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Development of an Ethno-Commognitive Based IEAC Learning Model to Improve TPACK of Prospective Mathematics Teachers

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Abstract: Development of an Ethno-Commognitive Based IEAC Learning Model to Improve TPACK of Prospective Mathematics Teachers. Objectives: Ethno-commognitive based IEAC learning model to improve the TPACK abilities of prospective mathematics teacher students. **Methods:** This type of research is development research. The development carried out in this research is a learning model consisting of a lesson plan, student worksheets, and ethno-commocognitive-based tests to improve the TPACK abilities of prospective teacher students in supporting independent learning. The development procedure used is the ADDIE model. Data analysis in this research is as follows: validation analysis, practicality analysis, and effectiveness analysis. **Findings:** Development of an ethno-commognitive based IEAC learning model to increase the TPACK of prospective mathematics teacher students to meet the criteria of valid, practical, and effective. **Conclusion:** Development of an ethno-commognitive based IEAC learning model to improve the TPACK abilities of prospective mathematics teacher students on number pattern material that meets the criteria of valid, practical and effective.

Keywords: IEAC learning model, ethno-commognitive, TPACK

Abstrak: Pengembangan Model Pembelajaran IEAC Berbasis Etno-Commognitive untuk Meningkatkan TPACK Mahasiswa Calon Guru. Tujuan: *Tujuan penelitian ini adalah mengembangkan model pembelajaran IEAC berbasis etno-commognitive untuk meningkatkan kemampuan TPACK mahasiswa calon guru matematika.* ***Metode:*** *Jenis penelitian ini adalah penelitian pengembangan. Pengembangan yang dilakukan dalam penelitian ini adalah model pembelajaran yang terdiri dari Rencana Pelaksanaan Pembelajaran, Lembar Kerja Peserta Didik, dan tes yang berbasis etno-commognitive untuk meningkatkan kemampuan TPACK mahasiswa calon guru. Prosedur pengembangan yang digunakan adalah model ADDIE. Analisis data pada penelitian ini adalah sebagai berikut analisis validasi, analisis kepraktisan, dan analisis efektivitas.* ***Temuan:*** *Pengembangan model pembelajaran IEAC berbasis etno-commognitive untuk meningkatkan TPACK mahasiswa calon guru matematika memenuhi kriteria valid, praktis dan efektif.* ***Kesimpulan:*** *Pengembangan model pembelajaran IEAC berbasis etno-commognitive untuk meningkatkan kemampuan TPACK mahasiswa calon guru matematika pada materi pola bilangan memenuhi kriteria valid, praktif, dan efektif.*

Kata kunci: *model pembelajaran IEAC, etno-commognitive, TPACK*

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INTRODUCTION

Professionalism is important for teachers in learning activities. Teachers as educators are required to be professional in carrying out their duties and obligations. In professionalism, teachers have at least four competencies which include pedagogical competence, personality competence, social competence, and professional competence. These competencies need to be improved to facilitate students learning. Professional teachers are teachers who master the four competencies and professionalism in facilitating their students to learn (Kirana, 2011). However, apart from these competency factors, there is another factor that is a challenge for teachers, namely the rapid rise of information technology. The low competence of teachers is one of the hot topics discussed regarding education problems in Indonesia (Lobo, 2021). This can also be seen from several studies that have been conducted previously, that 34.95% of elementary, middle, and high school educators lack technology mastery (Syukur, 2014). There are 54.2% of high school-level educators use whiteboards as learning media, 33.3% use PowerPoint applications, and 12.5% use interactive applications (Restiana & Pujiastuti, 2019). Therefore, the integration of knowledge about technology by teachers into learning needs to be carried out to increase their competence in facing technological advances, in this case, the ability referred to is Technological, Pedagogical, and Content Knowledge (TPACK).

TPACK is a theoretical framework that describes the components of effective technology integration in teaching and learning activities (Mishra & Koehler, 2006) (Schmidt et al., 2014). TPACK is a framework that introduces the relationships and complexities between the three basic components of knowledge (technology, pedagogy, and content) (Koehler et al., 2007) ; (Niess, 2011) ; (Brantley-Dias & Ertmer, 2013) ; (Graham, 2011). TPACK knowledge must be prepared from an early age to form teachers who are professional in carrying out their duties. Therefore, before becoming actual teachers, prospective teacher students must be equipped with TPACK knowledge through microteaching.

Microteaching is a course that can be used as a training forum for prospective teachers to apply the knowledge they have learned (Aminah, 2014). Microteaching is a means to train teaching practices in the classroom for student teachers in a small scheme to prepare students before carrying out real teaching practices in schools which aims to develop and improve student professionalism (Nurmasyitah, 2021). Microteaching is expected to equip educators with several basic skills for teaching and learning (Turmuzi & Kurniawan, 2021). Microteaching can be expected to be a means of developing the technological, pedagogical, and content knowledge (TPACK) abilities of prospective teacher students to prepare themselves to become professional teachers.

One of the learning model designs for improving TPACK capabilities is the IEAC Learning Model. This ethno-commognitive based IEAC Learning Model is a learning model from the acronym Identification, Exploration, Application, Communication. Several learning steps are integrated with the culture around us to make it easier for students to develop lesson plans and implement them. Besides that, there is an integration of cognitive components in the learning model which consists of word use, visual mediator, routine, and narrative.

Ethno-commognitive based IEAC learning model to improve the TPACK abilities of prospective teacher students in supporting independent learning. The feasibility study in research is the need for a development model to improve the TPACK abilities of prospective teacher students in developing their competencies. The increasing competency of prospective teachers will be in line with improving

the quality of students learning. This research is also in line with the LPPM Madura University research strategic plan regarding the development of independent learning-based teaching materials to provide quality learning products.

Technological Pedagogical and Content Knowledge (TPACK)

TPACK is knowledge contained in a framework where this knowledge is needed to integrate technology in learning effectively by teachers (Mishra & Koehler, 2006) ; (Graham, 2011) as in Figure 1. TPACK knowledge is pedagogical knowledge (PK) knowledge about learning management, content knowledge (CK) knowledge about the material being taught, technological knowledge (TK) knowledge about the use of technology in learning, as well as knowledge to integrate from these three knowledge. Furthermore, knowledge of TK, PK, CK, and the relationship between the three knowledge, namely Technological Pedagogical Knowledge (TPK) knowledge of how to use, skills in operating technology to achieve goals and solve problems, Technological Content Knowledge (TCK) knowledge of the learning process as a result from the use of technology in learning, and Pedagogical Content Knowledge (PCK), knowledge of integrating material with pedagogy to develop the learning process.

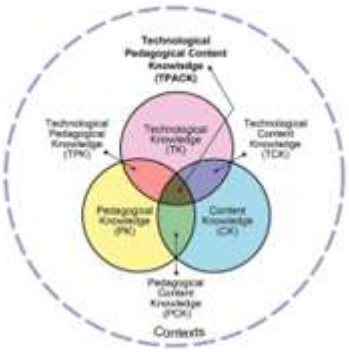

Figure 1. TPACK components

In the industrial era 4.0, prospective mathematics teachers do not only master the material, or have the ability to manage learning, but require special skills in using technology to support the learning activities carried out. The use of ICT technology in mathematics learning can increase learning efficiency and students' ability to understand basic concepts (Restiana & Pujiastuti, 2019) ; (Indrawati, 2021). The use of technology integration in learning has an influence on what is taught and when learning material appears in a curriculum (NCTM, 2000) ; (Keser et al., 2015) ; (Abbitt, 2011) ; (Kent & Giles, 2017). Using technology in learning, prospective teachers must understand the elements and implications of using technology related to content, pedagogies, and technology itself (Niess, 2011).

The use of technology has an impact on students' proximity to technology in life, teachers should be able to utilize technology in learning (Sintawati & Indriani, 2019). Therefore, today's prospective teachers are required to prepare themselves to face challenges in the digital era to become professional teachers with TPACK knowledge. TPACK in this research is knowledge contained in a framework where this knowledge is needed to integrate technology in learning which consists of content knowledge, pedagogy, technology, technological pedagogical knowledge, technological content knowledge, pedagogical content knowledge, and integration.

Microteaching

Microteaching learning is still widely carried out by several universities in Indonesia to provide experience and knowledge in the teaching process for prospective student teachers. Microteaching learning is a recorded and practical implementation system that applies during the teaching process (Tantu & Christi, 2020). In addition, micro education is believed to consist

of controlled elements, microteaching prepares prospective teachers for teaching practice and the teaching profession (Musyafa & Syefrinando, 2021) ; (Ambarawati, 2016). Microteaching is a cycle where prospective teachers plan lessons that focus on certain subjects and present the lesson in 10-15 to 10-15 minutes with classmates and the instructor and recorded on video (Bilen, 2015). In this research, microteaching in question is a system that controls all forms of teaching carried out by prospective student teachers with students as friends and lecturers as mentors. Microteaching is expected to prepare prospective teachers to carry out actual teaching.

Microteaching learning is expected to help student teachers in providing experience as real teachers in the classroom so that they can adapt to teaching. Microteaching is considered to provide a transition period to prepare the environment for classroom learning (Kilic, 2010). Mirco learning can provide benefits in solving problems related to preparing, presenting, and applying lessons (Remesh, 2013) ; (Mahmud, 2013). However, there are problems in implementing microteaching, the problem is the lack of ability to formulate lesson plans, which makes teaching practice in the classroom difficult. Therefore, it is necessary to prepare, design, and implement lesson plans for student teachers.

Ethno-Commognitive Based IEAC Learning Model

The learning design approach has provided a new perspective for the design and implementation of learning environments (Zhang et al., 2018), which is in line with changing times. There are various strategies, approaches, methods, frameworks, and models for developing teaching (Sfard, 2007). This ethno-commognitive based IEAC **Learning** Model is a learning model from the acronym **Identification**, **Exploration**, **Application**, **Communication**. Several learning syntaxes are integrated with the culture around us to make it easier for students to develop lesson plans and implement them. Besides that, there is an integration of cognitive components in the learning model which consists of word use, visual mediator, routine, and narrative. Commoginitve is a framework that combines thinking and communication (Zayyadi, et al, 2022) ; (Zayyadi et al., 2019) ; (Zayyadi et al., 2020). The ethno-commognitive based IEAC learning model was created specifically to increase TPACK knowledge and learning can be applied offline and online. Besides that, the IEAC learning model is supported by ICT technology so that it can be implemented in independent learning programs.

METHODS

This type of research is development research. The development carried out in this research is a learning model consisting of a lesson plan, student worksheets, and ethno-commognitive based learning media to improve the TPACK abilities of prospective teacher students in supporting independent learning.

Participants

The subjects in this research were mathematics education students at the University of Madura (potential teachers) who were taking microteaching courses. The selection of these subjects was carried out randomly to improve students' TPACK abilities. The subject of this research is a student who has a learning plan that uses an ethno-commognitive based learning model.

Research Design and Procedures

The development procedure used is the ADDIE model. The ADDIE model is an acronym for Analysis, Design, Development, Implementation, and Evaluation as in Figure 4. The reason for using this model is that it is very easy to suit current conditions. The ADDIE model can adapt very well to various current

conditions (Dickson & Hargie, 2006) ; (Molenda, 2007). Besides that, there are revisions at each stage, so that it is suitable for valid, practical, and effective development (Ngussa, 2014). The research was carried out within a period of 6 months from the initial stage to the final stage

The stages of this model are Analyze, namely analyzing objectives and competencies, characteristics of learners and analyzing instruction; Design, namely compiling the content framework, learning materials, compiling instruments and systematic achievements; Development, namely compiling a conceptual framework, characterization of model prototypes and teaching materials, validation of material models; Implementation; Evaluation, namely evaluating the achievement and feasibility of model development. The implementation and evaluation stages were not carried out in this research, because this research was only limited to producing a learning model that was based on valid, practical, and effective learning tools.

Analyze stage, at this stage, the aim is to analyze the learning objectives to be achieved and what competencies to be achieved from the planning carried out. Besides that, at this stage, we analyze the characteristics of students to make adjustments to the needs that have been planned. Next, at this stage analyze learning in general.

Design Stage, at this stage the aim is to plan or design the content framework, and learning materials, compose instruments, and achieve learning objectives. Preparation of content framework and learning materials based on ethno-commognitive based IAEC learning. This ethno-commognitive based IEAC Learning Model is a learning model from the acronym Identification, Exploration, Application, Communication. Several learning syntaxes are integrated with local culture and cognitive components.

Development Stages, at this stage namely preparing a conceptual framework, characterization of model prototypes, teaching materials, and validation of material models. This stage aims to produce a draft mathematics learning tool that has been revised based on expert input, readability tests, and data obtained from trial results. the final stage is implementation stages and evaluation stages. The following are the TPACK indicators used in this research in the table 1.

Table 1. TPACK indicators

No	TPACK components	Indicator	Learning Steps
1	Pedagogical Knowledge	Knowledge of classroom management	• Prepare learning devices
			• Carrying out apperception in learning
		Knowledge of teaching methods	• Using ICT-based media and learning resources that are relevant to the characteristics of students to achieve learning goals
		Knowledge of classroom assessment	• Understand Core Competencies and Basic Competencies and develop Indicators according to Basic Competencies in Mathematics Subjects
			• Develop instruments according to the indicators prepared in the lesson plan
			• Setting learning objectives and learning

		Structure	processes, learning planning and evaluation
		Adaptivity	• Group students heterogeneously and give praise to students
2	Content Knowledge	Content Knowledge	• Understand facts, concepts, principles and procedures in presenting material
			• Express definitions correctly, use notation appropriately, interpret and use graphic representations and step between connections carefully
3	Technological Knowledge	Technological Content Knowledge	• Determining and using technology in developing teaching materials,
		Technological Pedagogical Knowledge	• Utilizing technology in the learning process

Data Collection and Instrument

The data collection techniques in this research are as follows: Observations are carried out to collect data about prospective students' TPACK during teaching and learning activities. Observations were carried out by 2 people using observation sheets. Acting as observers were students and lecturers from the FKIP Madura University mathematics education study program. Interview, this interview is used to confirm the results carried out during the observation. The instrument for this interview uses a semi-structured interview guide. Test, the test used in this research is a test measuring the TPACK abilities of prospective teacher students both in the experimental class (IEAC class) and the control class using ordinary learning. This test uses a multiple-choice type with a pretest and posttest.

Data Analysis

The data analysis in this research is as follows: validation analysis of learning tools. This validity test was obtained from the validation results of lesson plan, student worksheets, test questions by validators (Putri et al., 2014). The validators in this research were 2 lecturers who were qualified in the field of mathematics education and learning. Analysis of the practicality of learning tools. The aspects that are assessed by the validator are aspects of format and completeness of components, material and learning aspects and linguistic aspects. The product being developed (student worksheets, lesson plans, test questions) is said to be practical if experts state that the product can be used in the field with little/no revision (Wicaksono et al., 2014). Analysis of the effectiveness of the learning model was carried out using data from student teacher test results. The value data obtained was then analyzed by calculating n-gain to determine the increase in student TAPCK, which was then used for hypothesis testing.

$$N\ Gain = \frac{Skor\ Posttest - Skor\ Pretest}{Skor\ Ideal - Skor\ Pretest}$$

Normalized gain score	Interpretation
$g > 0.7$	High
$0.3 < g \leq 0.7$	Moderate
$g \leq 0.3$	Low

Figure 2. N-Gain and criterion tests

RESULTS AND DISCUSSION

Analysis

The purpose of this Analysis activity is to analyze learning objectives and learning competencies. The learning objectives are formulated as follows; 1) Students can determine and identify the meaning and relationship between number pattern terms (Literacy). 2) By analyzing images, students can determine the form of number patterns to solve real problems and discover new problems (Numeration). 3) By providing student worksheets, students can complete solutions to contextual problems related to number sequence patterns (Numeration). The basic competency to be achieved in this learning is to generalize patterns in number sequences and object configuration sequences and solve problems related to patterns in number sequences and object configuration sequences.

Design

The aim at this stage is to plan or design the content framework, and learning materials, compose instruments, and achieve learning objectives. Preparation of content framework and learning materials based on ethno-commognitive based IAEC learning. In this research, the learning tools designed include lesson plan, student worksheets (LKPD), and ethno-cognitive based learning formats.

The Lesson Plan is designed with a learning model from the acronym Identification, Exploration, Application, and Communication. This learning development model is derived from the scientific approach, namely observing, asking, collecting data, associating, communicating. Observing, asking questions, collecting data activities are integrated into identification, associating activities are integrated into exploration, and communicating activities into communication. Besides that, there are additional applications before the communication stage Several learning syntaxes are integrated with local culture and commognitive components. lesson plan which contains the identity of the lesson plan, basic competencies, learning objectives, learning media and models, learning steps, and assessment. The lesson plan identity consists of school name, class, semester, material, and time allocation. one of the ethno integrations used in the lesson plan is as in the following figure 1.

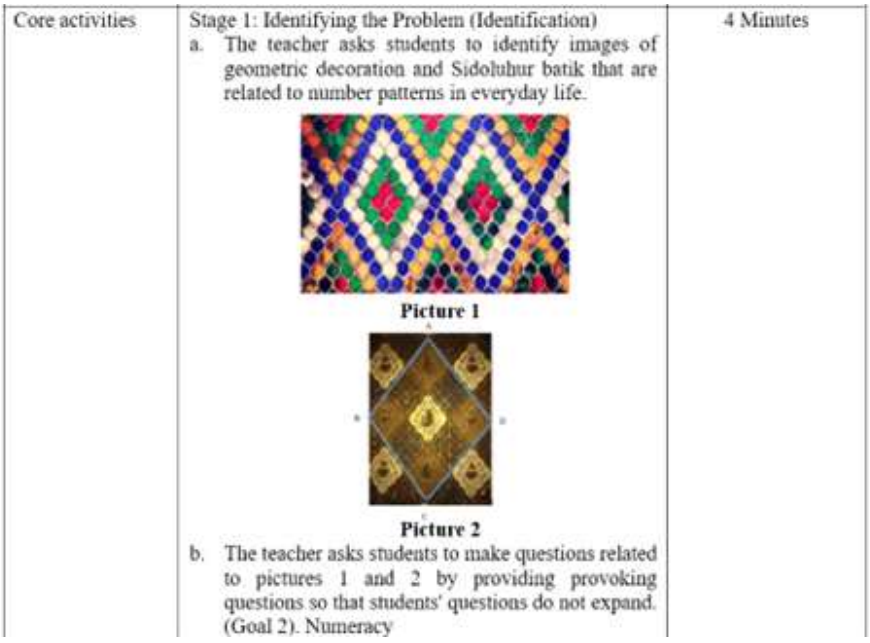

Figure 2. Ethno integration used in the lesson plan

Student Worksheets (LKPD) are designed with number pattern material. There are 3 problems given in the LKPD with each problem having a local Madurese culture (ethno) theme. In problem 1 the theme taken was Pamekasan written batik, in problem 2 the theme was Madurese sonok cattle, and problem 3 was the theme of Sidoluhur Batik which comes from Java (Oktafianti, dkk, 2019). This is in accordance with the use of student worksheets using Madurese culture which can improve students' thinking abilities (Subakti, et al, 2021). This LKPD will have to be done individually followed by group discussion.

Preparation of formative tests to find out students' understanding of the material provided. Before carrying out the formative test, students are given teaching materials to support students' understanding.

Development

This stage namely preparing a conceptual framework, characterization of learning model prototypes, and validation of material models. The results of the conceptual framework of the IEAC model based on local culture and cognitive components are in the following table.

Table 1. Conceptual framework of the ieac model based on local culture and commognitive components

The IEAC Model steps are based on local culture and commognitive components	Activity Description
Identification: Identifying the Problem	a. The teacher asks students to identify culturally oriented (ethno) images related to number patterns in everyday life. (Word Use, Visual Mediator) b. The teacher asks the students to make questions related to the picture by providing trigger questions so that the student's questions do not expand (Word Use, Visual Mediator, Routine)
Exploration: Exploring	a. Students plan possible forms of answers to the questions they have created by reading the material and example questions in the teaching materials. b. Students create new number patterns based on number pattern rules that they find themselves based on the problems they find.
Application: Application	a. The teacher distributes the LKPD that has been designed b. Students work on questions on the LKPD
Communication: Communicating	a. Students present LKPD and group discussions. b. The teacher and students conclude the concept of number patterns from the results of image analysis and answers to questions on the LKPD. (Word Use, Visual Mediator, Routine, Narrative) c. Formulate principles and generalize the findings,

including by concluding. How to complete solutions to contextual problems related to number patterns (Word Use, Visual Mediator, Routine, Narrative).

d. Teachers together with students identify the advantages and disadvantages of learning activities by identifying difficulties experienced by students and answering questions with information obtained by showing what is written in the book. (Word Use, Visual Mediator, Routine, Narrative).

Validation of IEAC model tools and teaching materials. This stage aims to produce a draft mathematics learning tool that has been revised based on expert input, readability tests, and data obtained from trial results. Lesson Plan The results of the development of the Lesson Plan that have been prepared have an average total validity value of 4.5. This shows that the lesson plan is valid by fulfilling the "Valid" category. This is in accordance with the lesson plan which is valid by fulfilling the "Valid" category (Kurniati, 2013) Based on the assessments of the two validators, it can be concluded that this lesson plan is in the "Good" category and can be used with minor revisions.

Table 2. Validation of learning implementation plan

Before Revision	After Revision
Activity: Introduction Activity Description: • Prepare students psychologically and physically to take part in learning (checking students' attendance and completeness of their learning, creating a pleasant atmosphere for learning by asking students how they feel and providing energy to raise students' enthusiasm for learning). • The teacher greets and greets the students. • Before starting the lesson, students and teachers pray. • Motivate students to learn contextually according to the benefits and applications of teaching materials in everyday life. • The teacher carries out apperception, namely linking number pattern material with previous material through questions and answers related to students' experiences. (Objective 1). Literacy • The teacher conveys the learning objectives that must be achieved in the learning process. • The teacher conveys the scope of the material and a brief description of the activities (learning and assessment process) Time Allocation: 5 minutes	Activity: Introduction Activity Description: • The teacher greets and greets the students. • Before starting the lesson, students and teachers pray. • Prepare students psychologically and physically to take part in learning (checking students' attendance and completeness of their learning, creating a pleasant atmosphere for learning by asking students how they feel and providing energy to raise students' enthusiasm for learning). • Motivate students to learn contextually according to the benefits and applications of teaching materials in everyday life. • The teacher carries out apperception, namely linking number pattern material with previous material through questions and answers related to students' experiences. (Objective 1). Literacy • The teacher conveys the learning objectives that must be achieved in the learning process. • The teacher conveys the scope of the material and a brief description of the activities (learning and assessment process) Time Allocation: 5 minutes
Stage 4: Communicating (Communication) g. Students present LKPD and group discussions (Objective 3). Numeracy. h. The teacher and students conclude the concept of number patterns from the results of image analysis and answers to questions on the LKPD. i. Formulate principles and generalize the findings, including by making conclusions: How to solve contextual problems related to number patterns. j. Teachers together with students identify the advantages and disadvantages of learning activities by identifying difficulties experienced by students, answering questions with information obtained by showing what is written in the book	Stage 4: Communicating (Communication) g. Students present LKPD and group discussions. h. The teacher and students conclude the concept of number patterns from the results of image analysis and answers to questions on the LKPD. (Word Use, Visual Mediator, Routine, Narrative) i. Formulate principles and generalize the findings, including by drawing conclusions. How to complete solutions to contextual problems related to number patterns (Word Use, Visual Mediator, Routine, Narrative). j. Teachers together with students identify the advantages and disadvantages of learning activities by identifying difficulties experienced by students, answering questions with information obtained by showing what is written in the book. (Word Use, Visual Mediator, Routine, Narrative).

Table 3. Validation of LKPD

Before Revision	After Revision
Masalah 1: Perhatikan gambar Berikut ini:  Salah satu batik tulis yang sangat terkenal adalah batik tulis pamekasan, P. Madura dengan motif unik dan melegenda. Warna klasik batik ini telah menjadi tren warna batik tulis pamekasan yang sangat melegenda. Dari gambar tersebut diketahui baris pertama motif zig-zag berwarna coklat, baris kedua berwarna coklat susu, baris ketiga berwarna ungu, baris keempat berwarna abu-abu. Pola warna tersebut akan berulang secara teratur. • Jika pak Rifanda membuat motif zig-zag tersebut sebanyak 32 baris, pada baris keberapa sajakah motif zig-zag berwarna coklat susu akan muncul? • Dengan pola yang anda ketahui, warna apakah yang muncul pada baris ke 44? Jelaskan strategi anda!	Problem 1: Look at the following image:  One of the most famous written batiks is Pamekasan batik, Madura with unique and legendary motifs. This classic batik color has become a legendary Pamekasan batik color trend. From this picture, it is known that the first row of zig-zag motifs is brown, the second row is milk chocolate, the third row is purple, the fourth row is gray. The color pattern will repeat regularly. a. If Mr. Rifanda makes 32 rows of the zig-zag motif, in how many rows will the milk chocolate colored zig-zag motif appear? b. Given the pattern you know, what color appears in row 44? Explain your strategy!
Problem 3: Look at the following image:  The batik image on the side is an image of Sidoluhur batik which comes from Java. The sidoluhur batik motif has a noble meaning. For Javanese people, life is about seeking material and non-material excellence. Material nobility means that you can fulfill all your physical needs by working hard in your profession according to your position, rank, degree, etc. From the sidoluhur batik picture, make as many number patterns as possible and explain the solution strategy! The three problems above are problems related to number patterns. Based on your observations, what can you conclude from the number patterns? Based on the conclusions you have made, give 3 examples of number patterns!	Problem 3: Look at the following image:  The batik image on the side is a batik image Sidoluhur comes from Java. Batik motif Sidoluhur has the meaning of nobility. For Javanese people live to search material and non-material nobility. Nobility material means that all needs can be met physically by working hard according to position, rank, degree, etc. From the picture Sidoluhur batik make a number pattern as much as possible and explain the strategy the solution! The three problems above are problems related to number patterns. Based on your observations, what can you conclude from the number patterns? Based on the conclusions you have made, give 3 examples of number patterns!

Formative Test

Formative tests in this development have an average total validity of 4.39. This shows that the test questions are valid in the "valid" category. Besides that, the assessment of the language and writing components of THB was understood in the "understandable" category. This shows that test questions with an average of 4.39 can be said to be valid (Aini & Irawati, 2019). Besides that, the assessment of the language and writing components of the test is understood in the "understandable" category (Aini, et al, 2023). However, validator I made suggestions to improve the placement and order of the sentences in the questions.

Results of Practicality Analysis of Learning Tools

Analysis also aims to find out whether the learning tools developed can be implemented in the field based on the validator's assessment. The learning tools developed can be implemented in the field based on validator assessments (Setiawan, 2020). The results of the practicality assessment of the learning tools developed include the Lesson Plan, Student Worksheets (LKPD), and Formative Tests.

The results of assessing the practicality of the Lesson Plan, Student Worksheets (LKPD), and Formative Tests based on the validator's assessment are as follows:

Table 4 . Results of practicality analysis of learning tools

Learning Media	Validator	Information
lesson Plan	1	Can be used with minor revisions
	2	Can be used without revision
LKPD	1	Can be used with minor revisions
	2	Can be used without revision
Formative Test	1	Can be used with minor revisions
	2	Can be used without revision

Based on Table 4 above, it can be concluded that overall the validator's assessment of the Lesson Plan, Student Worksheets (LKPD), and Formative Tests states that they can be used with little or no revision so that the learning tools can be said to be "practical".

Implementation and Evaluation

Testing at this implementation stage is to analyze students' Technological Pedagogical Content Knowledge (TPACK) abilities in carrying out learning. This analysis uses tests during microteaching learning. The test used in this research is a test measuring the TPACK abilities of prospective teacher students in both the experimental class (IAEC class) and the control class (ordinary learning). Then, analyzed using the N-Gain Score Test, following are the results of the analysis.

Based on the results of the N-Gain Score test calculation, it shows that the average N-gain Score value for the IEAC Learning Model is 82.05% and is included in the effective category. With a minimum N-Gain Score value of 76% and a maximum of 88%. Therefore, it can be concluded that the use of the IEAC learning model is effective in improving the TPACK abilities of prospective teacher students.

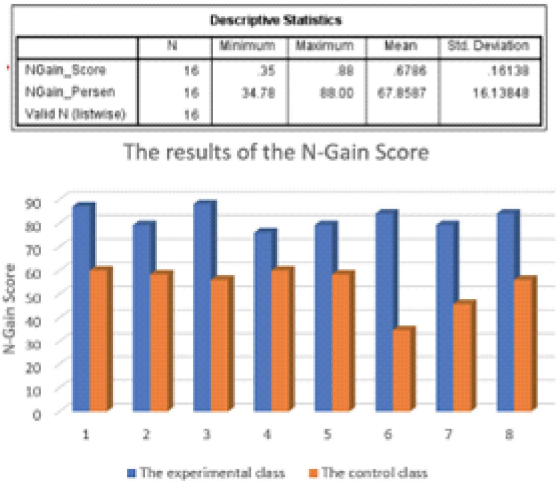

Figure 3. The results of the analysis of the effectiveness of the IEAC learning model

Based on the results of this analysis, students know about learning management from preliminary, core, and closing activities. Students also know the material being taught, namely number patterns and it is taught in a straightforward and detailed manner. Beside that, students know the use of technology which is used as a support in implementing learning. This is in

accordance with knowledge about the use of technology which is used as a support in the implementation of learning by students (Beckman, et al, 2014; Sari, et al, 2022). It can be said that there is an increase in students' TPACK knowledge in the learning carried out.

In general, it can be concluded that the development of the ethno-comcognitive based IEAC learning model to improve the TPACK of prospective mathematics teacher students meets the criteria of valid, practical, and effective. This is in accordance with the use of the project-based scaffolding tpack model to improve learning design ability and TPACK of pre-service science teachers (Dewi, et al, 2022).

CONCLUSIONS

Based on the results and discussion above, the research produced learning tools consisting of a Lesson Plan, Student Worksheets (LKPD), and Formative Tests. The resulting learning tools are ethno-cognitive based to improve the TPACK abilities of prospective teacher students. Development of an ethno-cognitive based IEAC learning model to improve the TPACK abilities of prospective mathematics teacher students on number pattern material that meets the criteria of valid, practical, and effective. It is hoped that this research will be implemented by a wider range of prospective teacher students by using the ethno-commognitive based IEAC learning model in improving TPACK abilities.

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