Investigation on students’ mathematical online discussion: A case study in grade 8 SMPN 1 Denpasar

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Abstract. Online discussions are now very important to build student thinking in a blended learning environment. This study aimed to explore the significance of mathematical abilities and communication skills that arose during online discussions. The research subjects were 40 (20 male and 20 female) grade 8 students of SMPN 1 Denpasar in the academic year 2016. The data were all students’ posts stored in the learning management system used as a tool to support the blended learning process. Data were analyzed using content analysis techniques and coded using mathematical proficiency. The results showed that (a) there was significant mathematical proficiency and communication skills appeared in the online discussion dashboard, (b) The total students’ posts were 556 consisting of 58.5% questions and 41.5% answers. The female students’ posts were 39.7% while the male students' posts were 60.3%. (c) The posts of female students contained 75.6% mathematics skills, 17.2% communication skills and 7.2% unclear, while the male students’ posts contained 89.3%, 9.0%, and 1.8 % for that category. It can be concluded that online discussion was able to create very significant mathematical proficiency (conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, productive disposition) and communication skills (clarification, advice). Female students appeared less active in online discussions than male students did. Female students had given more contribution to the communication skill, while male students had more actively participated in building mathematical skills. Further research is needed to explain the relationship between student activities in online discussion and student performance.

1. Introduction
Internet technology has become more developed nowadays. The availability of bandwidth is getting bigger, making the internet access much faster and more affordable. It provides an opportunity for all sectors, education and learning sector is no exception. In Indonesian context, the lines of department and authorities of education, as well as teachers are trying to take advantage of internet availability to support education and learning. However, until this very second, it could be said that there is no measured and tested model on how school could truly make use of this internet technology. In schools, the use of internet still tends to help sporadically, which is sometimes useful and sometimes not. The use of internet has not been a continuous systematic program, so that the results and impacts could not be measured well. Most of the teachers are still confused too regarding how to use the internet technology to support their learning process. On the other hand, in the digital era of 21st century,
mathematics education has also gone through a lot of changes and needs an ability in making use of internet technology.

The availability of advanced digital technology has changed the mind sets on mathematics and how effective mathematics learning is supposed to be. Several animated videos, which could be downloaded for free from the internet, are able to present and visualize mathematical problems in a real and challenging way, in order to improve the conceptual understanding, reasoning, problem-solving ability, as well as to increase curiosity and creativity. Either mathematical concept or skill that is presented in form of animated video could engage the students more into thinking and having the learning activities done more effectively, faster, and deeper compare to the conventional way, which could only be done by reading books, or face-to-face learning in class [1]. Moreover, if the animated video is presented with blended learning, which is a mixed learning process involving classroom face-to-face and online learning, in which the learning sources, such as the learning materials, assignments, or tests, which are in form of text, figures, audio, or video, could be put on the internet so that it could be accessed 24 hours by the students. YouTube is one of the richest source to contain animated video clips and short movies which would challenge the students to watch carefully and be involved in the thinking and learning process of mathematic. This rich source could be taken advantage of by the teachers as the source for learning process which utilized blended learning approach.

There are various understanding about blended learning. But in principle, it can be abstracted as follows. Blended learning is “a formal education program in which a student learns at least in part through online learning, with some element of student control over time, place, path, and/or pace” [2]. Meanwhile Lalima & Kiran Lata Dangwal [3] states that blended learning “is the concept that includes framing teaching learning process that incorporates both face to face teaching and teaching supported by ICT”. The results of research on blended learning also varied. In the early days of blended learning experiments carried out with different features, depending on the availability of existing technological resources. Some authors also found different results, for example, [4] and [5] revealed that blended learning did not significantly improve the learning achievement. But in its development many authors also found that blended learning or online learning has good potential to improve students’ performance. As Stenbom et al. [6], Leong & Alexander [7] revealed that online inquiry model and web-based homework plays an important role in students’ attitude possibly because of the immediate feedback that improves understanding. Osmanoglu et al. [8] also found that the use of online video case was effective to increase students’ participation in discussion among students as well as between the students and their teacher, in connecting among mathematical ideas and in using what has been learned as a result of mathematics learning. The newest research had been conducted and revealed that the blended learning experience benefitted students [9]. It gave a positive effect not only on the learning outcomes, but also on students’ attitudes toward mathematics. The male students and high-ability students were more motivated in the blended learning environment. Students also gave positive feedback on the use of blended learning platform.

About the implementation of blended learning is also strongly influenced by various things such as students’ satisfaction. This was closely associated with clear guidelines on assignment, rubrics, and constructive feedback [10]. The non-availability, non-accessibility and inadequate students’ ICT skills has also very significant role towards the result of blended learning in teaching and learning mathematics. There was significant difference on students’ perceptions towards the challenges of blended e-learning tools [11]. The institution and teacher have to clearly identify the challenges and opportunities of blended learning and then resolve adequate practical support to the students. Besides that, Francis & Jacobsen [12] found that the nature and quality of the mathematics task impacted the quality and nature of the online interaction. Mathematics problems that incorporated easily drawn symbols and minimal text worked best in the online collaborative space. To support the blended learning environment, online collaboration exercises can be used as part of a diverse assessment. “Online collaboration served as a highly effective method for promoting and assessing generic capabilities such as writing in a context-relevant manner and the development of self-awareness with regard to mathematical strengths and limitations” [13]. Besides online collaboration exercises, online
discussion has evolved into one of the most commonly used communication tools to support blended or online learning today. Online discussions, also known as online discourse or computer mediated communication, can be synchronous (e.g., chat rooms) or asynchronous (e.g., discussion boards). It is a commonly used tool to promote student understanding of a topic and to facilitate social interaction among students or between students and teacher. Some research concluded the promising benefits of online discussion in the blended learning environment.

A positive relationship was found between critical thinking and engagement, as well as peer interaction. This strategy can be applied to a wide range of educational environments to stimulate critical thinking and engagement [14]. Discussion forums are often utilized in the online classroom to build a sense of community, encourage collaboration and exchange, and measure time on task. There is evidence to support authentic knowledge transfer in the online discussion forums on a student-to-student basis but not from faculty to student [15]. Putman et al. [16] concerned about the lack of quality participation from students in online discussion. That is why the teacher needs to design a pre-structured form of discussion environment to scaffold the process of online discussion. The newest finding about the use of online discussion in blended learning environment indicates that using online discussion is likely to lead students to gain a better achievement [17]. In addition, it was revealed that there was a significant and positive relationships between student participation in online discussion and their final course mark. The social interaction and the collaborative nature in online discussion environments as well as the active learning in blended learning courses were likely to be the possible reasons for the increased achievement.

Based on the literature review above, it can be concluded that blended learning with its supporting features such as instructional videos, online assessment, online collaborative exercises, online discussions have great potential in improving students' performance and students’ attitudes. However, a good and careful preparation for the implementation is required from students and teachers as well as schools. In short, well developed blended learning model in terms of content design and pedagogical approach for the teaching and learning of mathematics is a must before it is implemented. Blended learning needs high commitment, motivated teachers and students to guarantee its success.

However, in the context of implementing blended learning approach in Indonesia, several critical questions emerge which are very relevant, as follows (1) how is the best blended learning process which is also most suitable with the students’ characters and schools in Indonesia, (2) Which blended learning model is the most effective and gives the most positive impacts towards essential mathematical competence such as (a) conceptual understanding, (b) reasoning and proof, (c) problem solving, (d) mathematical connection, and (e) mathematical representation and (3) which blended learning process is the most effective and gives the most positive impacts towards the students’ essential characters, such as hard-working, honesty, curiosity, and even adoration for mathematics. This research is part of a larger study on the implementation of video-based blended learning in the mathematic learning process in the 8th grader. This particular research aimed to explore the significance of mathematical abilities and communication skills that arose during online discussions. The formulations of the problems are as follows (1) What types of meaningful students' posts do appear in online discussions? (2) How do the mathematical proficiency and communication skills significantly emerge in the online discussion? (3) How are the differences between male and female students' behavior in online discussion?

2. Method
This research is a part of the larger study. One graduate student and an experienced mathematics teacher collaborated to implement flipped blended learning model. They have trained for a week to create learning videos as the source for online learning, to practice the developed blended learning scenario and to moderate the students online discussion. The research subjects were 40 (20 male and 20 female) grade 8 students of SMPN 1 Denpasar in the academic year 2016. The data were all students’ posts stored in the learning management system used as a tool to support the blended
learning process. Data were analyzed using content analysis techniques and coded using mathematical proficiency [18].

3. Result and Discussion

Table 1: The Distribution of Students’ Post on the Online Discussion

| No. | Description                        | Students |          |          |          |          |
|-----|------------------------------------|----------|----------|----------|----------|----------|
|     |                                    | Male     | Female   | TOTAL    |          |          |
|     | VOL | %  | VOL | %  | VOL | %  |
| 1.  | The number of students             | 20  | 50%   | 20  | 50%  | 40  | 100%  |
| 2.  | Questions-Students' Post           | 187 | 56%   | 138 | 62%   | 325 | 58.5% |
| 3.  | Answers-Students' Post             | 148 | 44%   | 83  | 38%   | 231 | 41.5% |
| 4.  | Total number of students’ post     | 335 | 100%  | 221 | 100%  | 556 | 100%  |
| 5.  | Difference male and female students’ post | 60.3% | 39.7% | 100% |        |

Table 1 shows the distribution of students’ post on the online discussion which took place for 4 weeks (8 meeting). The total students' posts were 556 consisting of 58.5% questions and 41.5% answers. The female students' posts were 39.7% while the male students' posts were 60.3%. It seems that the male students were more active in the online discussion. Furthermore, the male students proposed more answers and solutions than those of the female did (44%: 38%), while the female students posted more questions than those the male did (62%: 56%).

Table 2: The Significance of Students’ Posts on Online Discussion

| No | The Significance of Students’ Online Discussion | Students |          |          |          |
|----|------------------------------------------------|----------|----------|----------|----------|
|    |                                                | Male     | Female   |          |          |
|    |                                                | Vol | %  | Vol | %  |        |
| A. | Mathematical proficiency                      |        |          |          |          |
| 1  | Conceptual Understanding                      | 108   | 32%   | 61,00 | 28% |
| 2  | Procedural Fluency                            | 83    | 25%   | 65,00 | 29% |
| 3  | Strategic Competence                          | 66    | 20%   | 14,00 | 6%  |
| 4  | Adaptive Reasoning                            | 35    | 10%   | 11,00 | 5%  |
| 5  | Productive Disposition                        | 7     | 2%    | 16,00 | 7%  |
|    | SUM                                           | 299   | 89.3% | 167,00 | 75.6% |
| B  | Social Communication Skill                    |        |          |          |          |
| 1  | Clarification                                 | 19    | 6%    | 32,00 | 14% |
| 2  | Critic and Suggestion                         | 11    | 3%    | 6,00  | 3%  |
|    | SUM                                           | 30    | 9.0%  | 38,00 | 17.2% |
| C  | Unclear                                       | 6     | 1.8%  | 16,00 | 7.2% |
|    | Grand Total                                   | 335   | 100%  | 221   | 100% |

Table 2 shows the significance of students’ posts on the online discussion in term of mathematical proficiency and social communication skill. The result revealed that students’ post contained 89.3% mathematical proficiency, in which the conceptual understanding appeared predominantly, followed by procedural fluency, strategic competence, adaptive reasoning and productive disposition. There was also 9% of students’ post contained social communication skill, and 1.8% was unclear posts. It seems also that the male students posted more significant mathematical
proficiency than those the female students did (89.3%:75.6%), while in term of communication skill the female students did better than the male students (9.0%: 17.2%). Finally, the unclear posts were delivered more by female students than those by the male students (7.2%:1.8%).

It can be seen in figure 1 several discussion made by the students and the teacher about the topic of slope.

![Figure 1: Example of students’ post on online discussion](image)

Translation:

1DPS_WA: I want to ask something. Is there any faster way to decide whether it is perpendicular or parallel?

1DPS_CO: My opinion is the same with our teacher

1DPS_JG: My opinion is also the same with what our teacher said (smiling emoticon). Seeing the gradient rather than picturing the line into the Cartesian field one by one is faster.

1DPS_IK: Mr. Sancita (the teacher’s name) will elaborate more tomorrow.

1DPS_TH: Just take a look at the gradients Yu (pointing to his friend), that will be faster. It’s just like what our teacher said, rather than drawing the lines again in the Cartesian field.

1DPS_IW: Find the gradient first, and after finding it we could see whether it is perpendicular or parallel.

The following are students’ posts that emerged in the online discussion which can be viewed as significant representation of the mathematical proficiency [18] which consist of (1) conceptual understanding, (2) procedural fluency, (3) strategic competence, (4) adaptive reasoning, and (5) productive disposition.

**(1) Conceptual Understanding**

This is an example of conceptual understanding appeared in students’ post. It shows how students build their conceptual understanding of parallel and perpendicular line.

1DPS_THE: Parallel lines have the same gradients. Meanwhile, perpendicular lines have the opposite gradients.

1DPS_IWAY: Perpendicular lines gradients are opposing each other.

1DPS_IWAY: If the gradients are the same, it means the lines are parallel, and if the gradients are different, it means the position of the lines is different.

**(2) Procedural Fluency**

An example of procedural fluency appeared in students’ post. The students discussed how the procedure to draw a graph of the implicit equation $ax + by = c$ is.
1DPS_DE : To find the coordinates, find the cutting point between x and y. For example y = 3 and x = 4 in the coordinates. So, you just have to cross-times it so that it becomes 3x + 4y = 12 if we present it in form of ax + by = c
1DPS_MA : We find the coordinates first, then look for the lines equation.
1DPS_IG : Find the coordinates first. Then look for the lines equations.
1DPS_IP : In my opinion, we find the coordinates first, then substitute it to the formula that will be used.

(3) Strategic Competence
An example of strategic competence appeared in students’ post. The students described how the most accurate strategy in determining the line gradient was.
1DPS_COK : It is better to use the formula of ax + by = c or y = mx + c because they are more accurate in defining the values of a and b.
1DPS_IG : Use the formula of ax + by = c or y = mx + c to get more accurate results in finding the value of a or b.
1DPS_TH : To make it more accurate, just use ax + by = c or y = mx + c to find a and b.
1DPS_IW : What’s important here is that the value of x and y has been placed according to their places and order.

(4) Adaptive Reasoning
An example of adaptive reasoning appeared in students’ post. The students build reasoning about slope and gradient.
1DPS_KO : There should be. Gradient is used to measure the slope of a function chart. If there is no function, then we could not measure the slope of that chart.
1DPS_TH : Satyadi said that a = 4, means that the gradient is -1/3 because y2 – y1(a) is 3 – 4 which is -1. If a is 1, it becomes 3 – 1, the results we get is 2, Sir.
1DPS_MD : Maybe it was miscounted in y – 2 = 2(x – 10) which was answered by our teacher with -2x + 10 which was supposed to be -2x + 20. Maybe there’s a mistake there.

(5) Productive Disposition
An example of productive disposition appeared in students’ post. It proves that students have been able to see the benefits of mathematics being studied for everyday life as well as other scientific fields.
1DPS_TH : Learning gradients could be implemented in daily life for example to help measuring the slope of objects such as ladder or others (if we want to be a designer, architect, or to make something, etc.)
1DPS_IW : Parallel and perpendicular lines are used to design a building. Parallel lines are found in the fame and the perpendicular lines in the foundation.

The results of this study indicate that concerns about the quality of online discussions as said by [16] did not occur. On the contrary, many empirical pieces of evidence showed that the online students' post contains significant and validated mathematical proficiency. This evidence was being mapped with 6 aspects of mathematical proficiency according to [18]. The male and female students produced different, important mathematical proficiency and communication skills in online discussion dashboard. The male students participated and delivered posts that contained conceptual understanding, adaptive reasoning, and strategic competence than those the female students did. Meanwhile, the female students contributed more on social communication skills as well as mathematical disposition. In short, it can be concluded that online discussion was able to create very significant mathematical proficiency (conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, productive disposition) and communication skills (clarification, advice). This result is consistent with the previous research conducted by [15], [14] and [17]. But further research is needed to explain the relationship between student activities in online discussion and student performance.
4. Conclusion
(a) There was significant mathematical proficiency and communication skills appeared in the online discussion dashboard, (b) The total students' posts were 556 consisting of 58.5% questions and 41.5% answers. (c) The female students' posts were 39.7% while the male students' posts were 60.3%. (d) The posts of female students contained 75.6% mathematics skills, 17.2% communication skills and 7.2% unclear, while the male students' posts contained 89.3%, 9.0%, and 1.8 % for that category. (e) It can be concluded that online discussion was able to create very significant mathematical proficiency (Conceptual Understanding, Procedural Fluency, Strategic Competence, Adaptive Reasoning, Productive Disposition) and communication skills (Clarification, Advice). (f) Female students appeared less active in online discussions than male students did. Female students had given more contribution to the communication skill, while male students had more actively participated in building mathematical skills. (g) Further research is needed to explain the relationship between student activities in online discussion and student performance.

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References
[1] Jakaria M H D, Sudiarta I G P and Gede Suweken 2014 'Pengembangan Media Pembelajaran IKRAR Berbasis Video Untuk Meningkatkan Prestasi Belajar Siswa Kelas VII (Developing Video Based IKRAR Learning Media to Improve Grade VII Students’ Learning Achievement) ’, J. Pendidik. Mat 3 8-14
[2] Horn M B and Staker H 2014 Blended: Using Disruptive Innovation to Improve Schools (San Francisco: Jossey-Bass)
[3] Lalima and Dangwal K L 2017 Blended Learning: An Innovative Approach.’ Univers. J. Educ. Res. 5 129 - 136
[4] Joordens S, Le A, Grinnell R and Chrysostomou S 2009 Eating Your Lectures and Having Them Too: Is Online Lecture Availability Especially Helpful in “Skill-Based” Course? Electron. J. E-Learn 7 281–288
[5] Orabuchi N 2013 Effects of Online Visual and Interactive Technological Tool (OVITT) on Early Adolescent Students’ Mathematics Performance, Math Anxiety and Attitudes toward Math (Texas: Dissertation Texas Woman's University)
[6] Stenbom S, Hrastinski S, and Cleveland-Innes M 2012 Student-Student Online Coaching as a Relationship of Inquiry: An Exploratory Study from the Coach Perspective J. Asynchronous Learn. Netw. 16 37–48
[7] Leong K. E and Alexander N 2013 Exploring attitudes and achievement of web-based homework in developmental algebra Turk. Online J. Educ. Technol. 12 75–79
[8] Osmanoglu A, KOC Y and Isiksal M 2013 Investigation of Using Online Video Case Discussions in Teacher Education: Sources of Evidence of Mathematics Learning Educ. Sci. Theory Pract. 13 1295–1303
[9] Lin Y W, Tseng C L and Chiang P J 2017 The Effect of Blended Learning in Mathematics Course EURASIA J. Math. Sci. Technol. Educ. 13 741-770
[10] Lee J 2014 An exploratory study of effective online learning: Assessing satisfaction levels of graduate students of mathematics education associated with human and design factors of an online course Int. Rev. Res. Open Distrib. Learn. 15 111-132
[11] Umoh J B and Akpan E T 2014 Challenges of Blended E-Learning Tools in Mathematics: Students’ Perspectives University of Uyo J. Educ. Learn. 3 60 - 70
[12] Francis K and Jacobsen M 2013 Synchronous online collaborative professional development for elementary mathematics teachers Int. Rev. Res. Open Distrib. Learn 14 319–343
[13] Mallet D G 2008 Asynchronous Online Collaboration as a Flexible Learning Activity and an Authentic Assessment Method in an Undergraduate Mathematics Course EURASIA J. Math. Sci. Technol. Educ. 4 143–151
[14] DeNoyelles A and Foster B R 2015 Using Word Clouds in Online Discussions to Support Critical Thinking and Engagement Journal of Interactive Online Learn 19 n(4)
[15] Tucker J P, YoungGonzaga S and Krause J 2014 A Proposed Model for Authenticating Knowledge Transfer in Online Discussion Forums Int. J. High. Educ. 3 106 - 119
[16] Putman S M, Ford K and Tancock S 2012 Redefining online discussions: Using participant stances to promote collaboration and cognitive engagement Int. J. Teach. Learn. High. Educ. 24 151–167
[17] Alzahrani M G 2017 The Effect of Using Online Discussion Forums on Students’ Learning Turk. Online J. Educ. Technol. 16 164-176
[18] Kilpatrick J, Swafford J and Findell B 2001 Adding it up: helping children learn mathematics. (Washington, DC: National Academy Press)