

## EXPLORING STUDENT MATHEMATICAL ENGAGEMENT USING ADAPTED WATSON' ANALYTICAL TOOL: A QUALITATIVE APPROACH

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**Abstract:** This research was conducted with the aim of describing the engagement of junior high school students in the mathematics learning process measured using an adapted Watson analytical tool. This research is a qualitative study that analyzes video transcripts of a junior high school teacher in West Nusa Tenggara who are carrying out mathematical teaching on probability. In this study, the teacher carried out mathematics teaching designed by researchers using the ELPSA (Experience, Language, Pictorial, Symbolic, and Application) framework. The learning process was recorded through a video and then transcribed so that it is easily analyzed. The results showed that the dimensions of student mathematical engagement that emerged during the mathematics learning process were dominated by activities comparing/classifying and justifying/reasoning. These results also have a positive impact that by using the adapted of Watson analytical tool to analyze the learning process of mathematics can help teachers to gain deeper insight into students' mathematical engagement. This technique can be used as a reference by the teacher to further analyze so that better teaching actions can be planned.

**Keywords:** *mathematical engagement, adapted Watson's analytical tool, probability*

### EKSPLORASI KETERLIBATAN MATEMATIKA SISWA MENGGUNAKAN ADAPTASI ALAT ANALISIS WATSON: SUATU PENDEKATAN KUALITATIF

**Abstrak:** Penelitian ini dilakukan dengan tujuan untuk mendeskripsikan keterlibatan siswa SMP dalam proses belajar matematika yang diukur menggunakan adaptasi alat analisis Watson. Penelitian ini merupakan penelitian kualitatif yang menganalisis transkrip video seorang guru SMP di Nusa Tenggara Barat yang sedang melaksanakan pengajaran matematika mengenai probabilitas. Dalam penelitian ini, guru melaksanakan pengajaran matematika yang telah dirancang oleh peneliti menggunakan kerangka kerja ELPSA (*Experience, Language, Pictorial, Symbolic, dan Application*). Proses pembelajaran direkam melalui suatu video kemudian ditranskripsi sehingga mudah dianalisis. Hasil penelitian menunjukkan bahwa dimensi keterlibatan siswa secara matematika yang muncul selama proses pembelajaran matematika didominasi oleh aktivitas membandingkan/mengklasifikasikan dan membuat justifikasi/penalaran. Hasil ini juga memberikan dampak positif bahwa dengan menggunakan adaptasi dari alat analisis Watson untuk menganalisis proses pembelajaran matematika dapat membantu guru untuk mendapatkan wawasan yang lebih dalam tentang keterlibatan matematika siswa. Teknik ini dapat dijadikan salah satu rujukan oleh guru untuk menganalisis lebih lanjut sehingga dapat direncanakan tindakan pengajaran yang lebih baik.

**Kata Kunci:** *keterlibatan matematika, adaptasi alat analisis Watson, peluang*

#### INTRODUCTION

When we see students getting busy on a math task or make a conversation

with the teacher, sometimes we are curious "are they talking mathematics meaningfully?", "do they learn

something?" or they just do it for getting the task done. Overall, we basically ask about students' engagement in learning. Engagement is important primarily because of its relationship with the academic achievement of learners (Reyes, Brackett, Rivers, White, & Salovey, 2012; Dharmayana, Kumara, & Wirawan, 2012; Peterson & Fennema, 1985), students' level of confidence (Barkatsas, Kasimatis, & Gialamas, 2009), and student performance and attendance (Kanthan, 2011). Engagement also greatly influences the quality of education (Hu, Ching, & Chao, 2012).

Student engagement is shown by the active role of students in participating in learning activities held by teachers in the classroom (Chapman, 2003). Student engagement also demonstrated through active and collaborative learning, high student participation and communication (Coates, 2007). In mathematics, student engagement can be observed from the student's ability to identify the characteristics of mathematical objects, find patterns of the sequence of numbers, explain the reasons for the steps in solving the mathematical problem (Watson, 2007), identify the relationship and make the generalization of a role. If students are engaged in a process of learning mathematics, they will show respect for each process carried out while studying mathematics and very interested in mathematics, so they will be able to see the relationship between the mathematics they learn in school and the mathematics they use using in outside of school (Attard, 2012).

Many research on engagement is found in education literature. Some provide a narrow view that relates only to behavior and participation. Others provide a deeper understanding that is multi-dimensional (Attard, 2015). According to Kong, Wong, & Lam (2003), there are three dimensions related to engagement; behavioral, emotional/affective and cognitive. Behavioral engagement is about

the active participation in learning activities, emotional engagement is the students' attitudes (e.g. perceived value, interest in) towards the activities, and cognitive engagement can be seen as the 'psychological investment'. These three dimensions are used as a base to analyze the student's engagement through classroom observation and the follow-up interview with students. The focus of the follow-up interviews was the students' perceived classroom learning, and how they were involved in the learning of mathematics and the interviews were conducted individually. They used some indicators for their instruments, there are (1) answering the teacher's questions, (2) asking the teacher questions, (3) listening to the teacher's exposition, (4) reading textbooks, (5) discussing with classmates, (6) doing exercises, (7) doing other tasks assigned by the teacher, (8) irrelevant behavior (e.g., gazing out the window), and (9) others (e.g., preparing for the start of the lesson). On the other research, Warwick (2008) divides students' engagement into three distinct types, i.e. motivational engagement include "are you interested in studying math?", "is studying math useful in computing?", and "is studying math useful in general?", behavioral engagement include "the feeling I have learned something new", and "getting enjoyment from studying" and cognitive engagement include "mark obtained", "understanding the material", "being able to explain and apply material", and "completing and submitting work on time". Moller et al. (2014) measure the engagement based on children attentiveness, task persistence, eagerness to learn, learning independence, flexibility, and organization.

The many ways to analyze student involvement (as shown in the preceding description) still do not specifically show how to measure how students engage in mathematics. Most of the researchers are using aspects/dimensions of students' engagement in general and is far from the

context of teaching mathematics. We need a perspective which may help us to look at the student engagement in mathematics clearly. Watson & De Geest (2012) stated that the sequences of mathematical tasks expose the nature of mathematical engagement in the lessons. Watson (2007) also identifies seven dimensions of mathematical pedagogic orientations, that is (1) teacher makes or elicits declarative/nominal/ factual/technical statements; (2) learners are expected to exhibit certain actions; (3) teacher directs learner perception/attention; (4) teacher ask for learner response; (5) discuss of implications; (6) integrate and connect mathematical ideas; and (7) affirm/act as if we know some object. Each dimension

contains a range of public mathematical tasks and prompts followed by the kinds of shift a learner might be hoped to make during mathematical activity. A detailed description of the analytical tool can be found in Watson (2007). In answering this problem, Patahuddin, Puteri, Lowrie, Logan, & Rika (2017) adapted Watson's (2007) analytical framework to measure student mathematical engagement and by the result of their research, we found the fact that Watson's analytical tool is very helpful to identify student mathematical engagement (Patahuddin et al., 2017). Patahuddin et.al (2017) adapted seven dimensions of mathematical pedagogic orientations to be four main points as presented by Table 1.

**Table 1. Indicators of Student Mathematical Engagement**

<p><b>A. Related to remember [RE]</b></p> <ol style="list-style-type: none"> <li>1. Say what the mathematics lesson is about</li> <li>2. Define mathematical terms or give a mathematical definition</li> <li>3. Show/write mathematical procedures/techniques</li> </ol> <p><b>C. Related to personal/public orientation towards concepts, methods, properties, relationships, and implications [PO]</b></p> <ol style="list-style-type: none"> <li>1. Use prior knowledge</li> <li>2. Find answers without known procedure</li> <li>3. Visualize</li> <li>4. Identify the characteristics/ properties of a mathematical object</li> <li>5. Identify variables</li> <li>6. Seek patterns</li> <li>7. Compare or classify</li> <li>8. Describe</li> <li>9. Explore variation</li> <li>10. Make informal induction/prediction</li> <li>11. Make informal deduction</li> <li>12. Create mathematical objects with one feature</li> <li>13. Create mathematical objects with multiple features</li> <li>14. Exemplify</li> <li>15. Express in 'own words'</li> <li>16. Identify relationships</li> <li>17. Make justification and/or reasoning</li> <li>18. Summarise what has been done</li> </ol>	<p><b>B. Related to mathematical fluency [MF]</b></p> <ol style="list-style-type: none"> <li>1. Imitate method, copy object</li> <li>2. Follow procedure</li> <li>3. Find answer using procedure</li> </ol> <p><b>D. Related to making synthesis &amp; connection [MS]</b></p> <ol style="list-style-type: none"> <li>1. Clarification</li> <li>2. Association of ideas</li> <li>3. Generalization</li> <li>4. Redescription</li> <li>5. Summarise development of ideas</li> <li>6. Abstraction</li> <li>7. Formalization</li> <li>8. New definition</li> </ol> <p><b>E. Related to rigour and objectification [RO]</b></p> <ol style="list-style-type: none"> <li>1. Explore properties of new objects</li> <li>2. Adapt/ transform ideas</li> <li>3. Application to more complex mathematics</li> <li>4. Application to other contexts</li> <li>5. Evaluation of development of new idea</li> <li>6. Prove</li> </ol>
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(Patahuddin et al., 2017)

To engage students in a mathematics lesson, we have to provide opportunities for substantive conversations between students and the teacher, and amongst students. This opportunity can be provided through the learning design developed by the teacher, including how the teacher presents a mathematical content, asks questions and designs mathematical assignments that are relevant to the content to be taught (Shernoff, Csikszentmihalyi, Schneider, & Shernoff, 2014; Silver & Perini, 2010; Dudley, 2010; Fink, 2007). Therefore, mathematics learning needs to be planned intentionally so students show high mathematical engagement (Febrilia & Patahuddin, 2019).

One of the frameworks that can be used to assist teachers in designing mathematics learning is the ELPSA framework. ELPSA (*Experience, Language, Pictorial, Symbolic and Applications*) framework views learning as an active process where students construct their own ways of knowing (developing understanding) through both individual thinking and social interactions with others. This framework presents mathematical ideas through lived experiences, mathematical conversations, visual stimuli, symbolic notations, and the application of the applied knowledge (Lowrie & Pattahudin, 2015a; 2015b). The ELPSA framework lesson plan is detailed, continuous, structured and student-centered learning activity design; provide more interesting and interactive activities that can motivate and attract students to learn mathematics; the design of activities can promote student creativity and innovation; provide a list of questions that will be asked by the teacher to students; provide possible answers to students from each question asked; provide alternative questions that might be proposed to anticipate if the student cannot answer the previous question (Febrilia & Patahuddin, 2019). The results of the research conducted by Patahuddin et al. (2017) and Febrilia & Patahuddin (2019) showed that

students' mathematical engagement while participating in mathematics learning with ELPSA framework on the topic of one variable linear equations and triangles were quite good. This is indicated by the high frequency of emergence of several aspects of students' mathematical engagement.

Based on the description above, this study focuses on investigating the mathematical engagement that occurs during the learning process on the different topic of mathematics. This investigation is related to probability learning which aims to help students identify the chance of some event into "possible", "not possible", or "certainly", determine the sample space and their elements from one event, and compares the value of probability from the two events informally. The research question of this study is how did the students' mathematical engagement that emerged during the implementation of the ELPSA framework lesson plan on the topic of probability use a qualitative approach?

## METHODS

This study involved a year 9 teacher of a junior high school in West Nusa Tenggara. The teacher is female and has been teaching mathematics for 10 years in West Lombok. There are 22 students involved, with 11 males and 11 females. These students come from the area around the school environment. Their parents work as farmers, tradesmen and construction workers. In general, students in this school come from lower-middle-class families. The school does not have adequate resources and facilities such as textbooks, worksheet, and props which make the students to only depend on the material given by the teacher. Students at this school are used to communicate using local languages (not Indonesian) that sometimes affects the way they communicate with teachers. They tend to be passive because they feel less capable

to speak Indonesian. They often do not understand some of the terms used when the teacher explaining in the classroom.

Lesson plan used in this study is the first 2x40 minutes lesson from the overall 10x40 minutes of probability lesson in grade 9. The probability lesson plan consists of three main activities designed to answer three learning objectives. The description of this lesson plan is discussed in more detail in the results and discussion section. The lesson plan was designed with ELPSA framework. The development of this lesson plan is part of the Government Partnership for Development (GPDF) project entitled "Promoting Mathematics Engagement and Learning Opportunities for Disadvantaged Communities in West Nusa Tenggara (NTB), Indonesia" funded by Australia's Department of Foreign Affairs and Trade (DFAT). This project was in collaboration with IKIP Mataram, University of Canberra, Dikdas NTB, LPMP NTB, and Kemenag NTB. Through this project, a number of teacher training were held in order to improve the quality of their teaching. Teachers who were participants were mathematics' junior high school teacher and they were selected before attending the training. These teachers come from several schools in ten districts in NTB. In order to increase students' mathematical engagement in the teaching process, teachers are pedagogically trained in developing lesson plans using the ELPSA framework. During this training, the teacher was accompanied by teacher educators from IKIP Mataram, University of Canberra, LPMP NTB, Dikdas NTB, and Kemenag NTB. The teacher educator has been trained by the University of Canberra team and has succeeded in developing lesson plans for several topics in mathematics, including on the topic of opportunity. The lesson plan that has been developed is then used as a role model for the teacher. The teacher is also allowed to provide input on activities, questions, assignments and other matters in the lesson plan. Teacher educators then

collaborate with teachers to implement this lesson plan in the classroom by first demonstrate it through microteaching in front of the teacher before the implementation.

Data collected in the form of video teaching and transcripts. The data were analyzed qualitatively using Watson's analytical tool (Patahuddin et al., 2017). Before starting the analysis process, two researchers made preparations by watching video teaching while noticing the transcripts. An independent analysis was conducted towards video transcripts based on the adapted Watson's analytical tool. Researchers also discuss to agree on the code they have acquired through the analysis independently. This analysis focuses on the mathematical student engagement that emerged during the learning process, including how the students' reactions to the tasks that have been designed.

## FINDINGS AND DISCUSSION

### Findings

The ELPSA framework components that appeared in the designed lesson plan are Experience (E), Language (L), and Pictorial (P). Some of the activities in the lesson plan were intended to bridge the initial knowledge of students (which is often encountered in everyday life) to the more formal mathematical concept. Students observed some event in everyday life and try to classify the chances into "not possible", "possible", and "certainly". This lesson is designed with the following objectives: (1) students are able to identify a chance of some event into "possible", "not possible", or "certainly", (2) students are able to determine sample space and their elements from one event, and (3) informally, students are able to compare the value of probability from the two events.

The lesson plan designed in this study has different characteristics from the teachers' lesson plan in general, especially in the teaching note's column. Teaching

notes were used as a teacher's guide to being able to carry out the teaching and learning activities according to the design. The parts that normally exist in a teachings notes include, (1) Explanation of teachers on the subjects being taught in the classroom; (2) The question that will be asked by the teachers to explore students' understanding, build concepts, lead the students to understanding the concept, present new ideas and enhance students' creativity. It also includes critical questions and alternative questions if the conditions of the students are not in line with expectations; (3) The expected answer from the students and answers that may be raised by the students. It is used to collecting various possibilities of thinking of students, so the teacher at the beginning of the teaching also had to think of alternative solutions to deal with situations of this kind; (4) importance records as the things to keep in mind and watch out for teachers, including technical and non-technical. The lesson consists of three activities, there are:

**1. "Events Cards";** students work in the group to identify some events that have been written on the cards and make classification into "possible", "not possible", and "certainly". This activity is

useful to help students make connections between their experiences in daily life with the concept of chance. Then, the teacher asked some questions to guide students to make a justification for their "own word" based on their understanding. Furthermore, students asked to determine the value of chance from each event, start from 0% up to 100%. In this section, students are taught to be able to use their reasoning by considering all the things that can affect an event to occur. In order to strengthen students' ability in justification, the teacher told them to present their answers to the class and also posed some question to make sure that they really understand what they have done. One example of the teacher's question is written below.

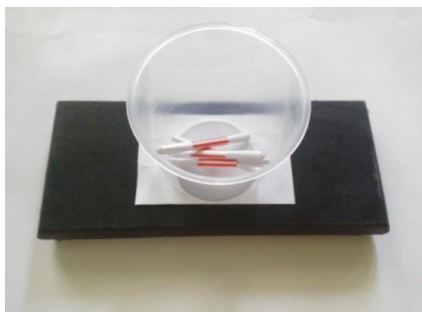
*"how you decide that the event are possible, not possible, and certainly?"*  
*"explain why you give ...% for the value of chance?"*

From this activity, students learn to communicate what they are thinking, use their understanding to explain something and recognize the term related to the possibility. Here is the sample of "Events Card".

Bulan mengelilingi bumi.	<i>Moon around the earth.</i>
Besok pagi saya makan mie goreng.	<i>I eat fried noodles tomorrow morning.</i>
Besok akan turun salju.	<i>Tomorrow's going to snow.</i>
Hari ini ibu saya ulang tahun.	<i>Today is my mother's birthday.</i>
Bayi yang lahir hari ini berjenis kelamin laki-laki.	<i>Babies born today are men.</i>
Umur saya di bawah 5 tahun.	<i>My age is under 5 years old.</i>
Indonesia akan memenangkan piala dunia tahun 2018.	<i>Indonesia will win the World Cup in 2018.</i>

**Figure 1. The Events That are Written on the Card**

2. **“Playing Lottery”**; teacher provides a bowl containing four rolls of paper that have written some kinds of sports, i.e. volleyball, football, swimming, and martial.



**Figure 2. Manipulative Tool for Playing the Lottery**

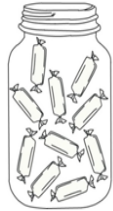

The teacher asked one of the students to come forward and took a roll of paper and before he/she opens it, the teacher asked a question in order to guide students' thinking about the chance of a roll of paper that is picked. The question posed by the teacher is written below.

*“is the roll of paper that is picked will say football?”, or “is the roll of paper that is picked will say chess?”, or “is the roll of paper that is picked will say tennis?”, and etc.*

Through this game, students are introduced to the term “sample space” and “elements of sample space”. The teacher explained that “sample space” is all the kind of sports that have been written in all roll of paper inside the bowl, and then the “elements of sample space” is one kind of sports that have been written in a roll of paper that is picked by the student.

3. **“Candy Problem”**; The final activity is about the probability of two events on an informal basis. Students were given a worksheet as shown in Figure 3. Students are given a worksheet as shown in Figure 3. In the worksheet, there are two column tables wherein the first column there is a jar with a few candies in it and in the second column, there is a sentence

corresponding to the jar on the left. The students were asked to imagine that they would take a candy from the jar with the closed eyes. so that the sentence in the second column can be true, students are asked to color the candy in the jar based on the consideration of the student.

<p>1.</p> 	<p>Saya lebih sering mengambil permen berwarna hitam dan jarang mengambil permen berwarna putih.</p> <p><i>I often take the black candy and rarely take the white candy.</i></p>
<p>2.</p> 	<p>Saya lebih sering mengambil permen berwarna hitam dan jarang mengambil permen berwarna putih.</p> <p><i>I often take the black candy and rarely take the white candy.</i></p>

**Figure 3. The Candy Problem That is Written on the Student Worksheet**

This activity will give students additional knowledge about anything that can affect their chances of getting candy with certain colors. For example, in the first row of the second column, it says "I often take the black candy and rarely take the white candy". In order for the chance of students to get black candy bigger than white candy, then a lot of black candy must be more than a lot of white candy. So the candies in the jar should be more coloured with black than white. This activity is intended to make students know that a lot of opportunities to get the black candy depend on the number of black candy and the number of the candies in the jar. This activity is intended to make students know that a lot of opportunities to get the black candy depend on the number of black candy and the number of candies in the jar. The more black candy in the jar, the greater the possibility of drawing the black candy.

### ***How can we analyze mathematical student engagement during the lesson?***

To answer this question, we gave a demonstration of mathematical analysis of student engagement that is focused on some parts of the video transcripts below using the indicator was adapted from Watson (2007):

[Students have clarified statements/events where the impossible, possible and certainly the case]

Teacher : Well, we will continue to possible event

Student : Babies born today are men

Students : Possible [Chorus]

Teacher : Is it possible?

Student : Yes

Teacher : Why did you think it's possible? Why your answer is possible? To the group 5, can you explain that?

Student : It's possible male or female

Teacher : Santi said it could be a woman, it could be a man, so put in as possible. Okay, next!

In analyzing the transcripts, researchers focus on the students' interaction with the teacher and other students. Some things that need to be observed are: what has been or is being students do before or at the time the statement was made, what purpose the students in giving statements, and what is meant by the question posed by the teacher. Based on the pieces of the transcripts, the student has done the classification that the incident "Babies born today are men" is an event that may occur (PO7). Students also disclose the reasons for its classification (PO17). Through this transcript, we can also detect the chorus answers (MEC).

[Student asked for giving the value of chance from some events]

Student : [statement] I am under 5 years old, this is 0%

Teacher : Why?

Student : Because I am 12 years old.

Expressions of students in the first row show that students were justifying the possible value of the statement "I am under the age of 5 years" which is 0%. From Watson's indicator, this statement shows PO17 aspect. Teachers also make efforts to find out what the reason for students in making the decision. Students then explained the reasons they gave a value of 0%, due to his age of 12 years (PO17).

### ***What are aspects of mathematical engagement that emerged by students during the lesson?***

Analysis of transcripts provides results on students' mathematical engagement that emerged during the lesson as shown in the Table 2.

Table 2 describes the students' mathematical engagement that emerged during the learning process. Based on the table, mathematics engagement is most apparent in the aspect of personal or public orientation towards concepts, methods, properties, relationships, and implications (PO), which is the indicator of make justification and/or reasoning (PO17) and compare or classify (PO7). The number of frequency of occurrence of this indicator for activities designed an activity that allows students to classify, compare and requires students to perform reasoning on the results of justification. Lesson also provides an opportunity for students to identify characteristics of mathematical objects (coins and dice) which can be used in determining the sample space and sample point (PO4), make predictions informally to name sports that will come out (PO10), make an example point samples and examples of other experiments that corresponded with the draw taking previous example (PO14), and express some of the terms in their own language.

Students are also given the opportunity to convey the definition of terms in mathematics (RE2). Enthusiastic students in participating in the study also demonstrated how to copy them in



methods or object (MF1) and follow the procedures that teachers do (MF2). On several occasions, the teacher also provides questions that provoke students to describe the (MS2) a concept that has been granted and clarified (MS1) what they have done.

### Discussion

The main objective of this study was to observe and explore mathematical student engagement that emerged during the learning process in the classroom. We use the Watson analytical tool in observing how student engagement. This lesson was designed to provide students opportunity

to build mathematical ideas through daily experience, explore and express what they already know and are thinking about, and give reasons for what they have done with their daily language (Lowrie & Patahuddin, 2015a; 2015b). Pictorial used to provide insight to students about the informal concept of chance (Febrilia & Patahuddin, 2019). Based on the lesson plan, students can observe anything that influences the likelihood of an event in the experiment and provides an explanation for observations. This activity is used to bridge the informal and formal concept of probability (in the form of mathematical formulations) in the next lesson plan.

**Table 2. Dimensions of Mathematical Engagement Emerging During the Lesson**

Dimensions of mathematical engagement based on Patahuddin et al. (2017)		ME
Related to remember [RE]		
RE.2	Define mathematical terms or say a mathematical definition	3
<i>Missing codes: RE1 &amp; RE3</i>		
Related to mathematical fluency [MF]		
MF.1	Imitate method, copy object	3
MF.2	Follow procedure	5
<i>Missing codes: MF 3</i>		
Related to personal/public orientation towards concepts, methods, properties, relationships, and implications [PO]		
PO.4	Identify the characteristics/ properties of a mathematical object	2
PO.7	Compare or classify	12
PO.10	Make informal induction/prediction	1
PO.14	Exemplify	2
PO.15	Express in 'own words'	1
PO.17	Make justification and/or reasoning	17
<i>Missing codes: PO1, PO2, PO3, PO5, PO6, PO8, PO9, PO11, PO12, PO13, PO16 &amp; PO18</i>		
Related to making synthesis & connection [MS]		
MS.1	Clarify	1
MS.4	Redescription	2
<i>Missing codes: MS2, MS3, MS5, MS6, MS7 &amp; MS8</i>		
Related to rigour, objectification, use [RO]		
<i>Missing codes: RO1, RO2, RO3, RO4, RO5 &amp; RO6</i>		
Total *)		49
MEC – Mathematical Engagement Chorus		37

Development of lesson plans in which includes the activities of students and teachers, assignments, teachers' questions and assessments are very important to make learning more directed and in accordance with the intended goals (NCTM, 2000). Mathematics learning does need to be planned intentionally to engage students during learning (Febrilia & Patahuddin, 2019). The Patahuddin et al. (2017) research shows that the form of questions that the teacher poses, the way the presentation of assignments and activities greatly influence student mathematical engagement. Learning planning is very influential on students' attitudes and habits, cognitive structures that will be developed within students and students' perceptions of the subject (Panasuk, Stone, & Todd, 2002).

The design activity of probability lesson plan was focused on classification, justification, and delivery of these reasons. In identifying each given event, students should consider certain reasons why the event was classified in the event that it was possible, certain or impossible to occur. It's led to the magnitude and frequency of occurrence indicator PO7 and PO17 on Watson's indicator. The magnitude of the frequency in some aspect of mathematical engagement is also caused by questions that the teacher poses (Patahuddin et al., 2017). When students finish identifying events, the teacher always asks "why ...". By asking the question, students are trained to express their opinions using their own language. It contributes to promoting their level of thinking and reasoning skills (Sunggingwati & Nyuyen, 2013; Eshun & Mensah, 2013; Kramarski, 2008). From here the teacher can also assess the extent of students' cognitive abilities to the content provided (Heritage & Heritage, 2013; Moyer & Milewicz, 2002; Zahorian, Lakdawala, González, Starsman, & Leathrum, 2001). This type of engagement needs because reasoning enables children to make use of all their other mathematical skills and so reasoning

could be thought of as the 'glue' which helps mathematics makes sense, and it also helps us to begin to think about how we could support children to develop their reasoning skills (Jennie & Bernard, 2014).

The other interesting thing is that many chorusing that occur during the learning taken place. Fauzan, Slettenhaar, & Plomp (2002) note that many classes in Indonesia are coloured with chorus answers. Similar things were also shown in other countries such as Namibia (Ottevanger, 2001) and Zimbabwe (Mtetwa, 2005). In this study, mathematical engagement through chorus is about 42% of 86 mathematical engagement in total. From the analysis of video teaching and its transcript, chorus answers often appear in questions such as "do you agree with your friend's opinion?" and "is this an event possible or impossible?". Chorus mean everyone is saying the same thing at the same time in classrooms, not implying any more involvement or meaning to reviews their utterances (Watson, 2007). Chorus answers are caused by yes-no questions (Sembiring, Hadi, & Dolk, 2008), questions that require short answers (Fauzan et al., 2002) or other closed questions and questions about the completion of sentences spoken by the teacher in the class (Kawalkar & Vijapurkar, 2013; Sullivan & McDonough, 2007). Chorus questions are usually lower cognitive questions (Tan, 2007). Questions that facilitate chorus answers will disguise some students who are actually still confused by the concepts taught by the teacher (Hourigan & O'Donoghue, 2007) because all students seem to understand what the teacher means through the answers given simultaneously. The number of chorus frequency that dominates student interaction in class can be considered as a form of low-level engagement (Patahuddin et al., 2017).

We tried to analyze the mathematical student engagement by the ELP component (See Table 3).

**Table 3. Summary of Students' Mathematical Engagement on ELP Component**

Dimensions of mathematical engagement	E (Experience)	L (Language)	P (Pictorial)
RE2	2	0	1
MF1	2	0	1
MF2	4	0	1
PO4	0	2	0
PO7	11	0	1
PO10	0	1	0
PO14	0	2	0
PO15	0	1	0
PO17	12	2	3
MS1	1	0	0
MS4	0	2	0
MEC	16	15	6

According to the table, the most dominant indicator appears on Experience component are PO7 and PO17. This is not apart from the purpose-designed activities, which classifies events into the event that is not possible, may and do occur and to determine how many chances the event occurred. The experience component of the design also includes assessments, since the teacher must determine what the students know and what new information needs to be introduced to scaffold their understanding (Lowrie & Patahuddin, 2015a; 2015b). Before taking a decision, the students had a discussion with friends in the group to reach an agreement. Questioning technique of the teacher also helps in giving students the opportunity to express their reasons. Other indicators that appear are RE2, MF1, MF2, and MS1.

The language commonly follows the E component of ELPSA and focuses on both the generic and specific language required to represent mathematical ideas (Lowrie & Patahuddin, 2015a; 2015b). Based on this perspective, students will be involved in aspects of personal/public orientation, as the indicator PO4, PO10, PO14, PO15, and PO17. Activities which have been designed give students the opportunity to repeat what was done/submitted by teachers in their own language. The pictorial is used to make visual representations to represent mathematical ideas (Lowrie & Patahuddin,

2015a; 2015b). Activities in this component were designed as a bridge between the concepts of informal and formal opportunities. In this activity, they are asked to do things according to the procedures or methods that have been determined (MF 1 and MF2), comparing the two images (PO7), justifying and stating the reason (PO17), occasional teachers are also asked about a term associated with these activities (RE2).

In each component, we can see how much the frequency of the chorus, which is 43% occurred in component E, 41% in component L and 16% in component P. Chorus occurs because students are not accustomed to raising their hands before answering a teacher's question. Other causes are some of the questions the teacher detected a type of closed questions whose answer consists of one or two words. A preponderance of chorus response questions will allow some students to glide through the lesson without actually learning the subject matter presented (Posamentier, Germain-Williams, & Jaye, 2013). Posamentier et al. (2013) also found the teacher in this situation will be unable to detect individual difficulties, because they are likely to be clouded by the chorus responses. This investigation shows that student engagement is increased when teachers provide enough space for students to explore their ideas, one of them with the

help of open questions by the teacher. The questions are an important part of this research because the questions facilitate the teachers to be able to know the way of students thinking, what they already know and what they do not understand. This is in line with the opinion of Kurniastuti, Setyawan, & Sonialopita (2018) which states that essential questions help teachers to provide focused and meaningful learning for students. Essential questions that are given will help the students get a clear understanding and develop their thinking habits actively and critically. Essential questions that are intended are questions that are able to stimulate the mind, stimulate further inquiry, and to raise new questions, including deep questions from students, and need answers that are more than ordinary answers. The question is provocative and generative. By giving questions like this, students are expected to be involved in rich and deep learning not just learning facts (McTighe & Wiggins, 2013).

## CONCLUSION

This article presents an approach to analyze the student mathematical engagement through a modified version of Watson's analytical tool by Patahuddin et al. This approach enabled the researchers to identify the types of engagement that emerging as the impact of the lesson design by ELPSA framework. The qualitative approach is beneficial to describe the learning process, students' responses, and pedagogical practice naturally. The type of student' mathematical engagement that most frequently occur indicates that the lesson design by ELPSA framework may engage student mathematically on a certain aspect, and it depends on the class activities that are designed by the teacher. The result of this analysis is also useful to see which aspect does not emerge during the teaching process in the class. It can help the teachers reflect on learning design about the probability that has been designed.

Furthermore, this study used to support the module development that is currently being conducted, and it provides new insight in how we should build a systematically and directional lesson design so that teachers are able to think what activities that could engage student mathematically through their talk, work, and perform.

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