

APOS Theory Implementation of a Module Contained with Autonomous Character and Mathematics Connection on Algebra Material

Krisno Budi Prasetyo
Universitas Negeri Semarang,
Indonesia
krisnobp@gmail.com

YL. Sukestiyarno
Universitas Negeri Semarang,
Indonesia

Adi Nur Cahyono
Universitas Negeri Semarang,
Indonesia

Abstract—This is a development research of a learning source based on APOS theory. The role of APOS theory is to facilitate framework constructions of an action, process, object, and scheme. This research aims to evaluate the existence of the learning material based on APOS theory and tests its validity and practicability based on the readers' responses. This is a Research and Development study. The stages consisted of 5 steps: analysis, plan, development, implementation and evaluation. The subjects consisted of the teachers, the parents, and the learners of Primary Schools, Junior High Schools, and Senior High Schools in Lingga Municipality. The variables consisted of the learners' autonomies and mathematics connections. The quality of the module was obtained from observation, interview guidance, and questionnaire. The findings showed the current learning source existence had not been oriented to APOS theory. The same thing also occurred in the action, object, and scheme stages. The findings also asserted that the develop module was valid and practical. The module had high validity, and an excellent criteria. The responses of both the parents and the teachers showed that the module could be used as a learning reference. The learners responded positively about the module since it was concluded that the module was applied for Primary School until Senior High Schools learners as the learning reference.

Keywords: APOS theory, characters autonomy, mathematics connection, algebra.

I. INTRODUCTION

Education is a conscious and systematic effort in developing the learners' potentials. Education is the people and nation's efforts to prepare the better sustainability of the next generation in the life of a society and as a nation. This 2013 curriculum indicates the importance of a dynamic paradigm in learning mathematics. It involves the teachers' roles as the learning motivators. Dealing with the roles of teachers, teachers are required to provide opportunities for the learners to construct their knowledge through several activities. They are such as mathematics problem solving activities. In facilitating the learners to construct their knowledge, a learning source that provides freedom for the learners is required. Learning source is every learning material that could facilitate the teachers to promote

the learning activities (Depdiknas, 2006). The developed learning material is arranged based on APOS theory. This theory is used as a collaboration of mental construction, started from the action, process, object, and scheme (Dubinsky & McDonald, 2002). The mental construction in this context is the formation of *action*. It is interiorized into a process and is encapsulated into an object. This object could be de-encapsulated into the process. Action, process, and object could be organized into a scheme. The implementation of APOS theory in this module had paid attention on the educational condition in Indonesia. It is typically focused on character developments of all levels. According to Listyani (2012), the character education could be integrated for each lesson. It includes the mathematics learning. Therefore, mathematics learning becomes a medium to develop the learners' characters. One of the developed characters in this module is autonomy. Sumarmo (2004: 4) argued that an individual's autonomy encouraged him to be better, to observe, to evaluate, to direct, and to control himself to think and act.

Internalizing autonomy in the learners' learning course is not an easy matter. Passive learners influence the autonomy character development. Other factors hindering learning autonomy is low asking question habit, cheating habit, and poor initiation to get other learning sources.

Besides autonomy character, this module also fosters the learners' mathematics connection skills. Based on the content standard of the Educational Unit Curriculum, it says that mathematics connection skills is an important skill. It covers skills to understand mathematics concepts, explain the conceptual interconnection, and apply the concepts. According to Siregar & Surya (2017), they state that mathematics connection consists of learners' cognitive skill improvements such as recalling the materials and recalling how to apply a certain concept in life. According to Resti Yuliani et al (2018) mathematics connection and autonomy are interdependent. An autonomous learner tends to perform an excellent mathematics connection.

Such skills in applying the mathematics concept in the related problems (called as mathematics connection) were very low. A study conducted by

Saminanto & Kartono (2015) showed that the senior high school learners' mathematics connection skills were still low. It was in the score of 34%. One of the most engaged difficulties was incapability to connect the previously taught materials. It is in line with a study conducted by Apipah & Kartono (2017). In mathematics learning, it was seen learners that had difficulties to connect the given materials and the prerequisite materials they mastered.

The module development in this autonomy character and mathematics connection would be focused on algebra material. Based on the findings of *Trends in International Mathematics and Science Study* (TIMSS) that the percentage of subjects in Indonesia that completed the standard questions of TIMSS under the algebra domain correctly was 22% (Mullis, *et al*, 2012: 459-463). By referring to this result, it showed that the learners' understandings were still poor. It was due to the teacher-centered learning. It is in line with the argument of Marsitin (2017). She argued that the learners were still habituated to listen to the teachers, to note the explained materials, and to memorize. Due to this inactivity during the learning process, the learning is not focused on the learners. Thus, the teacher's orientation is focused on the targeted material. Thus, it leads to meaningfulness learning.

There is a necessity for learners to learn and develop their understandings. The researchers developed a module that could be the learners' references. It is expected to facilitate them and make this module as reference in the learning. The developed module was based on APOS theory. Besides APOS theory, the module was also contained with autonomy character and mathematics connection. The provision of APOS theory framework is expected to habituate learners to solve the questions. Thus, they could construct their knowledge in connecting the concepts. The concepts are clearly written. Then, due to the learners' habits to construct their thought based on APOS theoretical framework would make them independently learn. Thus, it could trigger their mathematics connective skills. This research was focused on the APOS theory implementation on a module contained with autonomy character and mathematics connections of school algebra materials. The developed module is in the form of referential module for school level algebra learning.

II. METHODOLOGY

This is a *Research and Development* study. The developed model used 5 stages: 1) analysis, 2) plan, 3) development, 4) implementation, and 5) evaluation.

This research was carried out in Singkep Barat 1 Public JHS. The subjects consisted of VII A graders in the academic year 2019/2020. Meanwhile, the research objects were module based on APOS theory on the algebra material.

The techniques of analyzing the data: 1). Mathematics module validity analysis, 2) Teacher, parent, and learner validity analysis.

III. FINDINGS AND DISCUSSION

Mathematics module validation results.

The judgment done by the validators consisted these indicators: The whole module, APOS theoretical construction, autonomy characters, and mathematics connection skills. The applied revisions by the authors referred to the given suggestions by the validators. The module validation results are presented below:

Table 1. Mathematics Module Validation.

The assessed aspects	Average	Categori
The whole module	4.20	Valid
APOS Theoretical Construction	4.55	Valid
Autonomy Character	4.7	Valid
Mathematics	4.0	Valid
Connection Skills		
Average	4.37	Valid

Table 1 shows each assessment aspect score from 5 validators is higher or equal to $4 \geq 4,0$) with a criterion "valid". The whole score average of the mathematics model is 4.37 with a criterion "valid". The teachers' responses questionnaire validation results

The judgment of the validators toward the teacher and parents' response questionnaire are: The questionnaire format, the appropriateness of the questionnaire indicators with the teachers' and parents' responses, communicative language usage, simple and understandable language usage, and utilizing proper and accurate Indonesian language. In revising, the researchers referred on the suggestion and comments given by the validators. The experts' validation results toward the teacher and parents' responses could be seen below.

Table 2. The Results of the Teacher and Parents Questionnaire

The assessed aspects	Average	Categories
The questionnaire format	4.00	Valid
The appropriateness of the questionnaire indicators to the teachers and parents' responses.	4.00	Valid
The capabilities of the questionnaire to measure the teachers	4.14	Valid

and parents' responses.		
The indicators do not lead to ambiguous interpretations.	4. 43	Valid
Communicative language usage.	4. 14	Valid
Simple and understandable language usages.	4. 14	Valid
Proper and accurate Indonesian language usages.	4. 14	Valid
Average	4. 14	Valid

Table 2 shows each average of the assessed aspects from those validator is higher or equal to 4 ($\geq 4,0$) with a criterion "valid". The whole score average of the mathematics model is 4. 14 with a criterion "valid".

The Descriptions of the Learners' Questionnaire

The questionnaire was used to measure how the learners were interested in the mathematics module with character content and implementing APOS theory. Happiness, convenience to understand the components, figures, motivation stated in the module to encourage the learners' spirits that was arranged in the activity sheets for either groups or individuals, and joyful learnings are their responses. It could be concluded that the learners' responses toward the module with autonomy character and based on APOS theory was interested and not boring. The presented materials in the module were complete and could encourage learners to read. The module could facilitate learners to learn especially with Algebra material. Learning by using this module provided new experience for them because there were actions, processes, objects, and schemes. The questions from the processes until the objects had different difficulties to challenge the learners. During the autonomous learning by using this module, the learners did not have difficulties because the materials were complete. They were also entailed by related figures to the materials. Besides the understandable question examples with clear stages, it could also facilitate learners to arrange the stages when they worked on the questions.

IV. CONCLUSION

Based on the data analysis result and discussion, the results of the module development with APOS theory and contained with autonomous character and mathematics connection skill about algebra were: Valid based on APOS theory and contained autonomous character and mathematics connection

about the algebra material, valid with an average score of 4. 37, and had validity level of $4 \leq V_a < 5$. The results of the teachers' and parents' responses toward the module showed the valid criterion of the module with an average score of 4. 14. It had a validity level of $4 \leq V_a < 5$.

REFERENCES

- [1] Apipah, S & Kartono. 2017. Analisis Kemampuan Koneksi Matematis Berdasarkan Gaya Belajar Siswa pada Model Pembelajaran Vak dengan *Self-Assessment*. *UNNES Journal of Mathematics Education Research*. 6(20), 148-156. <https://journal.unnes.ac.id/sju/index.php/ujmer/article/view/20472>
- [2] Depdiknas. 2006. *Standar Isi Mata Pelajaran Matematika SD/MI, SMP/MTs, SMA/MA (Permendiknas Nomor 23 Tahun 2006)*. Jakarta:Depdiknas.
- [3] Ed Dubinsky & Michael A. M. "APOS: A Constructivist Theory of Learning in Undergraduate Mathematics Education Research" in *The Teaching and Learning of Mathematics*. New York: Springer.
- [4] Listyani, E. 2012. "Implementasi Model Pembelajaran Matematika dalam Pembentukan Karakter Peserta Didik". Makalah. Dipresentasikan dalam Seminar Nasional Matematika dan Pendidikan Matematika di Universitas Negeri Yogyakarta. Yogyakarta, 10 November 2012.
- [5] Marsitin, R. 2017. Modul Pembelajaran Limit dengan Teori APOS. Disampaikan pada Seminar Nasional Universitas Kanjuruhan Malang. Malang, 2017.
- [6] Mullis, I. V. S., Martin, M. O., Foy, P. & Arora, A. TIMSS: 2011 *International Results in Mathematics*, USA: TIMSS & PIRLS International Study Center.
- [7] Saminanto & Kartono (2015). Analysis of Mathematical Connection Ability in Linear Equation With One Variable Based on Connectivity Theory. *International Journal of Education and Research*. 3 (4): <https://journal.unnes.ac.id/sju/index.php/ujme/article/view/13135>
- [8] Siregar, N. D & Surya, E. 2017. Analysis of Students' Junior High School Mathematics Connection Ability. *International Journal of Sciences: Basic and Applied Research (IJSBAR)*, 3(2), 309-320. https://www.researchgate.net/publication/318560987_Analysis_of_Students'_Junior_High_School_Mathematical_Connection_Ability
- [9] Sumarno, U. 2004. Kemandirian Belajar: Apa, Mengapa dan Bagaimana Dikembangkan Pada Peserta Didik. Makalah Lokakarya Kemandirian Belajar Mahasiswa. FPMIPA IPI. [Online]. Tersedia: <http://math.sps.upi.edu/?p=61>. (diunduh 09 Januari 2020).
- [10] Yuliani, R. Suhena, E & Noto. M. S. 2018. Pengaruh Model Missouri Mathematics Project Terhadap Kemampuan Koneksi Matematis dan Kemandirian Belajar Siswa SMP. *Jurnal Elemen*, 4(2), 131-144. <https://core.ac.uk/download/pdf/229259263.pdf>