pagbuhat niini nga matang sa buluhaton.* **I look forward to doing this kind of task in the future. *(Behavioral)***	4.30	0.60	Very High	4.37	0.60	Very High	0.07
8. *Nahuman nako ang tanang buluhaton niini nga module sa dili pa ang deadline sa pag pasa niini.* **I can accomplish all the task in this module before the deadline of submission *(Behavioral)***	4.40	0.62	Very High	4.43	0.67	Very High	0.03
9. *Ga concentrate ko aron makuha ang saktong tubag ug ang paghuman sa mga buluhaton.* **I concentrate on getting the correct answer and finish the activities. *(Behavioral)***	4.40	0.67	Very High	4.50	0.62	Very High	0.10
10. *Gusto ko nga kanunay naa kini nga matang sa module aron makatabang kanako sa pagkat-on sa akong mga leksyon.* **I will always want this kind of module to help me learn my lessons. *(Behavioral)***	4.50	0.86	Very High	4.67	0.70	Very High	0.17
Over-all	**4.45**	**0.67**	**Very High**	**4.53**	**0.65**	**Very High**	**0.08**

The data presented in Figure 3 shows the consolidated results of the perceived level of engagement to the Augmented Reality Worksheet among the participants in terms of its cognitive, affective, and behavioral engagement for the second cycle. Both behavioral and cognitive aspects of engagement gained a 0.09 mean difference, and the behavioral aspect gained a 0.08 mean difference from the pre-post assessment of the two-research cycle. It suggests the level of engagement increased to a certain degree after some revisions were made to the worksheets.

Figure 3: Average mean score of before and after intervention in terms of its Cognitive, Affective, and Behavioral engagement. Cycle 2 (June-July)



Focus Group Discussion (FGD)

Focus group discussions (FGD) with the participants in cycle 2 disclosed their experiences in using the revised AROW worksheet and

were transcribed and thematized accordingly. Qualitative data presented in Table 7.1 implies that the revision in the worksheets indicates a significant improvement in the degree of learners' engagement.

It can also be noted that the feeling of enjoyment and amazement, stimulates the curiosity and interest of the participants. The revisions and adjustments in the worksheet were favorable to the participants and they responded with eagerness and excitement to perform each activity in the worksheet. They are aware that there are elements of the worksheet that can satisfy their curiosity as they go along with the learning process.

Table 7.1: Recurring themes for FGD question 1 (Cycle 2)

1. How would you describe your experience in using the revised AROW Worksheet ?	
Theme	**Sample Responses/Quotations**
Revised features	1. "Maayo kay apil na ang video ni teacher" (Its good that the teachers' video is included)
	2. *"Mas ganahan ko na naay estorya ang teacher" (I like it better that the teachers' voice-over is included)*
	3. *"Na improve na ang games"* (Gamification has improved)
Enjoyable	1. "Makalingaw man" (It's fun)
	2. " Enjoy maggamit sa module" (I enjoyed using the module)

Augmented Reality (AR) and multimedia has been a consistent feature perceived by the participants to be the stimulating factor in strengthening their engagement in modular learning.

Feedbacks among the participants shown on Table 7.2 reveals that multimedia and augmented reality are key elements in strengthening the learners' engagement. The moving images, interactive online-offline gamification of activities, embedded video clips, and audio captured much attention and received positive feedbacks.

Effective application of proper learning resources such as multimedia and AR, possesses the potential for building learning materials that creates in-depth knowledge on a particular subject which affirms to the study of Clarin, A.S.& Baluyos, E.L., (2022)

Table 7.2: Recurring themes for FGD question 2 (Cycle 2)

2. What part /feature of the AROW worksheet you like the most?	
Theme	**Sample Responses/Quotations**
Multimedia Capabilities	1. " *Maminaw sa tingog aron makasabot*" (Listening well to be able to understand)
	2. "*Nagustohan nako ang pagmit sa gadget*" (I like using gadgets)
	3. "*Mo lihok ang mga pictures*" (The pictures are moving)
	4. "Mag gamit ko ug cellphone" (Using my cellphone)

In an article published on http://www.dict.gov.ph on October 17, 2017, stating the condition of internet connectivity based on the Akamai State of the Internet Report for the 2nd Quarter 2016 that ranked the Philippines as 6th out of 15 Asia-Pacific countries with an average mobile internet speed of 8.5 Mbps. Connectivity and slow internet connection has been a consistent challenge among the participants. Feedbacks such as " Ganahan ko pero usahay dugay lang ma download kay hinay among internet" (I like it a lot, but sometimes it took too long to download due slow internet connection.) and "Dugay nako na download kay data ra man akong gigamit" (It took a long time to download because I'm using data only.) Thus, it is important for potential users to have a stable internet connection to experience the complete capacity of the leaning material.

Table 7.3: Recurring themes for FGD question 3 (Cycle 2)

What part /feature of the AROW worksheet that you dislike?	
Theme	**Sample Responses/Quotations**
Internet connectivity	1. "Ganahan ko pero usahay dugay lang ma download kay hinay among internet." (I like it a lot , but sometimes it took too long to download due to slow internet connection)
	2."ga lag among internet pero makita ra man gihapon ang effects." "Our connection is slow, but I can still view the effects."
	3. " Usahay dugay ma open ang quiz sa online" (Sometimes it's hard to access the online activities)

	4. "Duagy nako na download kay data ra man akong gigamit" (It took a long time to download because I'm using data only.)

Semi-Structure Interview

A randomly selected participants undergone a semi-structured interview for cycle 2. It was done via phone call or online via google meet and was undertaken using the mother tongue dialect, which is Binisaya, transcribe and translate into English language for research purposes.

Learners 2

"OK naman ang module, mas tsada kay naay tingog ni teacher. Wala na man koy ma hunahuna-an na suggestion."

(The module is OK, it's nice that the teachers voice audio is included, I cannot think of any more suggestions.)

Learner 9

"Sa una nag lisod ko gamay unsa-on pag gamit kay data ra man to akong gigamit, pero nakuha na nako unsaon ug ganahan ko. Wala na man ko ma suggest pa."

(I find it hard at first because I was using mobile data, but I figure it out already and I like it. I don't have any more suggestions.)

Learner 7

"Ganahan ko ani mag gamit, mayo unta tanan subject ingon-ani ang module."

(I like using it, I hope other subjects will have modules like this.)

Learner 17

"Hi-tech na kaayo. Sana all subjects ing-ani ang module"

(It's very hi-tech. Hoping that all subjects have this kind of module.)

Responses implies that the revisions made on the activity worksheet were perceived to have positive impact on learning engagement. It can be noted that feelings of eagerness and excitement has been consistently experienced by the participants throughout the duration of this study. They are more acquainted with multimedia content and respond well in a way in which the material is modified accordingly. It was even suggested by the participants that this type of innovation should be applied to other subjects. Although some had experiences of having technical issues due to unstable internet connection, they were keen enough to utilize the materials.

Integrating ICT into lessons and learning materials has been the motivating factors that engages the participants to complete their task

on hand. Augmented reality (AR) and interactive activities created an avenue for a new kind of learning. It opened diverse ways and opportunities for the participants to make learning fun and enjoyable.

VI. Reflection

The implementation and use of Augmented Reality Overlaid Worksheet (AROW) as supplemental learning material during modular distance learning modality showed a substantial improvement in strengthening the learner's engagement. Results from pre-assessment to post-assessment data and the voice of the participants are the basis to support this claim.

Data from the pre-assessment survey indicated a "High Level" of engagement on the current SLM that they are using. The results were in line with the findings of Bacomo, A C, et. al, (2022), which states the learners had high regard for SLMs manifesting positive attitude and considering that modules work best for them during the pandemic and must be improved for optimum learning.

Moreover, the findings confirmed that the learner-participants developed a more positive response and attitude toward the use of augmented reality technology manifesting a "Very High Level" of engagement within 10 weeks done in 2 cycles of inquiry. The learner-

participants expressed a certain degree to which they are happy and capable to accept the challenge in the learning task at hand with such interest and enjoyment. Validation to such feelings can be attributed to the fact that learners nowadays are more acquainted with technology and will learn better within a ICT-based material and environment. These findings were In line with the study of Sun, Lee, Lee & Law, (2016), which states that learners are likely to use the technology if they find it engaging and use it to enhance their understanding of a certain course.

It was also disclosed that a few revisions and modifications of the original AROW worksheets resulted in a much higher positive outlook toward the material. The modifications were based on the feedback of the participants during the conduct of the focus group and interview with the participants. Minor revisions such as re-phrasing of sentences especially in the instructions on how to use the material were made for an easier direction. These setbacks, however, were resolved as the learner-participants went along the process.

Furthermore, minor impediments were also evident during the intervention process cycles. A few of the participants reported instances included slow connectivity to the internet in downloading files and access to online interactive sites. Hence, it should be given ample consideration knowing it is a challenge to sustain a stable internet connection in some areas.

The integration of ICT and Augmented Reality impacts to positive student engagement and attitude toward learning. Findings suggest that the participants exerted effort and time to follow instructions and perform specific task which implies behavioral aspect of engagement. Moreover, feelings of excitement and interest towards the use of the materials are manifestations of emotional engagement. Willingness to learn and comprehend the task on hand and involve more into deeper learning are indications of cognitive engagement. It is, therefore, essential that more complementary learning materials incorporating augmented reality assisted instruction, online interactive assignment will be developed to strengthen learners' engagement and immersive experience to a specific subject.

VII. Action Plan

Action Plan and Timetable
AROW Learning Activity Sheet (LAS)

Areas of Concerns	Activities	Timeline	Person Responsible	Resources Needed
Cycle 1				
Pre-Implementation	- Distribution of usual Self Learning Modules (SLM) - Conduct Pre-test assessment and Survey	Week 1 & Week 2 April 2022	Teacher-adviser Proponent	ICT materials
Orientation of participants	Conduct online orientation on how to utilize the worksheet	Week 3 April 2022	Proponent	ICT materials
Implementation	Production Distribution of printed AROW Learning Activity Sheet (LAS)	Week 4 April to Week 1 May 2022	Proponent ICT coordinator	ICT and printed materials
Post-Implementation	Conduct Post-test and Survey	Week 2 May 2022	Teacher-adviser Proponent	ICT materials
Post Assessment	On-line Focus Group Discussion	Week 3 May 2022	Participants Proponent	ICT materials
Evaluation and Data Analysis	Project monitoring and evaluation (Self-report Online or Printed survey	Week 4 May 2022	ICT Coordinator Teacher Proponent	ICT materials
Cycle 2				
Pre-Implementation (Revision)	Revision of AROW Learning Activity Sheets	Week 1 June 2022	Teacher-adviser Proponent	ICT materials
Implementation	Production Distribution of printed AROW	Week 2 June to	Proponent ICT coordinator	ICT and printed materials

	Learning Activity Sheet (LAS)	Week 3 June 2022		
Post-Implementation	Conduct Post-test and Survey	Week 4 June 2022	Teacher-adviser Proponent	ICT materials
Post Assessment	On-line Focus Group Discussion	Week 1 July 2022	Participants Proponent	ICT materials
Evaluation and Data Analysis	Project monitoring and evaluation (Self-report Online or Printed survey	Week 2 & 3 July 2022	ICT Coordinator Teacher Proponent	ICT materials
	-end of cycle-			
Draft Reporting	Submission of final draft	Week 4 July 2022	Proponent	ICT materials
Submission of Research	Final submission of research notes	August 2022	Proponent	ICT materials

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Sample of Consent Form Used in the Study

Ma'am/Sir:

Greetings!

Your permission is being sought to have your child participate in a study entitled "**AROW** (Augmented Reality Overlaid Worksheets): Strengthening Engagement of Science Learners in Modular Distance Learning Modality"
The purpose of this study is to assess the effectiveness of a contextualized virtual and interactive learning activity worksheet aided with AR (Augment Reality) which will be utilized as supplemental material and to strengthen learners' engagement in performing their tasks in the modular learning modality.

Participants will be given a supplemental learning material worksheet in aid of the existing Self-learning modules. There will an online orientation via Google Meet for the orientation on how to use the material, furthermore, participants will need their own Android devices either smartphone or tablet that can access the Internet as primary tools for the study. Data privacy will be given utmost considerations following information privacy regulation assuring that their identity will remain anonymous

Respectfully yours,

RYAN Z. ROA
Researcher

SIGNING THE FORM BELOW WILL ALLOW YOUR CHILD TO PARTICIPATE IN THE STUDY DURING SCHOOL HOURS WITHOUT YOUR PRESENCE.
If you do not sign and return this form, the researchers will understand that you do not wish to allow your child to participate.

Parent Signature Box

I, the parent or guardian of _____, a minor _____ years of age, permit his/her participation in a program of research named above and being conducted by Ryan Z. Roa a faculty member of South City Central School.

_____ _____
Signature of Parent or Guardian Date

_____
Please print your name here.

Student Signature Box

I, _____, agree to participate in the program of research named above and understand that my participation is voluntary.

_____ _____
Signature of Student Date

_____

Please print your name here.

SAMPLE SURVEY QUESTIONNAIRE

Indicators	Very Low	Low	Moderate Degree	High Degree	Very High Agree
	1	2	3	4	5
Akong nasabtan ang leksyon pinaagi sa paggamit niini nga modyul. **I understand the lesson by using this module** *(Cognitive)*					
Gi kompleto nako ang tanang mga buluhaton niini nga modyul **I completed all the activities in this module** *(Cognitive)*					
Gipaneguro nako nga makakita kog panahon para makompleto ang tanang bukuhaton niini nga module **I make sure that I find time to complete all activities in this module.** *(Cognitive)*					
Naghinam-hinam ko sa mga butang nga akong nakat-unan niini nga modyul **I feel excited about the things I am learning with this module.** *(Affective)*					
Nalingaw ko sa pagbuhat sa mga buluhaton dinhi sa modyul. **I enjoyed doing the activities in the module.** *(Affective)*					
Nakahatag Kanako ug interes kini nga modyul. **I find this module interesting.** *(Affective)*					

Naghinamhinam ko sa pagbuhat niini nga matang sa buluhaton. **I look forward to doing this kind of task in the future.** *(Behavioral)*					
Nahuman nako ang tanang buluhaton niini nga module sa dili pa ang deadline sa pag pasa niini. **I can accomplish all the task in this module before the deadline of submission** *(Behavioral)*					
Ga concentrate ko aron makuha ang saktong tubag ug ang paghuman sa mga buluhaton. **I concentrate on getting the correct answer and finish the activities.** *(Behavioral)*					
Gusto ko nga kanunay naa kini nga matang sa module aron makatabang kanako sa pagkat-on sa akong mga leksyon. **I will always want this kind of module to help me learn my lessons.** *(Behavioral)*					

Interpretation Range:

1.00 – 1.80 : Very Low Extent of engagement

1.81 – 2.60 : Low Extent of engagement

2.61 – 3.40 : Moderate of engagement

3.41 – 4.20 : High Extent of engagement

4.21 – 5.00 : Very High Extent of engagement

FGD w/ Participants Guide Questions

1. **How would you describe your experience in using AROW Worksheet?**

   Unsa ang imong nasinati sa paggamit sa AROW worksheet?

2. **What part /feature of the AROW worksheet you like the most?**

   Asa/Unsa nga bahin sa AROW worksheet ang pinkagusto nimo?

3. **What suggestion can you give to improve this kind of learning material?**

   Unsang sugyot ang imong ikahatag aron mapauswag kini nga matang sa material gamit pag tu-on?

Timetable/Gantt Chart

Task	2021-2021												2022-2023											
	2022																							
	March				April				May				June				July				August			
Week	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1: TAC Meeting				*																				
2: Draft Literature									*															
3: Draft Methodology												*												
4. Research Cycle 1 Data Collection, Data Analysis Reflection														*										
5. Revision Cycle 2 Data Collection, Data Analysis																		*						
6. Reflection																								
7. Draft Final Report																						R		
8. Final Report																								F

*Deliverables
R - Draft report submitted for SDRC review.
F - Revised report submitted to SDRC for publication. End of contract.

Plans for Dissemination/Advocacy

Results of the study will be presented in strategic planning and research to promote and adopt the material as a supplemental tool to uplift learner's engagement The faculty of South City Central School will also gain awareness with regards to the intervention and learning package.

Moreover, these supplemental Learning Activity Sheet (LAS) can be considered as learning resources material and could be introduced during In-Service Training or Learning Action Cell (LAC) for teachers not only for South City Central School but for other districts within the division as well. The finding

of this study will give baseline data for policy improvements and contribution to the current knowledge, relative to the teaching and learning process significant for DepEd teachers.