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The shifting of students' epistemological belief about mathematics in polytechnic

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The research aims to figure out students' epistemological belief shift about mathematics after having attended a lecture in a Polytechnic. In addition, it also aims to find out the relationship between their beliefs and mathematics performance. The study applied mix method with explanatory sequential design approach by conducting first study quantitatively and further study qualitatively. The sample consists of 223 participants drawn randomly by stratified random sampling method. The result showed that students' epistemological belief about mathematics either pre- college or in-college period in Polytechnic was "poorly positive". Most of them (about 95%) had their epistemological beliefs about mathematics shifted with the changes "low increasing". Also, the belief shifting was positively correlated with mathematics performance at a significance level of 1%, and the Pearson correlation coefficient was 0.204. Some factors that affects students' epistemological belief about Mathematics shifted was: student's orientation purpose, assessment system, curriculum, methods of learning, and met-before.

Key words: Belief, belief shift, epistemological belief, students' belief.

INTRODUCTION

Belief is a personal judgment and views, which constitute one's subjective knowledge, and it does not need formal justification (Kapetanas and Zachariades, 2007). For the past three last decades, "belief' has become an interesting subject for researchers of mathematics education to conduct, especially in relation to mathematics behavior, performance and problem solving. Many researchers have proven that students' believe on Mathematics has a strong effect on students' mathematics behavior and performance (Steiner, 2007; Buehl and Alexander, 2005; Op't Eynde et al., 2002).

In the last ten years, there are many researchers who have epistemological beliefs revealed (Chen, 2010; Steiner, 2007; Buehl and Alexander, 2005). Student's epistemological beliefs about mathematics can be regarded as personal judgments and views, which is a one subjective knowledge, which does not need formal justification, which include individual beliefs about the nature, justification, resources and

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knowledge, and acquisition related to the learning about mathematics. Muis (2004) states that epistemological belief about mathematics (EBaM) consists of belief on: the nature of mathematics as a discipline, the nature of knowing mathematics, the acquisition of mathematics knowledge, and the usefulness of mathematics. Muis (2004) also differentiates beliefs on mathematics to be "availing", which is the supporting belief for learning process or the positively affecting belief on learning process, and "nonavailing" belief, which is non beneficial or negatively affecting belief on learning process.

The nonavailing belief has also been studied by Steiner (2007) stating that students' EBaM consists of required time to solve mathematics problem, mathematics problem complexity, the importance of understanding mathematics, and the usefulness of mathematics. This research will apply those earlier mentioned definitions. Steiner's research showed that generally, students hold no availing beliefs about mathematics and mathematics self-concept.

Most of them commonly believe that mathematics problem must be solved quickly; and they did not believe that mathematics problems can be solved with logic and reason instead of learned mathematics rules; and over 40% of the students did not believe that it was beyond basic mathematics which was useful to everyday life.

Nonavailing belief about mathematics has been proven to negatively affect mathematics performance either directly or indirectly. For instance, students who believe that most of all mathematics problems can be solved by applying facts, rules, formulas, and procedures tend to approach mathematics task by mechanical or by memorizing method (Garofalo, 1989). Those with non-availing belief may also have lower motivation level and task performance than those with availing belief (Buehl and Alexander, 2005).

Both students' availing and nonavailing belief about mathematics learned in the university or college as a certain subject of course differs from those who learn mathematics as mathematics user. In one hand, those who learn mathematics as a subject generally showed a positive attitude toward mathematics and had a higher motivation (Selden and Selden, 2007; Sowder and Harel, 2003). In the other hand, those who attended mathematics lecture in other majors generally showed a less positive attitude (Hassi and Laursen, 2009).

Mathematics lecture in Polytechnic (especially in Politeknik Negeri Malang) has some different characteristics compared to that of non-Polytechnic students. To mention some, they are short lecture duration (2 to 3 h per week on two semesters), plentiful material, and students with various different backgrounds (General High School, Islamic High School, and Vocational High School). Apart from those earlier mentioned characteristics, educational system in Polytechnic also has some peculiarities compared to other colleges (such as Universities, Institutes, Academies or Diploma programs). Among those peculiarities are: Polytechnic curriculum contains 45% theory and 55% practice; its lectures apply a package system; and its evaluation apply drop outs (DO) study system. Every semester, lots of students gets DO from their studies due to getting grade pointE or grade point average (GPA) which is below 2.00. Most of those DOs' students are those who acquire low mathematics grades (Dewi et al., 2007). One of the factors that affect students' achievement in mathematics was their EBaM (Buehl and Alexander, 2005; Schoenfeld, 1989; Szydlik, 2000) and their confidence in their mathematics capability (Kloosterman et al., 1996; McLeod, 1992; Schoenfeld, 1985). The belief about mathematics is formed in the context of students' individual academic experiences (Cobb, 1986; Schoenfeld, 1989). Meanwhile, academic experience is formed by personal characteristic such as gender, age and ethnicity (Wilkins, 2003; NCTM, 2000).

There are lots of studies focusing on students' belief about mathematics either in the elementary school, high school, or in college and its relation with mathematics achievement. Studying those earlier mentioned literature research; we have not found yet any study concerning mathematic with Polytechnics students as its subject research. As we have experienced for the past 23 years teaching in Polytechnics, there are lots of dropped out Polytechnic students due to their poor mathematics achievement. A study conducted by Griese et al. (2011) in German also says that there is a high number of engineering students who give up in learning mathematics before successfully passing. This indicates that technical students who fail in learning mathematics were not only found in Polytechnic. Daskalogianni and Simpson (2001) also confirmed the important role of belief about mathematics which determines students' success or failure at university. However, it is barely stated on those studies whether such belief has been related to the students since their early level education or there has been a shift on them. In regard to this problem, Steiner (2007) suggested that we had to conduct a research which explores how students' perceptions of mathematics can be challenged at the college-level and prior to college.

Considering the previously conducted research and some earlier mentioned reasons, we focus on studying shift of students' EBaM starting from pre-college up to in-college period in Polytechnic. The research aims to explore Polytechnic students' belief starting from their pre-college up to after having followed mathematics lecture at Polytechnic. The research also aims to figure out its relation with mathematic performance. The research questions explored were:

1. How did students' EBaM shift after having followed its lecture in Polytechnic?

2. How did Polytechnic students' epistemological belief relate with mathematics performance?

METHODOLOGY

The study applied mix method with explanatory sequential design approach, by conducting first study quantitatively and further study qualitatively (Creswell, 2002). Firstly, a quantitative study will be conducted and then it will be continued by little bit collecting qualitative data. Creswell gives a symbol of"QUAN-+ qual" to indicate that quantitative study has a heavier quality than qualitative study; meanwhile, arrow sign indicates that the quantitative study is prioritized, and then it will be completed by the qualitative study.

Sample

The population of this research was students of Politeknik Negeri Malang attending mathematics lectures in 2015 to 2016 academic year. Random sample was selected by stratified random sampling amount (N) 223 participants, consisting of 60 participants majoring in Electrical Engineering, 45 participants majoring in Civil Engineering, 46 participants majoring in Chemical Engineering and 72 participants majoring in Mechanical Engineering. Furthermore, randomly selected 30 of the 223 participants were able to provide qualitative feedback on the four statements about students' EBaM. Of the 30 participants, some subjects were selected to be interviewed relating to their beliefs by referring to the results of the questionnaire and mathematics test.

Instrument

Scale of students' EBaM designed by modifying Mathematics Beliefs Scale (MBS) questionnaire from Steiner (2007), consists of subscale: time, steps, understanding, and usefulness, each of which had six items; three of them were positive wording and the rest three were negative wording. MBS likert-type formula with five responses/alternative answers was modified to be six items, that is, by eliminating doubt vs unsure answer. Alternative responses for each item from MBS modification result were:

1. False/strongly disagree (not like me at all),
2. Mostly false/disagree
3. More false than true/ somewhat disagree
4. More true than false/ somewhat agree,
5. Mostly true/agree, or
6. True/strongly agree (It is very much like me).

And to figure out shift in students' belief, the questionnaire in the study was divided into two stages. The first stage was given at the beginning of the first semester, the participants were asked to provide feedback on the EBaM before studying at the Polytechnic. The second stage was given at the end of the second semester, the participants were asked to provide feedback on the epistemological belief about mathematics after college at the Polytechnic for two semesters. Also, to gain deep belief description, in the second stage questionnaire MBS added some qualitative questions that must be answered in writing.

The research instrument to be applied, apart from using MBS, would also applied mathematics test to gain data about students' mathematics performance. Furthermore, student test result was also applied to be one of the reference to figure out students' background experience in relation to mathematics- known terminologically as "met-before" (McGowen and Tall, 2010).

Data analysis technique

Weighting

MBS likert scale contains of 6 agreeing/disagreeing levels, that is, strongly agree (6), agree (5), somewhat agree (4), somewhat disagree (3), disagree (2), and strongly disagree (1). MBS scale also makes 6 sub scales, each of which contains six items. Three of them were positive wording, and the rest three were negative wording. For weighting calculation, we scores participants response using the equivalences below:

1. The positively worded items applied weighting 6 = +3, *5* = +2, 4 = +1, 3 = -1,2 = -2, and 1= -3
2. The negatively worded items applied weighting 6 = -3, *5* = -2, 4 = -1, 3 = 1, 2 = 2, and 1 = 3. As the result, we had a range from "strongly agree" = 3 to "strongly disagree" = -3.

Categorization

For instance, student X encompasses *5,* 6, 6, 2, 4 and 3 (first three item are positive wording, and second three items are negative wording) scoring attitude on Time Subscale. In this sense, the weight will each be translated into 2, 3, 3, 2,-1 and 1, with total quantity of 10. Due to 6 items in time subscale, we divide 10 with 6, of which we receive score 1.7 (from range score -3 to 3). To translate the score, we will categorize them not to be strongly "agree" (somewhat agree) or student X has belief in "somewhat positive" mathematics for Time subscale. So do the other subscales, and to see the whole complete, the categorization classified with criteria is presented in Table 1.

Shiftdetermination

Shifting belief is gotten from difference in the total of each subscale in students' belief pre-college (first stage) and in-college (second stage) in Polytechnic. For instance, student Y in his pre-college got belief response scores for each subscale which were: Time= 0.17; Step= -1.0; Understanding= 1.5; Usefulness= 1.83. Meanwhile, in his in-college, belief response score for each subscale were: Time= -0.5; Step= -0.83; Understanding= 1.83; and Usefulness= 2.33. So, shifting belief scores for each subscale were: Time= -0.5-0.17 = - 0.67; Sstep = -0.83- (-1.0) = 0.17; Understanding= 1.83-1.5 = 0.33; and Usefulness= 2.33-1.83 = 0.5, and total of shifting belief score (BS) was -0.67 + 0.17 + 0.33 + 0.5 = 0.33. According to the result, it was concluded that student Y belief about mathematics on his pre-college up to in college period in Polytechnic was low. We categorize belief shift into 7 groups that is, high increasing if BS is BS ≥ 8, average increasing if 4 ≤ BS <8, low increasing if 0 ≤ BS <4, stable if BS = 0, low decreasing if -4 ≤ BS <0, average decreasing if -8 ≤ BS <- 4, and high decreasing if BS <-8.

RESULTS AND DISCUSSION

Data EBaM was processed with MS Excel and statistical package for social sciences (SPSS) program. The following was presented for Polytechnic students' EBaM,

Table 1. Categorization reference of EBaM.

Category	Subscale score	EBaM score
Highly positive	2.5:'0 Score :'0 3	10:'0 Score :'0 12
Moderately positive	1.5:'0 score <2.5	6:'0 score <10
Poorly positive	0:'0 score <1.5	0 :'0 score <6
Poorly negative	-1.5 <score <0	-6< score< 0
Moderately negative	-2.5 <score:'0 1.5	-10< score :'0 6

Table 2. Summary statistics of students' EDaM intheir pre-college period in Polytechnic and reliabilities (Cronbach's Alpha) for MBS.

Subscale	Mean	Std. Dev.	Category	*Cronbach'sAlpha*
Time	0.72	0.8425	Poorly positive	0.609
Step	-0.29	0.8058	Poorly negative	0.640
Understanding	1.18	0.8617	Poorly positive	0.736
Usefulness	1.68	0.9914	Moderately positive	0.792
EBaM	3.28	1.7347	Poorly positive	-

Table 3. Summary statistics of students' EBaM in their in-college period in Polytechnic and reliabilities (Cronbach'sApha) for mathematics belief scale.

Subscale	Mean	Std. Dev	Category	Cronlxlch 's Alphtz
Time	1.06	0.8318	Poorly positive	0.711
Step	-0.54	0.9798	Poorly negative	0.712
Understanding	1.35	0.8758	Poorly positive	0.749
Usefulness	2.06	0.7999	Moderately positive	0.852
EBaM	3.92	1.8420	Poorly positive	-

Shifting of Polytechnic students' EBaM, Polytechnic student mathematics performance, relationships students' EBaM and mathematics performance, and qualitative response of Polytechnic students' EBaM.

Polytechnic students' epistemological belief about mathematics

Mean and standard deviation of Polytechnic students' EBaM in their pre-college period, and internal reliabilities *(Cronbach 'sAlpha)* of the total scale scores are presented in Table 2. Based on the calculation, we gained a description of students' belief on step subscale with the lowest mean score of -0.29. Such belief score was categorized as "poorly negative". The mean of other subscales respectively were: *Time* = 0.72; *Understanding*= 1.18; and *Usefulness* = 1.68. Although, *Cronbach's alphas* for MBS were lower than the *Cronbach 's alphas* reported by Steiner (2007), but reliabilities is still quite high (greater than 0.6). Overall, the score of students' EBaM in their pre-college period in Polytechnic is 3.28 which was the sum of all belief subscales and categorized *as* "poorly positive".

Furthermore, mean and standard deviation of Polytechnic students' EBaM in their incollege period, and internal reliabilities (*Cronbach 'sAlpha)* of the total scale scores were shown in Table 3. As we had seen on students' belief in their pre-college period in Polytechnic, that of in-college period also indicates that step subscale had the lowest mean score of -0.54 and categorized as "poorly negative" The mean of other subscales respectively were: *Time*= 1.06; *Understanding*= 1.35; and *Usefulness*= 2.06. Meanwhile, students' EBaM in their in-college period was 3.92 and categorized *as* "poorly positive". It confirms the results of Hassi and Lauren (2009) that students who attended mathematics lecture in other majors generally showed a less positive attitude. Specifically, this can be concluded that "students in general believed that to solve mathematics problems may

Table 4. The frequency of students' EBaM based on the category

Category	Pre-college period		In-college period	
Highly positive	0	0%	0	0 %
Somewhat positive	11	4.93%	24	10.76%
Poorly positive	205	91.93%	193	86.55%
Poorly negative	7	3.14%	6	2.69%
Somewhat negative	0	0%	0	0%
Highly negative	0	0%	0	0%
Total	223	100%	223	100%

Table 5. The shifting of students' EBaM.

Shift of belief	Mean (BS)	Std. deviation
Time	0.34	0.7865
Step	-0.25	1.0153
Understanding	0.17	0.5816
Usefulness	0.37	0.6116
EBaM	0.64	1.3900

take a long time, understanding concepts was important in mathematics, and mathematics was useful in daily life". Students in general did not believe that mathematics problem was solved by logic and reason. This description indicated that Polytechnic students hold the non-availing belief that problem was solved by memorizing formulas or following step-by-step procedures. The study result actually confirms what Steiner has done previously (2007).

Furthermore, when all participants were classified into belief category as explained on data analysis technique, it was revealed that most Polytechnic students' belief was categorized *as* "poorly positive" with total a of 193 (86.55%). Meanwhile, the frequency of students' EBaM in their pre-college period shows a total of 205 (91.93%). It appears that there was none who has "highly positive" belief as presented in Table 4.

The shifting of polytechnic students' EBaM

The shifting of students' EBaM was BS = 0.6415 and categorised low increasing. A positive shift occurs on the belief subscales of time, understanding and usefulness, each of which were 0.3414, 0.1741 and 0.3743 (Table 5).

Meanwhile, the negative shift occurred on step subscale being -0.2484 or low decreasing. This showed that after the lecture at the Polytechnic, students generally believed that understanding in mathematics is important, not just to get the right answer. It also revealed that the Polytechnic students were more aware of the usefulness of mathematics than pre-college students. Also, learning in Polytechnics is more on practical than theory which affected the learning condition. Students in Polytechnics are more familiar with the use of formulas or procedures in solving technical problems in mathematics. Taylor (2009) stated that curriculum and instruction designed specifically can influence students' beliefs about mathematics, it turned out to be in line with the curriculum, and learning at the Polytechnic affects students' EBaM. This specifically turned out to have a negative effect on the sub-scale step.

Further, the shift frequency of Students' EBaM is presented in Table 6. Most of the students' EBaM shifted: category of average increasing has 2 participants (0.90 %), low increasing has 147 participants (65.92 %), and low decreasing has 65 participants (29.15 %). It indicated that more than 95% participants shifted their EBaM. This also indicates that students' EBaM is not constant but shifting. A huge shift on usefulness subscales was due to Polytechnic students always relate with mathematics application on various lecture. When asked:

"why did your belief about mathematics shift from you pre-college up to in-college period?", a student S47 stated "because I am faced with many applied mathematics tasks and I also find mathematics usefulness on other lectures during my in-college period, the tasks and usefulness of which are barely found during my learning period in senior high school".

This means that mathematics lesson has given much application examples and other lectures also support

Table 6. The shift frequency of students' EBaM based on shift category.

Shift category	Frequency	Percentage
High increasing	0	0
Average increasing	2	0.90
Low increasing	147	65.92
Stable	9	4.04
Low decreasing	65	29.15
Average decreasing	0	0
High decreasing	0	0
Total	223	100

Researcher : *How many score do you think you will get?*
M70 : *I think around 60 Sir!*
Researcher : *Why can you get 100 instead of 60?*
M70 : *I have not reviewed yet how to complete number2 and 1c*
Researcher : *You left question number 1c empty. Why did not you write down any answer?*
M70 : *after I did the calculation and apparently I cannot still find the correct answer, I left it blank.*

(Participant only put the answer which he firmly believe they are correct. He only completed three from five numbers so he predicts that he will get only score 60)

Figure 1. Interview quotation 1 with participant M70.

students' belief about mathematics usefulness.

Mathematics performance of Polymchnic students

Mathematics performance of Polytechnic students was measured from the final score of their second semester results. From the collected data, gained performance scores were: minimum= 38, maximum= 100, mean= 69.81 and standard deviation= 14.3427. If the scores are categorized as high (score> 80), medium (50< score:::::; 80) and low (score ::::; 50), then gained scores are as follows: high category is 54 participants, medium category is 144 participants, and low category is 25 participants.

The researcher tried to find relationship between mathematics performance achieved by students and their EbaM. Researcher had conducted an interview with two participants based on test answer and shifting their belief. The interview below is quotation with participant's code M70 and M52. M52 is a participant with belief shift of "low decreasing" category and M70 is a participant with belief shift of "low increasing" category (Figure 1). Based on the interview in Figure 1, it indicates that students would not complete their answers whenever they feel doubtful about it. So that they answer the only three questions they feels sure of. Further, we asked a question to the M70 for his answer of question number lb.

The participant strongly was sure that his answer is correct, and he barely knows that its structure is incorrect (Figure 2). He gave an excuse that this was the way he was used to answer during his high school period, and it was considered correct by his teacher. This case is actually in line with what McGowen and Tall (2010) stated that the particular mental structures is built from previous experience (known as met-before). Moreover, assessment system factor also affects the participant's perception. It makes him think that what matters is the correct answer although the structure is incorrect (please refer to example ofM70's answer on Figure 3). This clearly indicates that students' understanding about mathematics is strongly affected by "met-before".

Furthermore, when he was asked about mathematics achievement in his pre-college period, M70 answers that he had good achievement in his Elementary school, Junior high school and tenth grade of his High school (Figure 4). He even mentioned that he was appointed to be the representative of mathematics Olympia during his elementary school. He also mentioned that his achievement was decreased during XI and XII grade of his high school due to his mathematics teacher's unclear explanation. When we compared between M70's interview answer and the questionnaire score of MBS, we knew that they fit each other, that is, low decreasing. He also mentions that his achievement was decreased during XI and XII grade of his high school due to his mathematics teacher's unclear explanation.

Researcher : Why do you not complete question 1b?
M70 : This is what I am used to doing this, sir. I have never completed it as long as I give the correct answer. I am used to have multiple-choice questions during my high school period, sir, so this (as pointing to the answer) means x1 and x2. We know the answer has been correct this way if it is a multiple choice question. And I think it was also justified as correct when high school. What matters is the answer is correct because there will be a separated calculation.

(Participant is affected by his habit of answering model of multiple choice questions during his high school period. He thinks what matters is the correct answer even though it has a mathematically incorrect answer. This is one of multiple-choice method weaknesses in that it may fatally affect on students' future mental structure. This also indicates that met-before strongly affect on students' belief about mathematics, especially in mathematics understanding.)

Figure 2. Interview quotation 2 with participant M70.

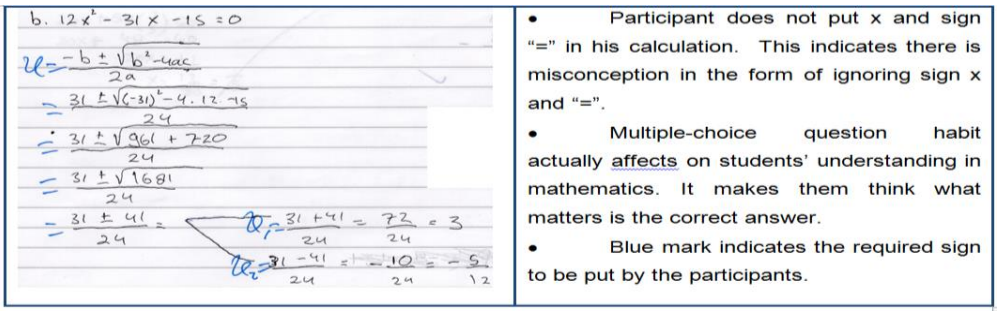

Figure 3. Work result of participant code code M70.

Researcher : Has your achievement always been like this from your elementary to Junior or high school?
M70 : I had achieved a good one when I was in elementary, junior high and grade 1 (X) of senior high school. However it had been decreased when I was in grade XI and XII of my senior high school,Sir.
Researcher : Why?
M70 : I think it was the teachers Sir. They gave us unclear explanation, and described the material too fast and made the student confused.
Researcher : had you ever asked to your friends, parents or others when you were in difficult situation?
M70 :I had Sir, Yes, My dad is actually a mathematics teacher. He had always taught me when I was in elementary or junior high school. However, I had never learned together with my dad since I was in senior high school because he had always been busy to give additional lesson to his own students every night. So it made me lazy then. .
Researcher : who gave you help ever since?
M70 : I was used to discuss with my friends Sir (while mentioning several of his friend names).

(At first, participant did like mathematics and he had a good achievement indeed. However, since he was in grade XI he did not like it any more. There is two factors causing this condition. First is unclear explanation from his teacher and second is guider unavailability in time of facing difficulty.)

Figure 4. Interview quotation 3 with participant code M70.

The condition experienced by M70 has also justified the previous study that students' negative behavior in mathematics generally occurs after grade I0 or after 15 years old (Hakim et al., 2014; Steffens et al., 2010). The qualitative questionnaire response showed the same indicators result, in his pre-college period, he believed that mathematics has no use for daily life. However, in his in-college period, he now believed that mathematics is useful in our daily life. M70 gave an excuse:

"I perceive that mathematics is helpful to do something in relation with my major study".

Second participant, M52 is a student whose belief

Researcher : how many score do you think you can earn from test 1
M52 : 80 sir!
Researcher : Why 80, why would it not be 100?
M52 : I think I had the last question wrong answer.
Researcher : Why?
M52 : I did it not seriously and only use my common sense.
Researcher : So do you think that using common sense for answering mathematics is unserious?
M52 : Not really sir!

(Participant believed that to solve mathematics questions, must use step-by-step procedure instead of logic or reason).

Figure 5. Interview quotation1 with participant code M52.

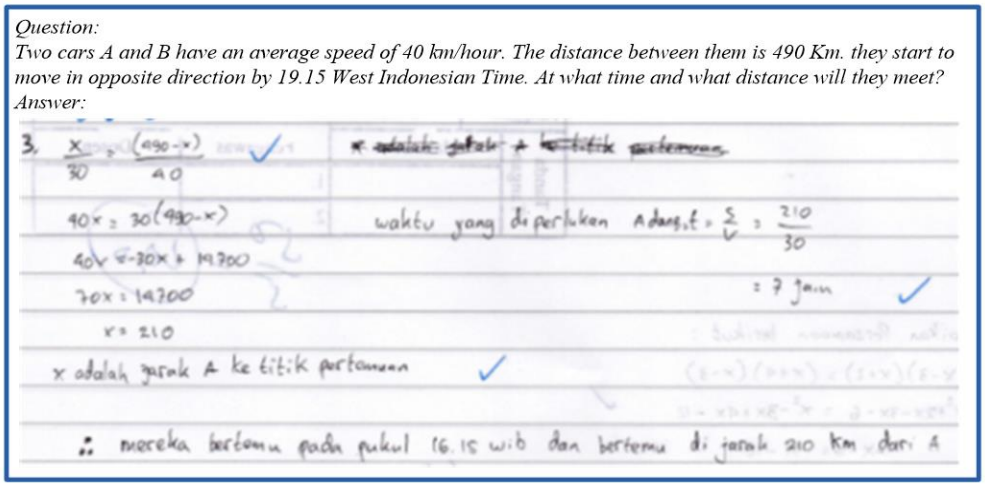

Figure 6. M52 question and answer.

questionnaire score in mathematics is categorized “low increasing". He believed that the answer he gave is incorrect, and it is actually correct. Below is the quotation interview with this participant (Figure 5).

In the beginning, participant was not sure that his answer on the last question is correct because he only uses logic instead of procedural formula (Figure 6). It indicated that the participant believed that to solve mathematics problems, a step-by-step procedure is required. M52’s answer actually fits his MBS scores, especially on the Step subscale, that is, 0.83 categorized as “poorly negative”. The following are question (linear equations) and M52 answers which he believed incorrect because it only uses logic and reasoning.

M52’s response about belief shift related with Step subscale indicated a negative shift. At pre-college, he believed that there were mathematics problems that were solved with logic and reason instead of learned rules and procedures, but in his in-college period, he now believes that there has always been a rule to learn to be complied with to solve mathematics problems. His opinion actually fits with MBS questionnaire results which indicate “low decreasing” on Step subscale. However overall, his belief shift categorized as “low increasing”. M52 also tells that in the beginning he didn't like mathematics, however, since 9 grade of his junior high school, he starts to show interest in mathematics due his teacher who explained the mathematics material clearly, and help him whenever he had difficulties.

Moreover, there were some participants whose belief does not shift such as S8, S11 and S17. In addition, the quantitative response actually also indicates the same consistency. There are lots of participants whose belief is shifting (increase and decrease); generally, they would be interested in mathematics whenever they able to understand and solve the mathematics problems well and whenever their teachers were friendly. On the contrary, they would not be interested with mathematics whenever

Table 7. Correlation between students' EBaM, internal correlation each subscale, epistemological belief shift, and mathematics performance.

		T	s	Un	Us	EBaM	EBaMS	MatPer
T	**Pearson Correlation**		**-0.188****	**0.395***	0.031	**0.553****	**0.272****	**0.214****
	Sig. (2-tailed)		0.005	0.000	0.641	0.000	0.000	0.001
s	Pearson Correlation		1	-0.284*****	-0.045	0.292*****	0.274*****	0.159*****
	Sig. (2-tailed)			0.000	0.503	0.000	0.000	0.017
Un	Pearson Correlation			1	0.415*****	0.683*****	0.231*****	0.313''
	Sig. (2-tailed)				0.000	0.000	0.001	0.000
Us	Pearson Correlation				1	0.622*****	0.170*****	0.215*****
	Sig. (2-tailed)					0.000	0.011	0.001
EBaM	Pearson Correlation					1	0.452*****	0.424*****
	Sig. (2-tailed)						0.000	0.000
EBaMS	Pearson Correl						1	**0.204****
	Sig. (2-tailed)							0.002

**Correlation is significant at the 0.01 level (2-tailed); *Correlation is significant at the 0.05 level (2-tailed). Description: T: Time subscale, S: Step subscale, Un: Understanding subscale, Us: Usefulneas Subscale, EBaMS: EBaM Shift, MatPer: Mathematics performance.

they think the material is hard to understand and the teacher is not quite friendly (unclear in delivering the material, too fast, or easily angered).

The relationship of students' EBaM and mathematics performance

Referring to observation and interview result with some participants, we knew that students' belief about mathematics is closely related with their mathematics performance. Below the statistical summary of relationship between students' EBaM and mathematics performance is presented in Table 7. The results of correlation analysis between students' EBaM and mathematics performance showed a positive association on significance level of 1%, with a Pearson correlation coefficient of 0.424. Each subscale epistemological belief has a positive correlation with mathematics performance at a significance level of I%: subscale understanding with correlation coefficient of 0.313; subscale usefulness with correlation coefficient of 0.215; subscale time with a correlation coefficient of 0.214; and the shifting students' EBaM with a correlation coefficient of 0.204. While subscale step showed a positive association at a significance level of 5%, with a correlation coefficient of 0.159.

Students' EBaM positively correlated with mathematics performance. This means that the high belief score obeyed the high mathematics performance. Surprisingly, students' EBaM shift positively correlated with the performance of mathematics, it is different from the previous year results of the study conducted by the researchers. Students who experienced positive shift of EBaM (or the increase in EBaM) will be followed by the increase in mathematics performance. One interesting result was step subscale which was negatively correlated with other subscales (Time, Understanding, and Usefulness). It was indicated that in general, students who believed in solving mathematics problems may take a long time understanding of mathematics concepts, and mathematics will be useful if only the students believes that mathematics problems must be solved by memorizing formula or follow a step by-step procedures.

Based on analysis and interview resulted as described earlier, we may recommend some types of belief shift as following: first increasing monotone, this is an always increasing belief such as the case of M52; second is decreasing monotone, this is an always decreasing belief *as* found in the case of M70; third is stable, this is a stable/unchanged, or less changed belief *as* shown in the case of S8; fourth is unstable, this is a dynamical belief (up and down) which often changes all the time.

Qualitative response

30 participants were randomly selected to the qualitative

Table 8. Summary of qualitative response of students' EBaM.

Subscale	EBaM	Number of participants
Time	Since pre-college I believe that to solve a mathematics problem to be in quick time	5
	In pre-college I believe that to solve a mathematics problem to be in quick time, but in-college I believe that to solve mathematics problems may take a long time	9
	Since pre-college I believe that solve mathematics problems may take a long time.	7
	In pre-college I believe that solve mathematics problems may take a long time, but in-college I believe that to solve mathematics problems to be in quick time	9
Step	Since pre-college I believe that there are mathematics problems that be solved with logic and reason instead of learned rules and procedures	4
	In pre-college I believe that there are mathematics problems that be solved with logic and reason instead of learned rules and procedures, but in-college I believe that there is always a learned rule to follow in mathematics.	7
	Since pre-college I believe that there are a rule that must be followed to solve mathematics problems	13
	In pre-college I believe that there are a rule that must be followed to solve mathematics problems, but in-college I believe that there are mathematics problems that be solved with logic and reason instead of learned rules and procedures	6
Understanding	Since pre-college I believe that understanding concepts is important in mathematics	19
	In pre-college I believe that understanding concepts is important in mathematics, but in-college I believe that in mathematics that important was about getting the right answer	0
	Since pre-college I believe that in mathematics that important was about getting the right answer	2
	In pre-college I believe that in mathematics that important was about getting the right answer, but in-college I believe that understanding concepts is important in mathematics	9
Usefulness	Since pre-college I believe that mathematics is useful in daily life	22
	In pre-college I believe that mathematics is useful in daily life, but in-college I believe that mathematics is not useful in daily life	1
	Since pre-college I believe that mathematics is not useful in daily life	1
	In pre-college I believe that mathematics is not useful in daily life, but in-college I believe that mathematics is useful in daily life	6

response from participants. Researchers have filed four statements about students' EBaM in the questionnaire to be given response and the reasons. The statement called on the students to give themselves an assessment of the associated changes in beliefs about mathematics (Table 8).

Based on qualitative response to the students' EBaM, the results were parallel with quantitative response of participants. The majority of students have availing belief in Time, Understanding and Usefulness subscales, whereas in Step subscale majority of students have non availing belief.

1. Time subscale: This consists of 16 (53.33%) participants who had availing belief "Solve mathematics problems may take a long time", and 14 (46.67%)

participants have non availing belief "Solving mathematics problems should be in quick time." This condition was in accordance with the quantitative results that the Time subscales had "low positive" belief.
2. Understanding subscale: There were 28 (93.33 %) participants who had *availing* belief “understanding concepts is important in mathematics”, and 2 (6.67 %) participants had *nonavailing* belief “in mathematics that it is important to get the right answer”.
3. In usefulness subscale there were 28 (93.33 %) participants who had *availing* belief “mathematics is useful in daily life” and 2 (6.67 %) participants have *nonavailing* belief “mathematics is not useful in daily life”.
4. In step subscale there were 20 (66.67%) participants having *nonavailing* belief “there is always a learned rule to follow in mathematics”, and 10 (33,33 %) participants have *availing* belief “there are mathematics problems that be solved with logic and reason instead of learned rules and procedures”.

Some of the reasons that many participants expressed related to their belief shift can be stated as follows.

1.The reasons for shifting of belief in the Time subscale, were: he/she is weak in mathematics that requires sufficient understanding which takes time; while in-college they learn more mathematics during High school and also increases the level of difficulty; while in-college mathematics problems become more difficult so it takes longer to complete; in-college variations matter become more complicated, solving it took a longer time; in college mathematics problem is more developed; in college all the materials tested in the essay that require students to answer coherently, different from at senior high school model of multiple choice questions; Senior high school mathematics problems were not too complicated as in-college, in-college mathematics takes long time because the matters are more complicated; solving mathematics problems should be gradual order, so it may take a long time.
2. The reasons for shifting of belief in the Step subscale, were: the higher the education level of the problems encountered, the more complicated it is which cannot be solved easily; actually there are some problems that cannot be solved easily; not all mathematics problem can solved easily but a specified procedure most be followed; rules are made to get answers from the problems that have been created; in-college, many questions requires us to reason before we can follow the steps in the formula.
3. The reasons for shifting of belief in the Understanding subscale, were: better understand the concept of getting a good value but do not understand the concept; in pre-college his final destination is only by value, but in-college he/she should also think about the application; in Senior high school they are informed about the formulas without knowing where it came from and assessed only answer, if the answer was wrong but the concept was true then it has not be completed, while in-college understanding of the concept was important; if he/she did not understand the concept then it is possible to solve the problem with a different method; honest, in pre-college he/she pursued grades, but in-college the process of working was more important in order for he/she to understand all the problems of mathematics problems; when at Senior high school he/she have always focused on National Exam with mathematics problem having multiple choice, it was important to get the correct answer, but in-college the concept is more important; in-college he/she must solve a problem by describing the process of obtaining the answers, whereas in pre-college it is not so; in Senior high school to get the correct answer was a good thing in getting value.
4. The reasons for shifting of belief in the Usefulness subscale, were: in-college, mathematics is associated with other academic subjects so that mathematics becomes useful; in pre-college, a complex mathematical seem useless in daily life, but in-college it turned out to have everything that has to do with mathematics along with other subjects that also deals with the majors that he/she take; in-college my firmament thinking increases, making his/her belief that mathematics is important in daily life; if there is no mathematics he/she will be blind to calculate and solve problems related to numbers; everywhere mathematics is always needed in all areas, mathematics is important and useful; in-college he/she feel the benefit of mathematics in doing something related to his/her majors.

Based on the reasons stated earlier, the researchers classify the reasons of participants into the following groups:

1. Student's orientation purpose, which is to get good grades
2. Assessment system by teachers/lecturers during school/college
3. Curriculum
4. Methods of learning
5. Meth-before.

Conclusion

Based on result and discussion as described earlier, we may conclude some points as follows:

1. In pre-college period, the average score of students’ EBaM sows is 3.28 (range -12 to 12), and can be classified in “poorly positive” category. The average score of students’ epistemological belief in their in-college period shows 3.92 and be classified in “poorly positive”.

Students' EBaM mostly shifts with details as following: 2 participants (0.90%) are average increasing; 147 participants (65.92 %) are low increasing; 65 (29.15%) participants are low decreasing. Meanwhile, those whose belief does not shift are 9 students (4.04%). This means that more than 95% participants have their EBaM shifted.
2. Step subscale shifts by -0.25 or can be said to be "decreasing". Meanwhile, *Time, Understanding* and *Usefulness* subscale positively shift by representatively 0.34, 0.17 and 0.37.
3. Some factors to affect students' EbaM shifted in were: student's orientation purpose, which is to get good grades; assessment system by teachers/lecturers during school/college; curriculum; methods of learning; meth-before.
4. There are four types of students' belief shift in mathematics that is, increasing monotone decreasing monotone, stable and unstable.
5. Students' EBaM and shifting Students' EbaM with mathematic performance were positively correlated on the significant level of 1%, with Person correlation coefficient respectively 0.424 and 0.204.

RECOMMENDATION FOR FUTHER RESEARCH

To gain the good result in the education department, especially for mathematics education in Polytechnic, we recommend for further studies to focus on qualitative research rather than quantitative research in order to gain a comprehensive description about students' belief shift in mathematics.

Conflict of Interests

The authors have not declared any conflict of interests.

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