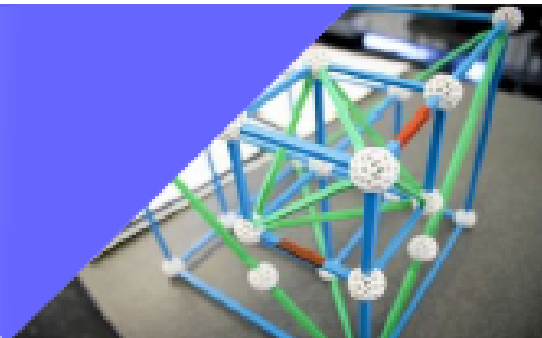


Proceeding



"Recent innovative issues and findings on
the development and the education of
mathematics and science"

2nd ICRIEMS

The 2nd International Conference on Research,
Implementation and Education of
Mathematics and Science

17 - 19 May 2015
Yogyakarta State University



ISBN 978-979-96880-8-8

Conference Proceedings

2nd INTERNATIONAL CONFERENCE ON RESEARCH,
IMPLEMENTATION AND EDUCATION OF
MATHEMATICS AND SCIENCE (2nd ICRIEMS)
Yogyakarta, 17 – 19 May 2015

ISBN 978-979-96880-8-8

Recent Innovative Issues and Findings
on The Development and The Education
of Mathematics and Science

Faculty of Mathematics and Science
Yogyakarta State University

2nd ICRIEMS : Recent Innovative Issues and Findings on The Development and The Education of Mathematics and Science

- Mathematics & Mathematics Education
- Physics & Physics Education
- Chemistry & Chemistry Education
- Biology & Biology Education
- Science Education

Published by:
Faculty of Mathematics and Science
Yogyakarta State University
Karangmalang, Yogyakarta 55281
Telp. (0274)550227, Fax. (0274)548203

© June 2015

Board of Reviewer

Prof. Dr. David Treagust (Curtin University)
Prof. Dr. Sopia binti Md Yassin (Universiti Pendidikan Sultan Idris)
Prof. Dr. Marsigit (Yogyakarta State University)
Prof. Dr. Mundilarto (Yogyakarta State University)
Prof. Dr. Sriatun (Yogyakarta State University)
Prof. Dr. A.K. Prodjosantoso (Yogyakarta State University)
Prof. Dr. IGP. Suryadarma (Yogyakarta State University)
Prof. Dr. Bambang Subali (Yogyakarta State University)
Dr. Ariswan (Yogyakarta State University)
Dr. Agus Maman Abadi (Yogyakarta State University)
Ouhao Chen (University of New South Wales)
Abdullah D. Dalee (Yala Rajabhat University)
Lilla Adulyasas (Yala Rajabhat University)

Preface

Bless upon God Almighty such that this proceeding of 2nd International Conference on Research, Implementation, and Education of Mathematics and Sciences (ICRIEMS) may be compiled according to the schedule provided by the organizing committee. All of the articles in this proceeding are obtained by selection process by the reviewer team and have already been presented in the conference on 17 – 19 May 2015 in the Faculty of Mathematics and Science, Yogyakarta State University. This proceeding comprises nine fields, these are mathematics, mathematics education, physics, physics education, chemistry, chemistry education, biology, biology education, and science education.

The theme of this 2nd ICRIEMS is '*Recent Innovative Issues and Findings on The Development and The Education of Mathematics and Science*'. The main articles in this conference are written by seven keynote speakers, which are Prof. David F. Treagust (Curtin University, Australia), Prof. Slava Kalyuga (University of New South Wales, Australia), Prof. Dr. Sopia binti Md Yassin (Universiti Pendidikan Sultan Idris, Malaysia), Susanne W. Brahmia, Ph.D. (Rutgers University, USA), Dr. Norjan Yusof (Universiti Pendidikan Sultan Idris, Malaysia), Prof. Dr. Supriadi Rustad, M.Si (Directorate General of Higher Education, Indonesia) and Prof. A.K. Prodjosantoso, Ph. D. (Yogyakarta State University, Indonesia). Besides the keynote speakers, there are also regular articles presenting the latest research results in the field of mathematics and sciences, and the education in the parallel sessions. These regular speakers are academics, researchers, teachers and practitioners from various places in Indonesia and abroad, including Australia, Malaysia and Thailand.

Hopefully, this proceeding may contribute in disseminating research results and studies in the field of Mathematics and Sciences and the Education such that they are accessible by many people and useful for the future development.

Yogyakarta, May 2015

The Editor Team

Forewords From The Head Of Committee

Assalamu'alaikum warrahmatullah wabarakatuh.
May peace and God's blessings be upon you all.

This conference entitled International Conference on Research, Implementation, and Education of Mathematics and Science (ICRIEMS) 2015 is organized by the Faculty of Mathematics and Science, State University of Yogyakarta. This is the second time that our Faculty is proudly holding an international conference, where this year's theme is "Recent innovative issues and findings on the development and the education of mathematics and sciences". This conference is also dedicated to the 51st anniversary of Yogyakarta State University.

This conference facilitates academics, researchers and teachers from two areas, mathematics and science which may be classified into physics, chemistry and biology. Innovative issues and findings are emerging from time to time, especially in the field of mathematics, science, and the education. It is through education that these developments may be understood and implemented. Hence, it is therefore necessary for us to follow come together and discuss these exciting recent developments of mathematics, science, and the education through this conference.

On behalf of the organizing committee of this conference, I would like to express my highest appreciation and gratitude to the keynote speakers from Australia, the USA, Malaysia and Indonesia. They and the keynote title are:

From educational field:

1. Prof. Slava Kalyuga (School of Education, University of New South Wales, Sydney, Australia), "Cognitive load issues in teaching and learning mathematics"
2. Prof. David Treagust (School of Science, Curtin University, Perth, Australia), "The development and use of diagnostic instruments for assessing students' chemistry knowledge and understanding"
3. Prof. Dr. Sophia binti Md Yassin (Department of Science Education, Universiti Pendidikan Sultan Idris, Malaysia), "Teaching Science And Mathematics In English (TeSME): The Malaysian CLIL Experience"
4. Suzanne W. Brahmia, Ph.D (Rutgers University, New Jersey, US), "Developing expert mathematization of physics in the introductory course: an impedance mismatch"
5. Prof. Dr. Supriadi Rustad (Directorate General of Higher Education, Department of Research, Technology and Higher Education), "Current reform and research in higher education in Indonesia"

From basic knowledge field:

1. Prof. AK. Prodjosantoso, Ph.D. (Department of Chemistry Education, Yogyakarta State University, Indonesia), "The chemistry of heavy metals immobilisation in Portland Cement"

2. Dr. Norjan Yusof (Department of Biology, Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris, Malaysia), “Pollution and management of landfill leachate”.

Furthermore, I would also like to express my appreciation to about 180 regular presenters who have travelled from Australia, China, Malaysia, Thailand, Sumatera, Kalimantan, Sulawesi, Papua, Bali and many places in Java and Yogyakarta to attend this conference. Slightly more than 30 per cent of the presenters are from mathematics education and around 20 per cent are from mathematics. About 16 per cent of the presenters deliver findings on chemistry and the education, and about 14 per cent on physics and the education. The other 20 per cent presents biology, biology education and general science education. We do hope this conference will bear fruitful results and promote networking and future collaborations for all participants from diverse background of expertise, institutions, and countries to promote science, mathematics, and the education.

Finally, I would like to extend my highest appreciation to the organizing committee who has been working very hardly since a half of a year ago to ensure the success of the conference. However, should you find any shortcomings and inconveniences, please accept my apologies.

Hope all participants have a very good moment during the conference and enjoy the city of Yogyakarta, the city of education, cultural and tourism. Thank you very much.

Wassalamu’alaikum warrahmatullah wabarakatuh. May peace and God’s blessings be upon you all.

Yogyakarta, 17 May 2015

Endah Retnowati, Ph.D.

**Forewords From The Dean Of Faculty Of Mathematics And Science,
Yogyakarta State University**

Assalamu'alaikum warahmatullahi wabarakatuh. My greetings for all of you. May peace and God's blessings be upon us all.

On behalf of the Organizing Committee, first of all allow me to extend my warmest greeting and welcome to the International Conference on Research, Implementation, and Education of Mathematics and Sciences, the second to be held by the Faculty of Mathematics and Science, State University of Yogyakarta, one of the excellent and qualified education universities in Indonesia. This conference is also celebrate the 51th Anniversary of State University of Yogyakarta.



This conference proudly presents keynote speeches by seven excellent academics, these are: Prof. Dr. Supriadi Rustad, Prof. Slava Kalyuga, Prof. A. K. Prodjosantoso, Dr. Norjan Yusof, Prof. Dr. Sopia Binti Md Yasin, Prof. David F. Treagust, and Dr. Suzanne W. Brahmia, and around 180 regular speakers.

The advancement of a nation will be achieved if education becomes a priority and firmly supported by the development of technology. Furthermore, the development of technology could be obtained if it is supported by the improvement of basic knowledge such as mathematics, physics, chemistry, and biology. The empowerment of this fundamental knowledge may be achieved by conducting research which is then implemented in developing the technology and the learning process in schools and universities.

This international conference is aimed to gather researchers, educators, policy makers, and practitioners to share their critical thinking and research outcomes. Moreover, through this conference it is expected that we keep updated with new knowledge upon recent innovative issues and findings on the development and the education of mathematics and science, which is in accord with the theme of the conference this year. All material of the conference which are compiled in the abstract book and proceedings can be useful for our reference in the near future.

This conference will be far from success and could not be accomplished without the support from various parties. So let me extend my deepest gratitude and highest appreciation to all committee members who have done an excellent job in organizing this conference. I would also like to thank each of the participants for attending our conference and bringing with you your expertise to our gathering. Should you find any inconveniences and shortcomings, please accept our sincere apologies.

To conclude, let me wish you fruitful discussion and a very pleasant stay in Yogyakarta.

Wa'alaikumsalam warahmatullahi wabarakatuh

Yogyakarta, 17 May 2015
Dean Faculty of Mathematics and Science
Yogyakarta State University

Dr. Hartono

Forewords From The Rector Of Yogyakarta State University

Assalamu'alaikum warrahmatullah wabarakatuh.
May peace and God's blessings be upon you all.

First of all, allow me to express my great thanks to God, Allah SWT, who gives us health and opportunity, so that we can join this very important conference, may Allah always bless us. It is a great honor and pleasure for me to welcome you all to the 2nd International Conference on Research, Implementation and Education of Mathematics and Science. Educational Research and Innovation (ICRIEMS) organized by the Faculty of Mathematics and Science, Yogyakarta State University in Yogyakarta, Indonesia. On behalf of the university and the committee, let me extend my warmest greetings and appreciation to all speakers and participants who have travelled hundreds or even thousands of miles by various transportation means to come to Yogyakarta to attend this conference.



It is indeed a privilege for Yogyakarta State University to have the opportunity to organise this very important conference in which educational researchers and practitioners on mathematics and science and the education, to get together to share ideas, experiences, expectations, and research findings. This conference is held as one of the activities, in the agenda of Yogyakarta State University to celebrate its 51st anniversary.

Research is one of the activities among the academic members of a university. It is a systematic effort to solve the problems or answer the questions by collecting data, formulating the generalities based on the data, then finding and developing organized knowledge by scientific method. It is expected that from research activities, valuable empirical facts can be obtained to improve and develop the theory and practice to bring a better quality of education.

Mathematics and science have been seen as important knowledge to be acquired by our children since it could assist them solving daily life problems. Efforts to improve the quality of teaching of mathematics and science must be continuously supported to produce new innovations, high-quality research and practice. In responding to this, the conference has taken a theme namely "Recent innovative issues and findings on the development and the education of mathematics and science". Participants, either speakers or non-speakers, in this conference are highly encouraged to discuss not only the recent findings of instructional theory or practice, but also new findings of basic knowledge of mathematics and science that may be useful to be applied in our life.

It is expected that this conference provides researchers, teachers, lecturers, education practitioners, college students, and policy makers the opportunity to share

their knowledge, experiences, and research findings which are innovative and relevant to develop the educational practices focusing on the process and product. Eventually, this conference is aimed to facilitate academics, researchers and teachers to yield some recommendations on the importance of education and development of mathematics and science based on empirical proofs which bring the benefits of the prosperity of all.

This international conference will not be what it is without the cooperation and support rendered by the whole committee whose names I will impossibly mention one by one. Therefore, I would like to take the opportunity to extend my highest appreciation and sincerest gratitude to especially the Dean of Faculty of Mathematics and Science. I would also like to thank the organizing committee for their commitment and hard work. Only with their support will this international conference certainly reach its declared objectives successfully. Yogyakarta State University has done its best to make this conference a big success. However, should you find any shortcomings and inconveniences, please accept my apologies.

To conclude, let me wish you all a productive conference and enjoyable stay here in Yogyakarta State University. Also I wish you all great success and this international conference will bring us fruitful benefits in education. Thank you very much. Wassalamu'alaikum warahmatullah wabarakatuh. May peace and God's blessings be upon you all.

Yogyakarta, 17 May 2015
Rector,

Prof. Dr. Rochmat Wahab, M.Pd., M.A.

Table of Content

	page
Front Cover	i
Board of Reviewers	ii
Preface	iii
Forewords From The Head of Committee	iv
Forewords From The Dean of Faculty	vi
Forewords From The Rector	viii
Table of Content	xi
Keynotes:	
01 The Development And Use Of Diagnostic Instruments For Assessing Students' Chemistry Knowledge And Understanding <i>David Treagust</i>	K-1
02 Towards Sustainable Biological Nitrogen Removal (BNR) Of Landfill Leachate In Malaysia <i>Norjan Yusof</i>	K-9
03 Cognitive Load Issues in Teaching And Learning Mathematics <i>Slava Kalyuga</i>	K-19
04 Teaching Science And Mathematics In English (TeSME): The Malaysian CLIL Experience <i>Sopia binti Md Yassin</i>	K-31
Regular Papers:	
MATHEMATICS	
01 Modification Of Crossover Operator On Ga Application For TSP <i>Darmawan Satyananda</i>	M-1
02 Stability Analysis And Optimal Control On The Model Harvesting Of Prey Predator With Fungsional Response Type III <i>Mohammad Rifa'i, Subchan, Setidjo Winarko</i>	M-11
03 Modeling Economic Growth Of Districts In The Province Of Bali Using Spatial Econometric Panel Data Model <i>Ni Ketut Tri Utami, Setiawan</i>	M-19

Suciati, Puspita, L; Azizi, A

SCIENCE EDUCATION

- 01 **Use of Computer Management Instruction For Development Standardized Test For Equivalency Quality Assessment As Determinants Of School Graduation In The National Exam System Fair** SE - 1
Dadan Rosana, Sukardiyono
- 02 **Curriculum Development For Natural Science Secondary School Through Integration Value Of Character Based On Contextual Teaching And Learning** SE - 11
Evi Suryawati
- 03 **An Evaluation Of A Micro Teaching Subject Of Physics Education Study Program To Meet The Inqf Of Grade VI At Yogyakarta State University** SE - 21
Febrina Siska Widyaningtyas, Zuhdan Kun Prasetyo
- 04 **Integration Of 21st Century Skills As Efforts To Develop “Jupe Ditata” Character Of Biotechnology Subject** SE – 29
Hasan Subekti
- 05 **Science Learning By Using Guided Inquiry Approach Through Experiment And Demonstration Method Viewed From Students’ Scientific Attitudes** SE – 39
Ika Candra Sayekti
- 06 **Developing Integrated Science, Character, And Literacy-Based Science Package Asscience Learning Model** SE – 47
Insih Wilujeng, Zuhdan Kun P., Senam
- 07 **Study Of Dissemination Junior High School Science Teacher At Hulu Sungai Selatan Regency And Their Skills To Use Learning Media** SE – 63
Intan Rahmadani, Sri Hartini, Mustika Wati, Chairil Faif Pasani
- 08 **The Comparison Between The Daily Lesson Plan of Indonesia and cores (Content Representation) as Lesson Plan model in Pedagogical Content Knowledge (PCK) To Develop Professional Science Teaching** SE – 67
Maryati dan Susilowati
- 09 **The Effectiveness of Thematic Learning To Improve Science Process Skills of Junior High School Students** SE - 75
Mundilarto

PE - 2

**THE DEVELOPING AN ASSESSMENT INSTRUMENT BASED ON BOARD
GAMES TO MEASURE PHYSICS LEARNING ACHIEVEMENT OF SENIOR
HIGH SCHOOL STUDENTS**

**Edi Istiyono, Rahayu Dwisiwi Sri Retnowati, Puspita Wulandari, and Akbar Dyah
Oktavilia**

*Physics Education Department, Mathematics and Natural Science Faculty,
Yogyakarta State University*

edi_istiyono@uny.ac.id, edi_istiyono_uny@yahoo.co.id

Abstract

This research aims to develop an instrument based on board games for measuring senior high school students' physics learning achievement (PhysIBoGame) and to obtain the characteristics of the PhysIBoGame. The instrument blue print has been developed based on the aspects and subaspect of cognitive domain, then it was used to develop the items. The PhysIBoGame consisting of 60 items were validated by physics educational measurement experts, physics educational experts, and practitioners. The validated instrument was tried out to 401 students of senior high schools in DIY. The polytomous data were analyzed according to the partial credit model (PCM). The results show that the 60 items of the PhysIBoGame were fit to the PCM and the PhysIBoGame was reliable. Therefore, the PhysIBoGame is qualified for the measurement of senior high school students' physics learning achievement.

Key words: Instrument development, board games, physics learning achievement, polytomous, and PCM

INTRODUCTION

Assessment defined as a process for obtaining information that is used for making decision about students; curricula, programs, and school; and educational policy (Nitko & Brookhart, 2011:3). Mardapi (2013:2) states that assessment is an activity of data calculation. So, assessment is a process of collecting student's information by calculating their learning achievement and then the data calculation will be concluded using a criteria to make diccision.

Assessment of physics learning achievement is a process of collecting the student's information in physics learning process by calculating of physics learning achievement, then the data of the physics learning calculation will be concluded using a criteria to make diccision about physics learning achievement of students. The result of the assessment of physics learning will be shown in qualitative characteristic, and will be used to distinguish the students' ability into three levels, namely: high, medium, or low.

Learning achievement is a paterns activity, assessments, understandings, actions, apreciations, abilities, and skills (Oemar, 2004: 31). In other word, learning achievement is an ability that can be owned by the students after the study (Jihad & Haris, 2008:15). Based on those statement can be concluded that learning achievement is student's skill after study process

in kinds of patterns activity, values, understandings, actions, apresiasion, abilities, and skills.

Assessment instrument is needed to measure physics learning achievement student's. One of technique to assess the student's physics learning achievement is objective test. Objective test items include: true-false, matching, multiple choise, and short answer.

There are two types of multiple choise test, conventional multiple choise test and reasoned multiple choise test. The reasoned multiple choise was developed by Edi Istiyono (Istiyono, Mardapi, & Suparno (2014:5). The reasoned multiple chiose test has characterictic which is scored for completing several steps in the solution process. The score of reasoned multiple choise are polytomous data with four categories, i.e. category 1, 2, 3, and 4. So, reasoned multiple choise scored with partial credit model (PCM).

Partial credit model (PCM) was developed for analyzing test items that require multiple steps as physics problems or math problems where partially correct answee possible (Embretson & Reise, 2000:105). The student must complete four steps in order to student's response in the highest category.

The result of observation indicate that assessment instrument to measure physics learning still formed paper and pencil test. So, variation, inovation, and creation are needed to develop an assessment instrument. The assessment instrument can be made more fun. Games in learning can make situation more fun, relax, however the situation of learning still condusif (John, 1988:110). The advantages of games in learning are making student get the benefit of cognitif and creative.

Based on the above discription, assessment instrument based on board game can be used as alternative assessment to measure physics learning achievement with reasoned multiple chiose. So that, It is needed to develop of assessment instrument based on board games (PhysIBoGa). Based on the desription in the future, the goal is: (1) to develop assessment instrument based on board games and (2) to obtain the characteristic of the PhysIBoGa.

RESEARCH METHOD

This research is the development research with quantitative approach. This instrument development research was done with the modified of the Wilson Model and Antonio Oriondo Model.

The stages of the development of the test are: (1) the design of the test, there are the determination of objective test, the determination of competency to be tested, the determination of the tested material, the preparation of test blue print, the writting of the items, the preparation the scoring guidlines, test validation, and repairing the items and assembling the test; (2) the test tryout, there are the establishment of try out subjects, the implementation of the try out and analyzing of try out data, and test assembling.

The subject that used in this research is senior high school student's X grade in DIY. The instrument was tried out on 401 students of : SMAN 5 Yogyakarta, SMAN 7 Yogyakarta, SMAN 1 Minggir, SMAN 1 Wates, SMAN 2 Wates, SMAN 1 Pengasih, SMAN 1 Lendah, and SMAN 2 Playen. Selection of school as research subject was based on National Examination ranking in 2014.

The polytomous data with four categories was analyzed using IRT according to Partial Credit Model (PCM) using Quest program. Analyzing question item was done to know the goodness of fit items using PCM, estimation of item difficulties index, and test reliability.

RESULT AND DISCUSSION

Result of The Test Developed

1. Design of The Test

The test design phase included: the determination of test, the determination of competency to be tested, the determination of the tested material, the preparation of test blue print, the writing of the test, the preparation the scoring guidelines, test validation, the repairing the items and assembling the test. The purpose of the test is to measure physics learning achievement of senior high school students. The competency of the test are based on competency 3.3 of 2013 curricula on grade X of senior high school. Base on competency 3.3 of 2013 curricula is analyzing physics quantities on straight line motion with constant velocity and straight line motion with constant acceleration. Material of the test is the motion along a straight line. Test blue print was made as guidelines of writing test. The instrument consisted of 60 items.

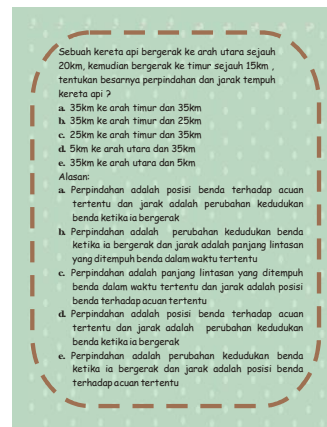
This research uses board game media. So that on design step, board game was design modified monopoly game and snake-ledder game. The modified monopoly game and snake-ledder game were used as assessment instrument based on board game. Design of monopoly board and snake-ledder board presented by Figure 1a and 1b.

a. Question Card

Question items was moved to question card design. Question card was design using Corel Draw X4.



(a)



(b)

Figure 1. a. Design of Monopoly Question Card
b. Design of Snake-ledder Question Card

b. Design of Board Games snake-ledder

The design of monopoly board and snake-ledder board was made with Corel Draw X4. The design of monopoly board and snake-ledder board was presented in Figure 2.



a
 b
 Figure 2. a. Design of Monopoly Board
 b. Design of Snake-ladder Board

c. The Equipment of Games

The equipment of monopoly game consists of a dice, tokens, pions, chance card. The equipment of snake-ladder game consists of a dice and tokens. Content validation of the instrument was carried out by experts judgement. The instrument was validated by measurement experts, physics education experts, and practitioners.

2. The Test Try Out

Goodness of fit and Reliability

Empiric data was obtained by the result of test goodness of fit analysis presented in Table 1. All of the items consisting 60 items and PhysIBoGa are fit according to PCM. Reliability of PhysIBoGame is 0.97. Therefore, PhysIBoGame is fit according to PCM (valid) and reliable

Table 1. Test Statistic Fit Parameter

No.	Test Parameter	Item estimation of monopoly game	Item estimation of snake-ladder game
1	Infit MNSQ	1.00 ± 0.02	1.00 ± 0.12

The difficulty index

The item's difficulty index were from -0.06 to 0.07. So that based on difficulty, all of 60 items were good. For more detail, please see diagram distribution of items according to difficulties index subsaspect of the instrument in Figure 3. Based on Figure 3, the order of item difficulty index of each aspect form lowest to highest is remember, understand, and apply.

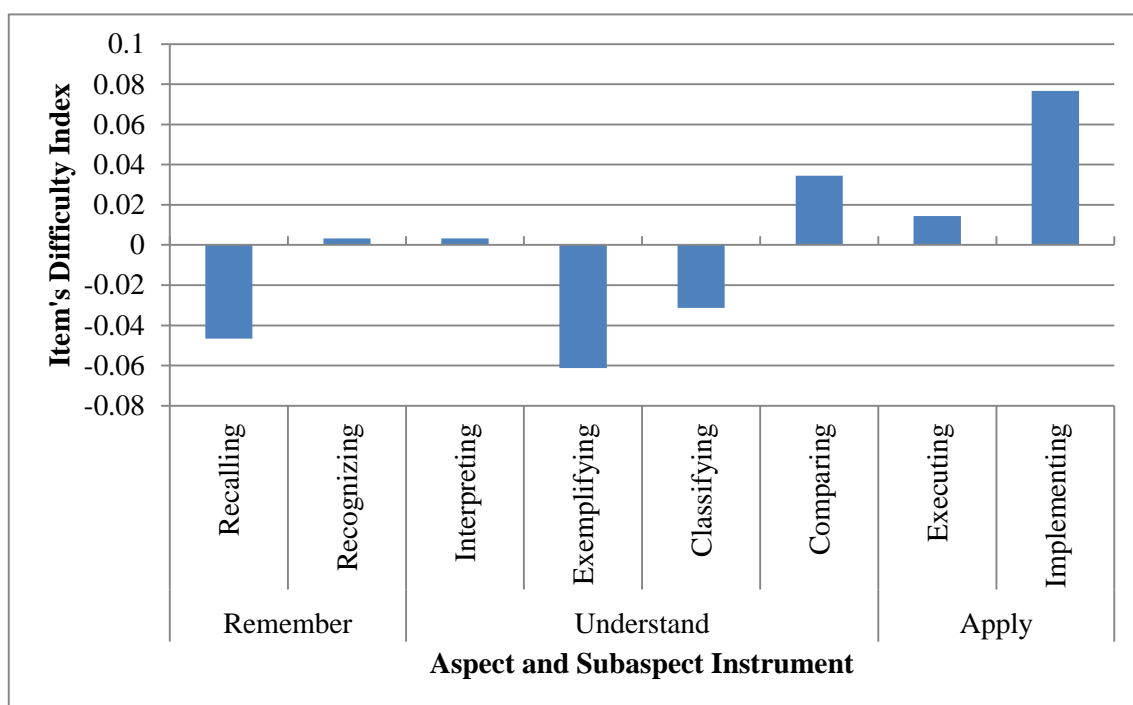


Figure 3. Item's Difficulty Index of Each Aspect and Subaspect Instrument

3. Test Assembling

The instrument was assembled become assessment instrument based on board games. The instrument is called PhysIBoGame.

DISCUSSION

PhysIBoGame's reliability estimation is 0,79 that means the test is qualified as good instrument.. Content validity of the test has been proved by expert judgement. Empirically verified the validity of goodness of fit of partial credit model (PCM). Based on the Table 1, items estimation of monopoly game has the average value and the standard deviation Infit MNSQ 1.00 (about 1) and 0.02 (about 0), then the fit test with 1 PL PCM. Item estimation of snake-ledder game has the average value and the standard deviation Infit MNSQ 1.00 (about 1) and 0.12 (about 0), then the fit test with 1 PL PCM. This is means that PhysIBoGame empirically valid. This is supported by Infit MNSQ of all the items from 0.97 to 1.03, between 0.77 and 1.33, means that all of items that consist 60 items are fit according to PCM. This is caused by several things, among others: (1) the items were developed according to procedure correct item development instruments, (2) the content validity test which consist of 60 items has been proven by expert judgement.

According to Hambleton & Swaminathan (1985:36), the item's difficulty index are good if they varied between 2.00 to 2.00. Based on Figure 3 item's difficulty index the instruments are good.

CONCLUSION AND SUGESSTION

Conclusion

Based on the analysis, the conclusions are as follows:

1. PhysIBoGame instrument was developed on senior high school student's to measure physics learning achievement on physics matter motion along a straight line.
2. Characteristic of PhysIBoGame are:
 - a. The PhysIBoGame consists of 60 items.
 - b. PhysIBoGame has content validity provided by experts judgment and empirical evidence has been getting fit with Partial Credit Model (PCM) based on polytomous data four categories.
 - c. PhysIBoGame is qualified instrument based on reliability estimation.

Sugesstion

Based on the analysis, it is recommended that teachers of senior high school can implement an assessment instrument based on board games.

REFERENCES

- Asep Jihad & A. Haris. (2008). *Evaluasi Pembelajaran*. Jakarta: Multi Press
- Bambang Subali & Pujiyati Suyata. (2011). *Panduan Analisis Data Pengukuran Pendidikan untuk Memperoleh Bukti Empirik Kesahihan Menggunakan Program Quest*. Yogyakarta: Lembaga Penelitian dan Pengabdian pada Masyarakat UNY
- Djemari Mardapi. (2013). *Penilaian Hasil Pembelajaran*. Bahan Pelatihan Penilaian Pembelajaran Dosen Fakultas Farmasi Universitas Airlangga.
- Edi Istiyono, Djemari Mardapi, & Suparno. (2014). Pengembangan Tes Kemampuan Berpikir Tingkat Tinggi Fisika (PysTHOTS) Peserta Didik SMA. *Jurnal Penelitian dan Evaluasi Pendidikan*. Tahun 18, Nomor 1, 2014 page. 1-12
- Embretson, S.E. & Reise, S.P. (2000). *Item Response Theory for Psychologists*. New Jersey: Lawrence Erlbaum Associates, Publishers
- Nitko, A.J & Brookhart, S.M. (2011). *Educational Assessment of Students* (6th ed). Boston: Pearson
- Oemar Hamalik. (2004). *Proses Belajar Mengajar*. Jakarta: Bumi Aksara
- Syaifuddin Azwar. (2014). *Penyusunan Skala Psikologi*. Yogyakarta: Pustaka Pelajar