A Model of Mathematics Research Community in the Context of Indonesian Higher Education

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Abstract

Community is essentially a needed vehicle in academic world including those related to research activities. Through community, ideas from its member could be developed by continuance research so that original ideas are born which could enrich the treasury of knowledge development. The model of mathematics research community offered in this article emerges from the demand to increase the productivity of well-qualified research both among the students through their final assignment and among the lecturers. The model offers inter-related research activities among students and lecturers whether it is internal or cross-universities. Through this model, it is expected that the productivity of research outcome could always be increased in line with the improvement of its quality.

A. Introduction

The research productivity of a discipline including mathematics can be observed from its outcome. The numbers of research articles written by Indonesian mathematicians acknowledged internationally are still low. Since the birth of Indonesian first doctor in mathematics in 1919 until 2006, it is noted that there are only 163 papers written by Indonesian mathematicians observed by *Mathematical Review* (Gunawan, 2007). *Mathematical Review* is an online database organized by *American Mathematical Society*. The database contains evaluation result and synopsis of mathematics article, statistics, and theoretical computer science. The productivity of research is very contras compared to Malaysia which has published 701 papers and to Singapore with 4741 papers.

The previous explanation describes that the productivity of mathematics research in Indonesia is generally still very low. It also becomes an indicator that the development of mathematics in Indonesia is still limited to the use of all existed mathematics laws and products and has not touched the level of new innovative concepts. Therefore it can be concluded that Indonesian mathematician community has not acquired sufficient research culture and innovation.

As a result, an atmosphere which could grow and develop research activities is needed so it can reach the innovation of new concepts. In university level, this atmosphere can be created through a research community (later will be short as RC) which consists of the element of students and lecturers. Through this community, lecturers' research capability will always be sharpen and could affect the students to enter and love research world.

Literature studies show that the abilities to do innovation and research are influenced by the abilities to think creatively and critically (Suryadi: 2005). Therefore, this research would construct an activity model which makes use the ability of creative and critical thinking based on research community. The combination of creative and critical thinking abilities and well research culture is expected to increase the productivity of research in general.

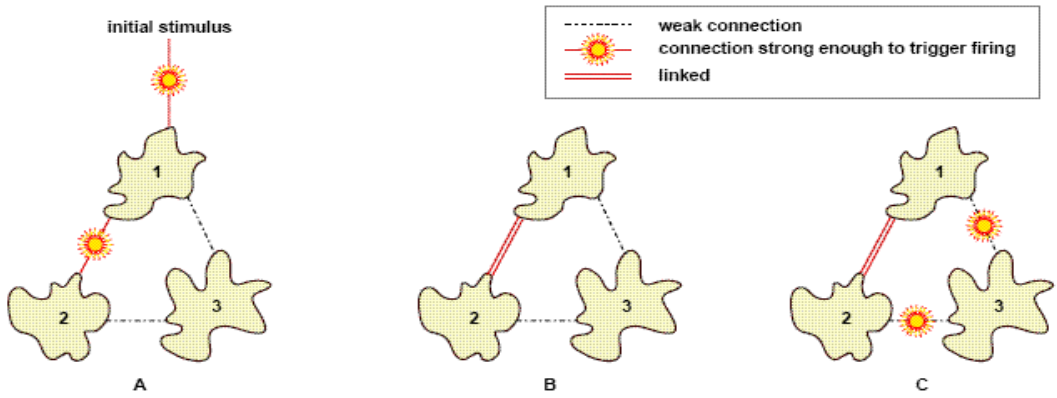
B. Mathematics Research: Why It Needs Community?

The development of creative and critical thinking abilities is very important in mathematics because through these abilities someone would be able to explore the existing information so that innovative information derived presented attractively and

interestingly. One of the strategies to develop both thinking skills can be done under a circumstance in which someone is actively involved as a member of a research community. The importance of research community as a learning vehicle is based on several reasons. Firstly, there are many lecturers who are not optimum yet in conducting a research. Secondly, students are individuals who have not acquired full independency yet in the development of new knowledge. Thirdly, the thinking process of someone who is involved in a research community will always get encouraged and developed so she or he could do information exploration more productively. It can be understood because through the activity in research community, a serial mental action which leads to thinking productivity will always happens so that it could produce new potential ideas to support the process of new knowledge development.

The Development of ZPD in a Learning Community

The emerging process of new knowledge (especially in mathematics) is believed as a result of a series of process which is introduced by Dubinsky as *Action-Process-Object-Schema (APOS)*. The object which has been stored in someone's memory as knowledge will be processed when an *action* happened by certain stimulus. This process is explained by Tall (1999) through the following diagram.



APOS theory is a constructivist theory about how someone learns a mathematical concept. Basically, the theory is based on the hypotheses of the essence of mathematical knowledge and about how it is developed. That theoretical perspective is explained by Dubinsky (2001, p.11) who stated that,

> *An individual mathematical knowledge is her or his tendency to respond to perceived mathematical problem situations by reflecting on problems and their solutions in a social context and by constructing mathematical actions, processes, and objects and organizing these in schemas to use in dealing with the situations.*

The terms of *action, process, object,* and *scheme*, is someone's mental construction in order to comprehend a mathematical idea. When someone tries to comprehend a mathematical idea, the process will start from a mental action of the mathematical idea, and eventually reach the scheme construction about a certain mathematical concept covered in the given problem.

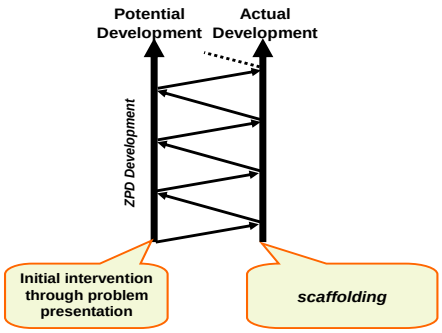
Action is a transformation of mental objects to obtain another mental object. This is experienced by someone when facing a problem and tries to connect them with prior knowledge. Someone is called having an action if trying to focus on mental action to understand a given concept. Someone who has a deeper comprehension about a concept may do better action or it may also happen that the focus of attention goes beyond the given concept so that the expected action does not occur.

When an action is repeated, and reflection of the action happens, then it will enter the process phase. Different from action, which might happen by exploring concrete

materials, the process happens internally under the control of the doer. Someone is called experiencing a process about a concept covered in the facing problem, if her or his thought is limited to the mathematical idea being faced and is indicated by the ability to describe or to do reflection of the mathematical idea. New processes can be constructed from another process through a coordination and correlation of every process.

If someone do a reflection of an operation used in a certain process, becoming conscious of the process as a totality, realizing that certain transformations could apply to the process, and could do the transformation, it can be stated that the individual has made the construction process becomes a cognitive object. In this case, it can be stated that the processes have been encapsulated become a cognitive object. Someone can be said to own an object conception of a mathematical concept when she or he has been able to treat the idea or concept as cognitive object which covers the ability to do an action to the object and give reason or explanation about its characteristics. Besides that, the individual has also been able to do *de-encapsulate* process of an object to be a process of how it was initially when the characteristics of the object will be used. A scheme of a certain mathematical material is an action collection, process, object, and another inter-related scheme so it constructs an interconnected framework in someone's brain or mind.

If the process of schema construction is approved like the previous explanation, the next step is how to do a mathematical-thinking so that a more optimum result can be achieved. One of the foundations that can be used to achieve the result is the theory of Zone of Proximal Development (ZPD) from Vygotsky. Someone's cognitive-skill development is divided into two stages, namely the *actual* and *potential development* stage. Actual development is derived from self-effort when do problem solving of a problem. Meanwhile, potential development is derived from an interaction with other who has higher ability. The distance between the two developments is called the ZPD. According to Suryadi (2005), the process to reach actual development can be facilitated by the creation of cognitive conflict. Through the implementation of indirect learning approach, a series of continuance actual and potential development can be encouraged which is called ZPD development model. This model is developed by Suryadi (2005) which is explained through the following diagram.



The development process of ZPD can be started through the creation of cognitive conflict which can be done through the presentation of problem or the exploration of concept-deepen in a community. Through discussion which occurs in that community, the process to reach continuance actual and potential stages for every member can happen. The process will always happen when community members always interact. The process is in line with the *Theory of Knowledge Creation* as it is explained by Nonaka (2005). According to the theory, there is an interaction model between two types of knowledge which are *tacit knowledge* type and *explicit knowledge* type. *Tacit knowledge* is a subjective and experiential knowledge that could not be expressed yet in the form of words, sentence, number, or by definitive formula. Therefore, *tacit knowledge* is very relative and tightly related with the context known by the owner or the prior knowledge. Meanwhile, *explicit knowledge* is an objective and rational knowledge which

can be expressed in form of words, sentence, number, or by definitive formula so that it can be stated as a knowledge which are free of context. In someone's knowledge development process, both of the two types of the development are tightly inter-related one to another. For example, someone's knowledge derived from an observation (*tacit knowledge*) is influenced by the prior knowledge (*explicit knowledge*). A child faced to a certain geometrical shape, for example a rectangular area which is made from carton, then when the child is asked to describe the geometrical shape, the description will be related to her or his prior knowledge. Therefore, definitive knowledge can be a reference framework to construct a new knowledge; meanwhile, the new knowledge which has not been definitive can be a foundation for the creation of a new definitive knowledge.

Tacit knowledge formed based on the result of someone's observation or experience can grow into an *explicit knowledge* through individuals' interaction. If a number of individuals involved in a discussion, different *tacit knowledge* will occur according to the reference framework that each individual has. The exchange of tacit knowledge in a discussion will force the construction of a productive new knowledge especially if the involved-individuals in that discussion has different knowledge background.

C. The Model of mathematics Research Community

This section will explain about the components relate to the Mathematical Research Community and its activity including Expertise group (EG), Interest Group (IG), and Research Milieu (RM).

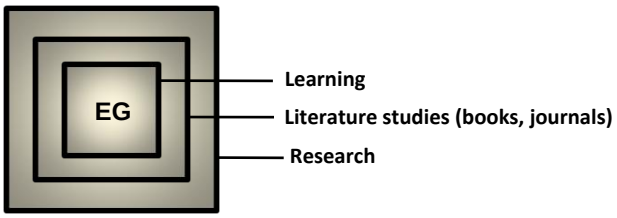
Expertise Group (EG)

Basically Expertise Group (EG) will naturally formed by itself as a consequence of the existence of a group of subjects such as Analysis, Algebra, Statistics, Geometry, and Computation. However, even though the existence of EG is admitted to exist in Mathematics subject, but its work in doing research for the need of subject's material development, material enrichment, contemporary material discussion, or to do science development through research, depends on the academic culture developed in each EG.

The members of EG naturally has a relationship with other members because it has the same skill and knowledge. Therefore, if a problem related with the skill occurs, a discussion between the same EG will automatically happen because in order to solve the existing problem will be more likely possible if it is handled by the lecturers with the same expertise. This natural relation is essentially a potential foundation to grow cooperation in facing many academic problems related to EG. If the cooperation is increased to be a more functional relation in terms of self improvement, academic carrier development, self existence development, and in a more broaden aspect, this EG will grow as an innovation agent in knowledge development which has a potency to create a positive image academically both for the individual and the institution.

Actually, a lecturer has a moral responsibility to work academically in teaching, researching, and giving public service. Teaching is essentially a basic aspect of academic work because through this activity, a lecturer has a possibility to disseminate ideal thoughts to the students. Idealism signs a modest value which historically always assisted with the struggle to fight for it. In other word, to fight for making the ideal thought comes true is the daily activity which has been internalized with the life of academicians.

In doing a research related to the subjects of concern, it will be very ideal if it is done in the context of EG. So it is possible that this research would emerge new problems that could not be solved simply and it may require a research activity. If this activity is chosen by the lecturers, their comprehension, knowledge, and confidence will be improved every time. This is the escential meaning of EG which can be illustrated in the following figure.



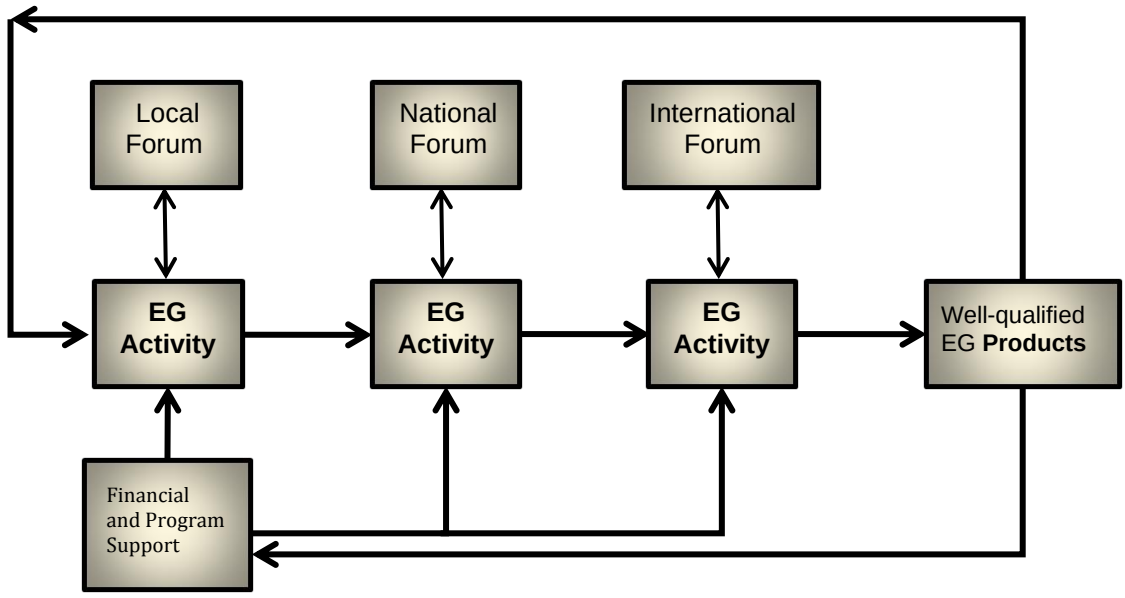
This illustration describes that EG consists of 3 layers namely the inside, the middle, and the outside layer. Those three layers will then always be called as Level-1, Level-2, and Level-3. The focus of Level-1 tends to be more on learning issue. Therefore, even though the member from this level do material research, its characteristics might not be substantial but only limited to the effort to search the alternative materials to obtaint more effective learning processes. For the second level, not only doing learning research but also do another research especially enrichment material through alternative book studies, new books, higher level books (for example those which are labeled GTM), or contemporary issues which are usually derived from relevant scientific journals. The third level is the most ideal EG in which that it is not only doing learning research, enrichment and contemporary material research, but the members also doing knowledge development through research activity. EG with this activity is said to be ideal because the member can be made sure to have broad knowledge which always expanding so that when having a class, it has a possibility to influence the material exploration in the lecturing process.

To encourage more EG activities to the third level, a program that could facilitate EG members is needed to be able to improve the academic situation so that it could gradually increase the activity to the third level. The most basic aspect to encourage the occurrence of this activity is the availability of contemporary material research periodically provided by the institution. If this research material available, there would be no reason for EG members not to do research because the fact shows that the demand to always improve the knowledge and expertise are some things naturally demanded in academic life. This is very rational because how a lecturer would be able to give an optimum academic service especially in the process of assisting the students to finish their final paper, if the lecturer does not do self-improvement through EG activities in each level. The research that would be conducted by the students for their final assignment will pretty much likely in line with the national and international knowledge development. Therefore, lecturers' effort in EG is to be able to guide the students needs to be done through the third level research. This means that EG should have a research agenda so that students with the same interest could easily obtain a relevant research idea.

The availability of research material has not been a guarantee for the lecturers to directly increase their EG activities up to the third level. Therefore, other program which consists a demand for EG to regularly conduct investigation needs to be developed. Dissemination of research outcome will become a tangible evidence of the existence of EG activities such as seminar papers, journal articles, or might be new textbooks developed by EG. In UPI case, support program to encourage this activity has been provided by the university in the form of research fund for the novice researchers which are called Developmental Research Grand, Competitive Research Grand, Doctoral and Non-Professor Research Grand. Besides, research fund from the Directorate General of Higher Education (in Indonesia it is called DIKTI) which is provided through many competitive grand is a very positive element which could encourage EG activity productively. University's and DIKTI's support fund needs to be made optimum by EG to improve the academic culture and situation which leads to a better image and existence

of EG so that its existence is well considered in the national and international academic environment.

Once the activity of EG starts, the next important effort is to maintain the continuance, and increase the productivity and quality of the research outcome. To bring about this effort, scientific forum both national and international scale should be started to be attempted. Through the developed forum, it is possible to establish new tied-deals for the community members so that it will be a new motivation to always do research so that every EG member could individually fill the activity of the forum regularly. The scientific forums attended by the EG members will certainly motivate the productivity of EG and will always in line with the ability to improve the quality. This is because through the expose of research outcome, every new explained-idea will get comment, input and even critical view which could be followed up through the next research so that the quality of the masterpiece can be developed and improved from time to time. The explanation can be illustrated in the following figure of EG activities.



EG Activity

This section explains examples of EG activity based on the experience of Mathematics Department in Universitas Pendidikan Indonesia (UPI, Indonesia University of Education). The activities presented cover routine research activity such as those which deal with learning issues, curriculum implementation, inter-subjects relationship, textbook content used in teaching, new textbooks review, mathematical proofs, basic ideas for research activity for both lecturers and students.

Discussion on Learning Issues

EG activity in the first level is a basic aspect of academic life in university level. One of the activities that can be done in this level is the discussion related to the learning issues. For lecturers, it is considered that learning issues can be an interesting topic to be discussed. Difficulties or special aspects in the lecturing process related to the students' characteristics can be an interesting discussion topic. Besides, we can also discuss about the characteristics of students in the same year on several different subjects. For example, discussing the ability of first year students in the subjects of Foundation of Mathematics and Calculus not only becoming an interesting topic, it could also be a controller of the lecturers' performance and the curriculum implementation. For example, it needs further investigation to figure out why the same year students

have a good performance in several subjects but has less performance in the other subjects.

Discussion on Curriculum Implementation

The results of EG discussion can be raised to be a department policy or decision. This kind of policy is easily accepted by many sides because it is bottom up. Several department policies that can be raised from EG discussion are: (1) the determinate and the depth of a subject matter, (2) the determination of the types and evaluation process of a subject matter, (3) the arrangement of subject matter group, such as analysis, algebra, statistics, application, or computation, and (4) the arrangement of teaching schedule.

Discussion on Inter-Subjects Relationship

Gradual process of mathematical concepts understanding of every subjects is expected not to make the mathematics comprehension becomes partial. Essentially, a research topic has a good connection between one to another, directly or indirectly. Direct relationship can be a requirement for another topic. In this case, a subject requires the complete of another subject. For example, Real Analysis is a requirement for taking Functional Analysis because the comprehension of the concepts in Functional Analysis depends on that of Real Analysis concept. In other word, one subject is a continuance of the other subject. Therefore, connection between one subject to another should be made clear. As a result, the textbooks handed should be appropriate. For example, it will be very good if the textbook for Abstract Algebra is carefully chosen to be able to show the connection of this subject with Linear Algebra, Calculus, Real Analysis, Complex Analysis, etc. Sometimes a textbook is not explicitly stated its connection with the other subjects. A discussion between lecturers who take care different subjects, for example between those who take care of Calculus and those who take care of Algebra will really help this problem. From this kind of discussion, the connection among concepts in different subjects could be derived.

Interest Group (IG)

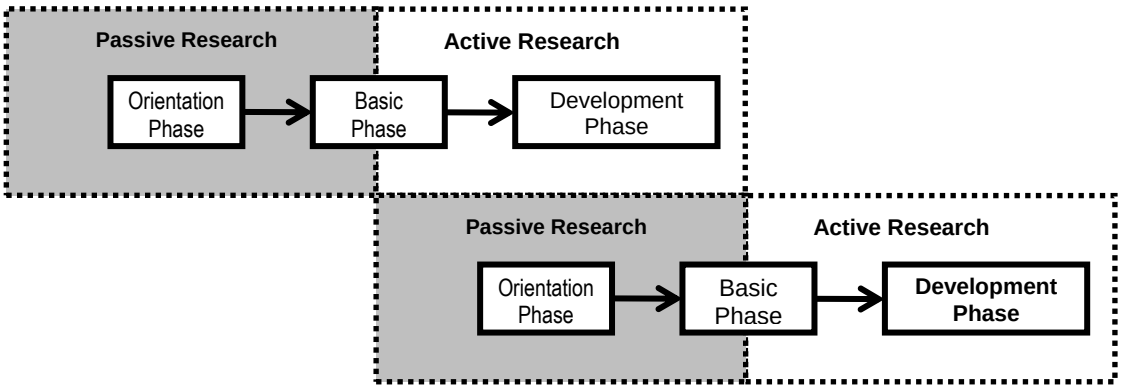
Different with lecturer groups gathered in EG based on their expertise, students could gather in a group based on their interest, especially related to the final paper that they are about to write. Therefore, the research group for students with the same interest can be called as Interest Group (IG). Based on the previous experience, in the Department of Mathematics Education in UPI, students' interest is focused on four research group namely Analysis, Algebra, Statistics, and Computation. This evidence is pretty much more likely because the EG in this institution is also focused on those four research groups. Students' research interest upon a discipline might be based on many reasons whether pragmatics or ideal reason. Nevertheless, whatever the students' reason is, eventually they have to be able to work hard to finish their final assignment punctually with good quality. It is not easy to achieve the goal because the complete of the final paper with good quality could not be separated from the systematic and continuously efforts which have to be done since the very beginning of their study.

Even though in almost the end of their study at university, students will naturally gather in accordance with their interest in taking several chosen subjects, however this process could not merely develop IG as a group who has a research orientation. In fact, until the end of their study, there are many students who are worried to decide the subjects that they will choose. Therefore no wonder that generally, students could not finish their study punctually. Consequently, academic situation outside the lecturing process should be conditioned so that since the very beginning of their study, students should be involved in research situation whether it happens in IG or EG. That research situation could be developed in the form of local,

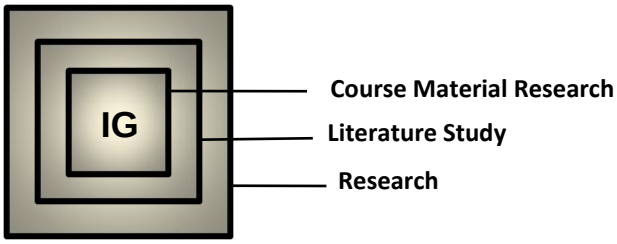
national, or international forum, or the dissemination of students' and lecturers' research on journal, proceeding, or yearbook.

If we take a closer look to the journey of the students since they enter the first grade until they finish their study for undergraduate level, it can be divided into three phases namely *orientation phase, basic phase*, and *development phase*. In the orientation phase, students generally still do many adjustments whether it is about how to learn, how to socialize, and how to live independently because generally it is their first time to live separately from their parents and family. In academic life in this phase students also still do orientation by following general courses which consists of many values to develop social knowledge and personality. After going through the orientation phase, students come into the basic phase by taking several basic-science subjects which are important for the next knowledge development. The last phase of their study journey is development phase where usually leads to specialization by taking several subjects in line with the interest of every students. In this phase students should start to focus on thinking and doing research for the requirement of their study.

Basically, Research Situation can be introduced to the students since orientation until about the basic phase. In that phase they start to be introduced to the investigation of research outcome both for the students and lecturers through many formal and informal forums organized by EG or IG and the exhibition of written research and investigation. In this phase, the involvement of students in the academic forums is still passive so that we can call it passive research. Meanwhile after they enter the middle part of basic phase, it seems that students should start to actively enter the research forum. Active research means that students have had enough basic knowledge to start to learn to explain mathematics ideas in IG based on their interest. Because at the same time, there will be a number of students in the basic and the development phase, and there is another number of students in the orientation and basic phase. For the students in the development phase it is their turn to take initiative to do active research, meanwhile for another phase students, they have just started to do passive research. The situation can be illustrated in the following figure.



Even though in orientation and basic phase the students have just been able to do passive research, it does not mean that they do not do the research actively. This last mentioned research is related to the course materials. Therefore students' activity can be started by examining basic ideas derived from course materials and followed with advanced mathematical ideas and lead to the research activity for the final assignment. Therefore, IG activity for students is essentially will be the same like the activity developed in EG of the lecturer as it is shown in the following figure.



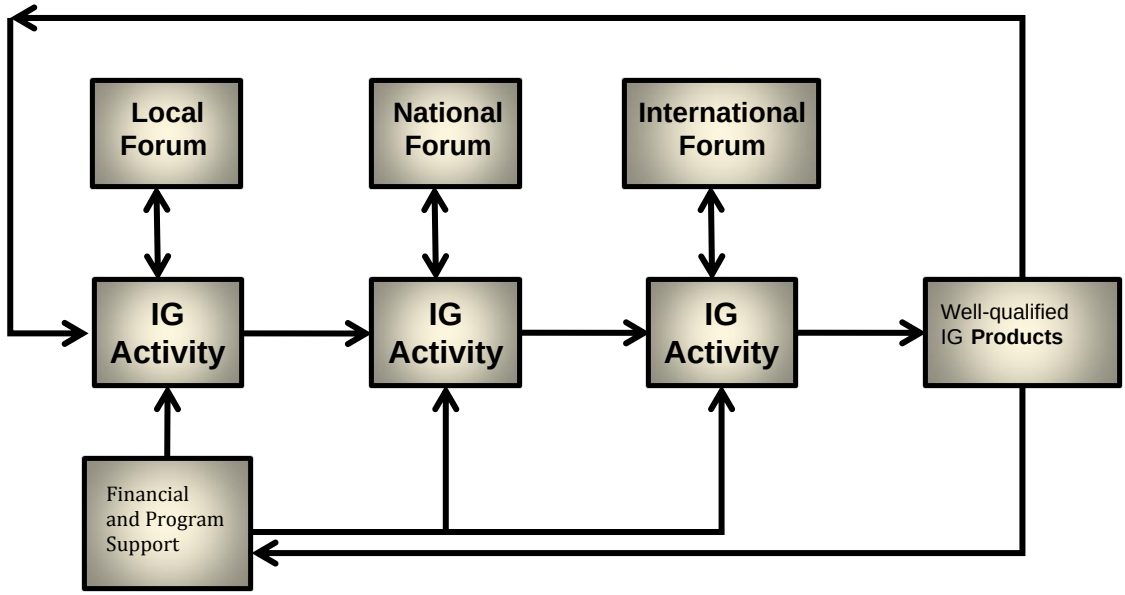
This illustration describes that IG consists of three layers which are level-1 (in the inside), level-2 (in the middle), and level-3 (in the outside). Focus of IG in level-1 is more to the course material issues. For the second level, not only doing research of course materials, they also conduct another research especially about enrichment material through alternative source book research, new textbooks, higher level books such as those labeled GTM, or contemporary issues usually derived from relevant scientific journal. The third level is the most ideal IG in which that the members not only do course material research, enrichment material and contemporary research, they also do research activity. IG with this activity is said to be ideal because the members could be said as having broad knowledge which always expanding, so that when they come into the last phase of their study they will easily finish their final assignment.

To encourage the emerging activity of IG in the third level, a program which systematically could facilitate the IG member is needed in order to be able to improve its level of activity up to the third level. The most basic aspect to encourage the activity improvement is the availability of contemporary material which periodically provided by the department up to the university level. If these materials are available, there would be no more reason for IG members not to do research because the fact shows that the demand to always improve the knowledge and ability is a natural thing to do in academic life. This research can be done internally in IG environment or in a certain context; students are possibly involved in the activity of EG. And even, for the students who are doing final assignment research, their involvement in EG is not only as a passive participant but they could also present their research so that they receive more critical advice that would be an input for the completing of their final paper. It is possible that the research done by the students is a part of EG wider research, so that their existence in EG activity supposedly happen.

The availability of research material and the occurrence of scientific forum in the university, has not guaranteed the students to directly improve IG activity up to the third level. Therefore, another program which consists of the demand for IG to regularly conduct research is needed. The demand can be the orders of research result done in small scale or big scale which involves many people. The research result which could be an evidence of the existing of IG activity, for example research outcome report, seminar paper, or article journal. Research fund form the institution or government is a positive aspect if it involves student in the completing of their final assignment. For several research grand even there is a demand to involve students in the research activity. If it is well organized, the effort to improve research productivity and quality can be realized soon.

Once the activity of IG has been started, the next step to do is to maintain its continuance and improve the quality and productivity of the research outcome. To bring about this effort, students' involvement in scientific forum range from local, regional, national, up to international forum should start to be done. Through the developing forum, it is possible to give new inspiration for students so that it would give new motivation to do the research in continuance. If the scientific forums followed by the IG members are varied, from local, national, and international level, it would trigger the productivity of students research which would influence their study complete. If students have a chance to present their research through scientific forums, there will be a chance to receive comment, input, and even critical views that can be followed up

through further research so that the quality of the developing work will improve from time to time. The explanation will further be illustrated in the following.



The Figure of Continuance IG

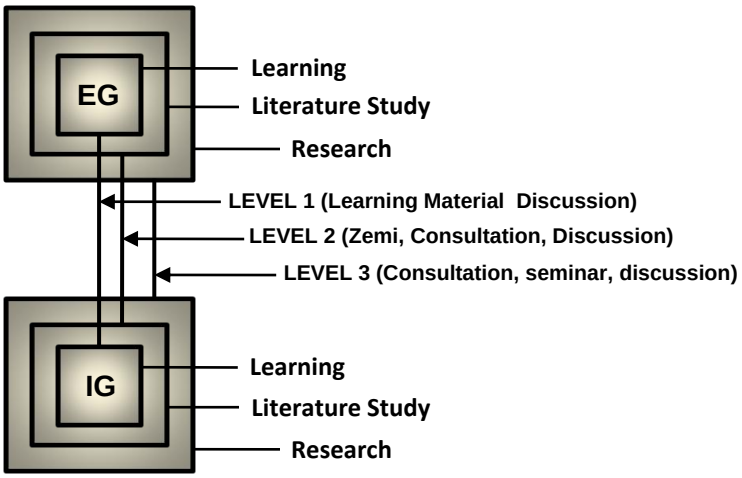
The Relationship of EG–IG

As previously explained, there are 3 activities level which would be done in EG and IG circumstances namely the investigation of learning material, enrichment material or intensification of advance textbooks or journal article, and research. However, there is a basic difference of both groups as it is shown in the following table.

EG Activity	IG Activity
Course material research is conducted to fulfill the following purposes: finding more effective way to achieve learning goal, finding didactical design that could help students to study easier, enriching learning material by adding contemporary issues, investigating the relationship of every subject so that the implementation of the curriculum will be more synergic	Course material research is conducted by students to fulfill the following purposes: understanding the concept being learned, practicing to do problem solving regarding the learned material, solving the difficulties in the learning process, deepening the material
Investigating new issues to: enrich learning material, increase the knowledge in line with the expertise, find inspiration to get the basic ideas to develop the expertise	Investigating new issues in order to find basic ideas to do final assignment research
Conducting research in terms of knowledge development	Conducting research to fulfill the final assignment which also to develop the knowledge

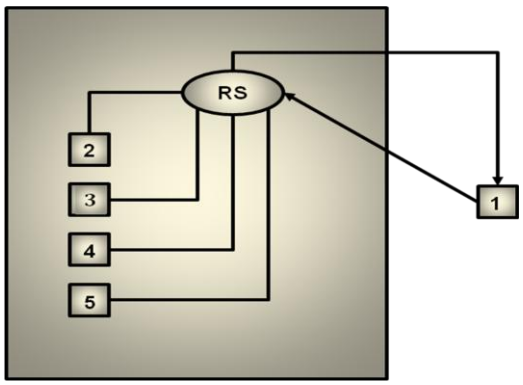
Even though the research characteristics done by the two groups are different, but in fact, the implementation of the activities done can make a synergy between one to another so that students get benefit from the developing academic circumstance especially when both groups are interacted. In accordance of the activity level in each group, the level of relationship happened could also cover three levels of corse material research, enrichment research through advance textbook discussion or journal article,

and research activity. Therefore the relationship between those two groups can be illustrated in the following figure.



Research Milieu (RM)

A community might be easy to be built as an organization so that the job desk and its membership clear. However, if a community is related to a certain community including research, there is new aspect to be considered which is how each community developed could do a continuance activity so that the productivity and quality of the research output will improve from time to time. To achieve the expectation, a community model needs to be found to guarantee the occurrence of sustainable activities. One of the ways to encourage the expecting activity is to develop a research activity as a *Research Milieu (RM). Research Milieu* is a community model that existence depends on *research situation (RS)* created by community members individually or in group. Therefore, this *research milieu* will automatically be developed when the *research situation* in the community always maintained. On the other hand, if there has never been *research situation*, the *research milieu* will automatically disappear by itself. To have a clearer picture about this research milieu, here is the illustration.



Research Milieau (RM)

This illustration shows that community (1) creates an RS in the community so that responds to the situation occur. The interaction that happens in every community members will motivate the occurrence of deep thinking especially for (1) and also for another side so that RS will grow dynamically in line with the critical ability of the existence community members. The productivity and the quality of research outcome are actually influenced by the productivity and well qualified research outcome which are developing in an institution. In order to obtain the goal, RM culture should be grown up since the students begin their study at university. There are several stages that have

to be done by students so that at the end of the learning process they would be able to contribute in creating a qualified RM. The stages are as follow: (1) Introduction, (2) finding basic ideas, (3) formulizing the issue of research idea, (4) developing and elaborating, (5) socialization, and (6) publication.

Research milieu will happen in the first until the fifth stage. The students in introduction stage are those who enter orientation phase. In this stage, students' involvement has not been based on interest, but only as a first introduction to do investigation. As a novice RM member, students could learn from other senior members. The things learned are about how to present a mathematical idea which could create RS, what kind of mathematical ideas appropriate to be raised, where the inspiration is from, how to give comment to the expanding RS, how to raise a question and how to critically elaborate the ideas and comment which emerge as the respond of dynamically-expanding RS. From another RM followed, students are expected to know the characteristics of every discipline deeper so that eventually will get interest to one of the disciplines, and when they come into the middle of basic phase, they have already had an understanding to choose one of the IG (Interest Group).

The finding of basic idea will be started when the students join one of the IG permanently. This stage is ideally started when students come into the middle of the basic phase. The activities done are doing research of advance mathematics materials, previous research results, and the latest journal articles. By following the routine activity of RM as an active member and giving more thoughts contribution for the expanding-RS, at the end of the basic phase students are expected to have found basic ideas regarding the research issues that would be deeper investigated. At that time, they have been able to start their role in RM as a member who could create RS. Critical comment and another respond to RS are important aspect to do further exploration until the status of basic idea increase to be a hypothesis ready to be investigated further. In the time that students get into the development phase, ideally they have been able to make their hypothesis even though it is only a beginning. However, because of the involvement of students in the RM activity between students and lecturers continuously happen, the hypothesis would be further elaborated to be socialized through seminar forum (for example between IG or EG) so that through bigger RM which involves many IGs, critical comments which could improve the quality of the scientific work is expected.

If the scientific work developed by the students is considered well-qualified both from the aspects of originality and content, it is possible that the work is published in a scientific journal. To obtain the goal, the role of lecturers as an advisor is very important to bridge the possibility of publishing the work into a journal. This effort is importantly done because there would be several positive aspects both for the graduated students and for the lecturer. For a university alumni, the evidence of the scientific work which has been able to be published in a scientific journal means a recognition of the work from the related community which also become a good capital to work in the job field. When an alumni of a university try to apply for a job, one aspect that could use as a strength is the recognition of certain community. Published scientific research is basically recognition of the writer's capability. Besides, the scientific work would also be very beneficial when the writer willing to continue her or his study, especially in the universities abroad which really appreciate someone's scientific work, so that when the student recruitment takes place, one of the most frequently question is about the scientific work which has ever been written or published.

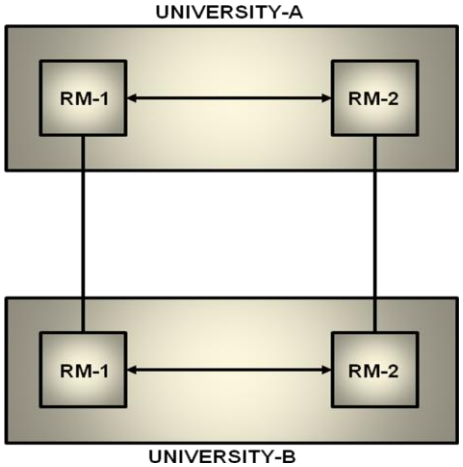
To encourage the growth of research activity among students, the important thing to be developed is a conducive academic situation so that the students could feel the existence of *research milieu* since the very beginning both among students (IG) and especially among lecturers (EG). Growing up this circumstances, EG activities which lead more to the research is something which have to be programmed continually by facilitating the activities which might be done and create a forum and scientific publication periodically. By this effort, then the demand to always create something

both for the lecturers and the students could emerge automatically as a consequence of routine demand which has to be fulfilled by every member of EG and IG. If it is possible, best investigation and research from each EG and IG are facilitated in the form of yearbook or scientific journal, so that it's not only becoming a pride for its member but also will trigger a motivation for the new students to do better and qualified in the future.

The Relationship between RM

Investigation of research activity does not always happen in the same community. It is because there would be a possibility of cross-discipline research. For example, for a community or students who have willing to investigate industrial and financial issues in terms of future probability, to design methods, to lessen the probability of unexpected event and lessen the negative effect of future activities, so the research is cross-discipline between mathematics, statistics, and economy which now is called actuarial discipline. The relationship between RM not only could occur because of the same attention of an issue with different perspectives, but also to exchange the information of the new research so that academics circumstances could motivate each other. This relationship could occur through collective activity in form of conference or seminar which provides a chance to each RM to present their research. Through this activity, every RM could do benchmarking of each other about the improvement that has been achieved by each RM so that a healthy competitive situation can be obtained which could motivate to always do research.

The similar RM relationship could also occur between universities. This relationship is very important to be done as benchmarking effort and create a synergy of every university. The potency could be related to the existence of human resources with different expertise, different research focus, and different superiority of every side so that in order to achieve the improvement with higher acceleration, mutual cooperation is needed which can be done by the similar RM of every university. The following diagram shows the relationship of RM in university or inter-universities.



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