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Research Article

Development and Validation of Instructional Material in Astronomy

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ABSTRACT

This study used descriptive - developmental education research design. There are 17 science teacher education students whose currently taking Astronomy subject as major subject, and 12 faculty specialist in the field of science and professional education who served as participants of the study. Two instruments were used in gathering data, including; assessment tests and descriptive checklist. Findings revealed the following: the level of competency of the students were satisfactory before the development of the material; the developed instructional material was a module entitled "Solar: Module for Astronomy." It was composed of different parts. It contains 19 congruent worksheets; the instructional material was perceived as "Very Useful."; and the instructional material was perceived as "Not Difficult" to utilize. Thus, in view of these conclusions, it recommends to heighten the level of competency of the students by using developed instructional materials as references and resources; innovate and improve the developed module by adding parts and worksheets; utilize the developed instructional material as resources and references in teaching astronomy and other related fields; and maintain the difficulty of the instructional material.

Keywords*: Astronomy, Instructional material, Module, Science teacher education students*

Introduction

The world is experiencing a rapid metamorphosis, and education must flow with it. Higher education institutions sought technology can become a catalyst of educational process improvement. Yet, the culture of innovation signifies awareness of the fact that values in the external world constantly change. This education must change as well in order to meet student expectations (British Council, 2015.)

Astronomy is a three-unit general education or major subject course in teacher education programs in higher education. According to Dantic's (2021) assessment, higher education students have poor conceptual knowledge of the subject. Meanwhile, Serttaş and Türkolu (2020) discovered that students had several misconceptions about astronomy. However, according to Chavan (2013), "most science teachers face difficulties in teaching concepts."

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Emphasis on the time spent on diagram sketching on the board" and "lack of instructional tools." Meanwhile, Kaptan and Timurlenk (2012) remarked, "The teaching process is at an information level." If a student is in a passive stance (only listening and writing). While teachers are in active positions (writing on the board and instructing in a traditional manner.)" These dilemmas are critical for a qualified teacher to engage students in an interesting and enriching science course (UNESCO, n.d.)

According to studies conducted by UP NISMED (2011), students in the Philippines have poor conceptual retention, limited rational and analytical skills, and poor communication skills, which means that they are either unable to express ideas or explanations of events and phenomena in their own words or have poor communication skills.

Teachers must be innovative in the design and use of instructional materials in order to reduce the costs of lowering and maintaining instructional resources. The usage of improvised instructional material, according to Oladejo and Olosunde (2011) research, enhances and improves the quality of the teaching and learning process. As a result, science teachers in higher education are encouraged to embrace improvisation in their courses. According to Mehisto (2012) that Learner's Materials in different formats contains knowledge which may be useful to teachers achieving the intended learning outcome. Through these, it uplifts the students' conceptual understanding which can be assess though module test or unit test (Rahman, 2015). Also, Rogayan and Dollete (2019) emphasized that in response to the new curriculum, the workbook intends to promote more effective instruction in concretizing abstract science topics and to maximize the learning experience, despite restricted resources state public schools. This innovation may help with basic schooling.

With a lack of learning resources, teachers must create appropriate instructional materials to promote student learning and overcome a dearth of reference materials. In response to the science teacher education curriculum, the astronomy module was created to encourage more effective instruction in realizing abstract astronomy topics and to maximize the learning experience despite limited resources in higher education. This idea may be able to fulfill pressing needs. The findings of the study may serve as baseline information that offers support to the school heads and curriculum designers and developers to create other instructional materials that may be of help to students for more efficient learning.

Conceptual Framework

In accordance with CMO No. 4 S. 2020, educational institutions should offer students the utmost amount of flexibility in terms of learning content, timetables, access, and innovative assessment. The current crisis prompted the implementation of Modular Distance Learning to assure academic continuity. The Philippines is adapting to a new normal style of education, and educators and other stakeholders are driving its success (Dangle & Sumaoang, 2020).

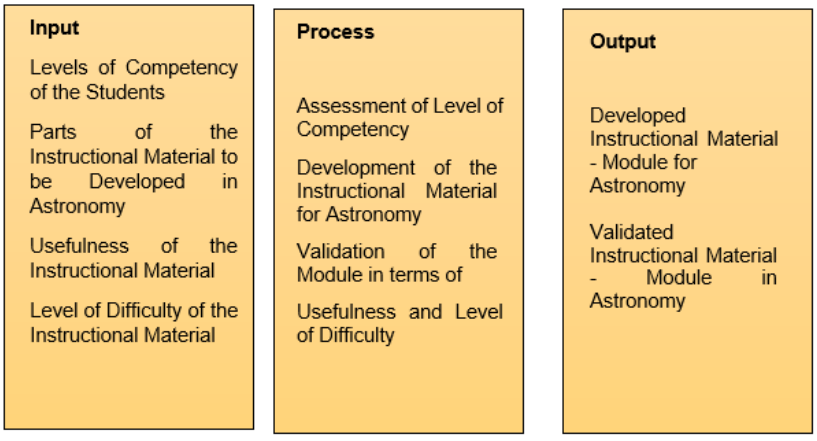

Figure1. Conceptual Paradigm of the Study

The input – process – output model was used in the study. The model shows that needs assessment and review of the available instructional materials were done, as part of the input. The process included the design and development, and validation of the instructional material. The output of this study is the validated Astronomy Instructional Material in the form of module.

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Methods

The study used a descriptive-developmental educational research design which focused on the development of instructional material in terms of module in astronomy. There are 17 science teacher education students whose currently taking Astronomy subject as major subject, and 12 faculty specialist in the field of science and professional education who served as participants of the study. The instructional material's usability was validated by the science teachers and technical design experts. There are two tools used to gather data. The first tool consisted of of three parts, these are; 1) Profile of the Participants; 2) Usefulness of the Instructional Material; 3) Level of Difficulty. Second is the pencil-paper assessment which is composed of a one hundred three questions. Free and percentage distribution was employed to analyze the quantitative aspect of the data.

Results and Discussion

Levels of Competency of the Students

The table shows the level of competency based from the quiz scores before any intervention happened. It was revealed that most of the students were very satisfactory (VS), and got a mean test score of 201.86. Meanwhile least of the students did not meet the expectation (DME), and got a mean test score of 138.2.

Table 1. Levels of Competency based from the test Scores in Astronomy

Interval	***Frequency***	***Percentage***	***Mean test score***	***Verbal Description***
0 – 150	1	6	138.2	Did not meet the expectation
151 – 175	4	23	162.25	Fairly Satisfactory
176 – 200	3	18	181	Satisfactory
201 - 225	5	30	201.86	Very Satisfactory
226 – 250	4	23	225.33	Outstanding
Total	17	100	183.50	**Satisfactory**

The competency level of the students were satisfactory (S), evident from an overall mean test score of 183.50. The competency level on astronomy is only satisfactory. They still have misconceptions towards astronomy. Also, they have difficulty understanding fully the critical concepts in astronomy. It means that there is a need of intervention to enhance their level of competencies.

According to the study of Balfour and Khonle (2016) it found that misconceptions have distinct appearances and that new information can be incorporated into old beliefs without requiring considerable conceptual alteration. Furthermore, quantitative abilities are important and are necessary in all areas of astronomy. Significant advances in computational literacy are strongly advised (Zingale, Timmes, Fisher & O'shea, 2016). They still have not fully grasp the fundamental concepts that binds astronomy. They still lack skills to critic concepts. It was justified by Buxner, Impey, Romine & Neiberding (2018), believed the ability to analyze and criticize science information, as well as the foundation of science information itself, were key components in creating more educated consumers. The Introductory Astronomy field provides genuine opportunity to improve basic science knowledge and information literacy.

The level of competency is too low. There is a need of intervention in the form of instructional material to support and improve their learning towards astronomy.

Main Parts of the Instructional Material Developed

Table 2. Parts of the Astronomy Developed Module

Part	Description
Title Page	It indicates the name of the author, title, publisher and date published.
Introduction	It states the purpose and scope of the module that gives brief summary.
Table of Contents	It indicates the list of topics or contents covered with their page numbers.
Assessment Test: Pre-test and Post-test	It indicates the test that assess their learning before and after the use of module.
Worksheets	These indicate the work activities by each topic.

The topics included were in this module were aligned in the competencies in the syllabus. It is composed of several parts, which included title page, introduction, table of contents, pre-test and post-test; worksheets.

Table 3. List of Worksheets

List of worksheets	
Number of worksheet	**Title of worksheet**
1	Evolution of the Universe
2	Evidence of Big Bang Theory
3	Accretion Theory
4	Nebular Theory
5	Terrestrial and Jovian Planets
6	Kepler's Planetary Motion 1st Law of Orbits
7	Kepler's Planetary Motion 2nd Law of Orbits
8	Kepler's Planetary Motion 3rd Law of Orbits
9	Planetary Information
10	Planets and Moons
11	Asteroids, Meteoroids and Comets
12	Parts of the Earth
13	The Spheres of the Earth
14	Moon Phases and Revolution
15	Solar Eclipse
16	Lunar Eclipse
17	The Parts of the Star
18	Stellar Parallax
19	Star Types and Surface Temperature

The table revealed the number of worksheets and their titles. The module contains 19 worksheets. The developed module contains worksheets, which the same components, which were congruent with each other. Meanwhile the worksheets were composed of the following: learning objectives, activity proper, and suggested readings.

Table 4. Parts of the Worksheet

Parts of the Worksheet	
Part	**Description**
Learning Objectives	These are the targets to be accomplished at the end of the worksheet. These are aligned to the competencies of the subject.
Activity Proper	These are various activities that supplement and strengthen the learning of the students.
Suggested Readings	These are the references to be utilized. These where they could seek answers to their questions.

Each worksheet has these three (3) parts the: learning objective, activity proper and suggested readings. The learning objectives are the targets to be accomplished. Activity Proper the various activities the supplements and strengthen learning. Suggested reading are the references could be used.

Usefulness of the Instructional Material

Table 5. Usefulness of Instructional Material based on Content Feature

	CONTENT FEATURE	MEAN	SD	VD
1.	Given real-life applications	3.12	0.69	Useful
2.	Clarity of explanation to the information and directions	3.25	0.60	Useful
3.	Developmental appropriateness of activities.	3.12	0.56	Useful
4.	Accuracy and integration of non-text content (graphs and pictures) to the text.	3.12	0.80	Useful
5.	Interdisciplinary of lessons/ activities	3.42	0.64	Very Useful
6.	Activities apply to a diversity of student abilities, interests and learning styles	3.08	0.64	Useful
7.	Included guiding questions in the activities which encourage the development of higher-level thinking skills	3.5	0.76	Very Useful
	Total	3.25	0.14	**Useful**

The table showed that among the indicators of content feature of the instructional material, indicator 7 "Included guiding questions in the activities which encourage the development of higher-level thinking skills" got the highest mean of 3.5 with a standard deviation of 0.76 which perceived as very useful (VD). Meanwhile, indicator 6 "Activities apply to a diversity of student abilities, interests and learning styles." got the lowest mean of 3.08 and standard deviation of 0.64 which perceived as useful (U). In overall, the content feature is useful evident from the mean of 3.25 with standard deviation of 0.14.

Simple to read, clear, intelligible, and engaging content is appealing. It piques viewers' interest. Its positive features encourage audiences to seek out for more (Vividus, 2017).

Table 6. Usefulness of Instructional Material based on Instructional Design

	Instructional Design	MEAN	SD	VD
1.	Provided table of contents, glossary and index to the textbook	3.08	0.76	Useful
2.	Consistency of layout and logical arrangement of chapters	3.17	0.80	Useful
3.	Clear and comprehensive introductions and summaries to the chapters	3.17	0.80	Useful

Instructional Design	MEAN	SD	VD
4. Contained references, bibliography and resources of the IM	3.33	0.75	Very Useful
5. Accuracy and currency of information	3.42	0.64	Very Useful
6. Appropriateness of reading level	3.33	0.47	Very Useful
7. Appropriateness of size and format of the print	3.33	0.47	Very Useful
8. Visual appearance and template of the format	3.17	0.80	Useful
Total	**3.26**	**0.13**	**Very Useful**

The table showed that among the indicators of instructional design of the instructional material, indicator 5 "Accuracy and currency of information." got the highest mean of 3.42 and standard deviation of 0.64 which perceived as very useful (VD). Meanwhile, indicator 1 "Provided table of contents, glossary and index to the textbook." got the lowest mean of 3.08 with a standard deviation of 0.76 which perceived as useful (U). In overall, the instructional design is very useful evident from the mean of 3.26 with a standard deviation of 0.13.

Effective learning for students is ensured by appropriate instructional design. It considers both the strengths and shortcomings when constructing it. This gives it the chance to be personalized and cater to the individual needs of students (Purdue Online, 2020).

Table 7. Summary of the Usefulness of the Instructional Material

Difficulty	MEAN	SD	VD
1. Content Feature	3.25	0.14	Useful
2. Instructional Design	3.26	0.13	Very Useful
Total	**3.26**	**0.14**	**Very Useful**

The table showed the summary of usefulness of the instructional material. The instructional material is very useful evident from the of 3.26 with standard deviation 0.14.

Level of Difficulty of the Instructional Material

Table 8. Level of Instructional Material based on Difficulty

Difficulty	MEAN	SD	VD
1. Difficulty of the material relative to the expected ability level of the audience (e.g., vocabulary, phrasing and technicality)	3.42	0.49	Not Difficult
2. Difficulty of the chronological aspect and sequence relative to the intended ability levels of the students (college level).	3.42	0.64	Not Difficult
3. Difficulty of the multiple levels of instructions relative to the individual differences of students.	3	0.40	Moderate Difficult
4. Difficulty of the understandability of graphic illustrations, such as photographs, diagrams and realistic drawings, relative to the age, and/or developmental level of student.	3.33	0.85	Not Difficult
5. Difficulty of the quantity of concepts, principles and laws presented at a time relative to the cognitive science level of the audiences.	3.33	0.62	Not Difficult
Total	**3.3**	**0.15**	**Not Difficult**

The table showed that among the indicators of difficulty of the instructional material, indicator 1 "The material relative to the expected ability level of the audience (e.g., vocabulary, phrasing and technicality)" and indicator 2 "The chronological aspect and sequence relative to the intended ability levels of the students." got the highest mean of 3.42 with a standard deviation of 0.49 and 0.64 respectively which perceived as Not Difficult (ND). Meanwhile indicator 3 "The multiple levels of instructions relative to the individual differences of students." got the lowest mean of 3.00 with standard deviation of 0.40 which perceived as Difficulty (D). In overall, the instructional material is not difficult to use evident from the mean of 3.3 with a standard deviation 0.15.

Conclusion

From the above mentioned findings, the following conclusions were derived:

1. The level of competency of the students before the development an instructional material for Astronomy were satisfactory.
2. The developed instructional material was a module entitled "Solar: Module for Astronomy." It was composed of different parts. It contains 19 congruent worksheets.
3. The instructional material was perceived as "Very Useful."
4. The instructional material was perceived as "Not Difficult."

Recommendation

In view of the findings and conclusions, the researcher recommends some ways to uplift development and validation of the instructional material.

1. Heighten the level of competency of the students by using developed instructional materials as references and resources.
2. Innovate and improve the developed module by adding parts and worksheets.
3. Utilize the developed instructional material as resources and references in teaching astronomy and other related fields.
4. Maintain the difficulty of the instructional material.

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