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The effectiveness of formative assessment with understanding by design (UbD) stages in forming habits of mind in prospective teachers

R Y Gloria^{1,2,*}, S. Sudarmin¹, Wiyanto¹ and D R Indriyanti¹

¹Program Pascasarjana Universitas Negeri Semarang, Indonesia.

²Tadris IPA-Biologi IAIN Syekh Nurjati Cirebon, Jawa Barat, Indonesia

*Corresponding author: riyulgloria@gmail.com

Abstract. Habits of mind are intelligent thinking dispositions that every individual needs to have, and it needs an effort to form them as expected. A behavior can be formed by continuous practice; therefore the student's habits of mind can also be formed and trained. One effort that can be used to encourage the formation of habits of mind is a formative assessment strategy with the stages of UbD (Understanding by Design), and a study needs to be done to prove it. This study aims to determine the contribution of formative assessment to the value of habits of mind owned by prospective teachers. The method used is a quantitative method with a quasi-experimental design. To determine the effectiveness of formative assessment with UbD stages on the formation of habits of mind, correlation test and regression analysis were conducted in the formative assessment questionnaire consisting of three components, i.e. feed back, peer assessment and self assessment, and habits of mind. The result of the research shows that from the three components of Formative Assessment, only Feedback component does not show correlation to students' habits of mind ($r = 0.323$). While peer assessment component ($r = 0.732$) and self assessment component ($r = 0.625$), both indicate correlation. From the regression test the overall component of the formative assessment contributed to the habits of mind at 57.1%. From the result of the research, it can be concluded that the formative assessment with UbD stages is effective and contributes in forming the student's habits of mind; the formative assessment components that contributed the most are the peer assessment and self assessment. The greatest contribution goes to the Thinking interdependently category.

1. Introduction

The success of education in universities is influenced by many aspects, including the ability and character of thinking (habits of mind) owned by students. Habits of mind is a combination of various skills [1], habits of mind can develop personal skills and self-regulation [2]. Individuals who have good habits of mind have character and behave intelligently when facing problems or facing unknown answers [3]. The description above explains the importance of habits of mind in relation to what is often experienced by students who often face various problems in their study.

The problem at this time is learning only takes precedence to form understanding and knowledge without forming the character of thinking. Learning done in the classroom is only to improve learning outcomes. Therefore, a learning that can form habits of mind is needed. The question is what kind of learning can form habits of mind?



Habits of mind can be formed and trained through the learning process, one of which is by applying formative assessment. Formative assessments relate to how to conduct assessments during the learning process, i.e. on the students' active roles or processes experienced by students during learning and for obtaining information on students' progress during learning [4-6]. Formative assessment consists of information compiled by teachers or lecturers, especially during daily meetings in the classroom, which indicate students' internal processing of information, the development of students' understanding, interaction among students, discussion as a way for exchanging ideas [7]. Formative assessment involves communication between teachers and students, or between students and students to gain meaningful learning together [8]. Formative assessment can provide effective results in improving learning outcomes [9,10].

Formative assessment can encourage the formation of habits of mind, this is supported by the presence of formative assessment components and formative assessment strategies used in the learning process. The components of formative assessment in the form of feedback, peer assessment, and self-assessment applied to formative assessment strategy if done correctly will encourage the formation of 16 habits of mind [1], i.e. (a) persisting, (b) managing impulsivity, (c) listening with understanding and empathy, (d) thinking flexibly, (e) metacognition, (f) striving for accuracy, (g) questioning and problem posing, (h) applying past knowledge to new situations, (i) thinking and communicating with clarity and precision, (j) gathering data through all senses, (k) creating, imagining and innovating, (l) responding with wonder and awe, (m) taking responsible risk, (n) finding humor, (o) thinking interdependently, and (p) remaining open to continuous learning.

Feedback will train students to realize their mistakes (Listening with understanding and empathy). Feedback can encourage the desire to improve and not easily give up (Persisting) [4,8], and potentially lead to motivation [11]. Peer assessment will train students to consider suggestions and not to haste and decision making [12], think flexibly when receiving a criticism from friends (Thinking flexibly), try to solve problems and be able to discuss well (Questioning and problem posing). In addition, with peer assessment students will also be encouraged to communicate well (Thinking and communicating with clarity and precision), collect data through all senses (Gathering data through all senses), be able to accept peer criticism and improve their work (Creating, imagining and innovating), be willing to put themselves in all situations despite resulting in failure (Taking Responsible Risk), and practice to be able to work with others (Thinking interdependently). Self-assessment will encourage metacognitive formation, cultivate prior knowledge to create new contexts (Applying past knowledge to new situations), and can enjoy and find out all new things (Responding with wonderment and awe). Through the three components of the formative assessment students will be trained on how to control and accept all the problems faced with humor (Finding humor).

A lot of research related to formative assessment has been carried out, generally resulting in conclusions that demonstrate general success of this type of assessment, such as: formative assessment can encourage students to be interested in the topics studied, give motivation and improve learning outcomes. Formative assessments can provide confidence, shape intelligent behavior, and generate optimistic feelings [13-15]. Other research results on feedback provide conclusions: direct and automatic feedback on formative assessment is a good way to achieve an independent learning process [15]. Feedback can encourage student engagement and can improve their learning motivation [16].

In contrast to previous studies, the formative assessment strategy in this research was selected through the UbD (Understanding by Design) stages. UbD is known for its inverted design consisting of three stages ie 1) identifying desired results, 2) defining acceptable learning evidence, 3) designing learning experience and learning instruction. Formative assessment with the stages of UbD ensure students get what they need, they get an effective and efficient learning path. Understanding by Design (UbD) is a way of thinking and meticulous in each design that aims to make students have an understanding [17]. Lacking of data regarding the habits of mind of Costa & Kallick, then in this study the habits of mind were observed using habits of mind indicators from Costa & Kallick. From the description, this research very interesting and need to be done, with applying formative assessment through Understanding by Design (UbD).

2. Methods

This study uses a quantitative correlation design, which uses correlational statistical tests to describe and measure the degree of relationship between two or more variables [18].

Participants in this study were students of sixth semester in biology education who attended Plant Physiology. During lectures they got learning process that used formative assessment with UbD stages. The components of the formative assessment received consist of three components, namely: feedback, peer assessment, and self assessment. Formative assessment strategies were given in the form of a presentation discussion, mind-mapping task, analysis of scientific articles, and problem-based practicum. Formative assessment strategy was given repeatedly for one semester or 12 lecture meetings.

The instrument used is a questionnaire to assess students' habits of mind. The students' habits of mind are evaluated using the habits of mind category according to Costa-Kallick, consisting of 16 items: (1) persisting, (2) managing impulsivity, (3) listening with understanding and empathy, (4) Thinking flexibly, (5) metacognition, (6) striving for accuracy, (7) questioning and problem posing, (8) applying past knowledge to new situations, (9) thinking and communicating with clarity and precision, (10) gathering data through all senses, (11) Creating, imagining and innovating, (12) responding with wonderment and awe, (13) taking responsible risk, (14) finding humor, (15) thinking interdependently, and (16) remaining open to continuous learning. The value of habits of mind is a dependent variable, while the formative assessment is an independent variable.

To know the relationship between habits of mind and formative assessment through the stages of UbD bivariate correlation test was conducted, while to know the strength of the relationship we conducted determination test. To determine the effectiveness of formative assessment correlation test was followed by regression test. Regression test is done to know the contribution of formative assessment to the habits of mind.

3. Result and Discussion

3.1. Relationship between Formative Assessment and habits of mind

The correlation test shows a positive relationship between the formative assessment and the habits of mind of prospective teachers. The correlation test results are shown in Table 1.

Table 1. Correlation test results: formative assessment - habits of mind

Variable	r count	r table	r ²	Remark
Feedback – HoM	0.323		0.104	No correlated
Peer Assessment - HoM	0.732**	0.355	0.536	Correlated
Self Assessment - Hom	0.625**		0.3231	Correlated

Note : Level of significance $\alpha = 0.05$, if r count > r table = significant (there is a correlation)

Table 1 shows that from the three formative assessment components, one component i.e. feedback is not correlated with habits of mind, while other components have a positive correlation. The result of determination test (r^2) shows that the highest correlation strength is between peer assessment and habits of mind (53%), it means peer assessment has the strongest influence in forming habits of mind.

Formative assessment strategies in the form of repeated discussions and presentations during the learning process will train students to have various categories of habits of mind. Among others the students will be trained to communicate well trying to solve the problem. The formation of the habit of mind is evidence of a correlation between formative assessment and habits of mind, it is also known from several studies on the advantages of formative assessment, ie formative assessment involving communication between teachers and students, or between students and students to gain meaningful learning together [8]. Formative assessment can indicate students' internal processing of information,

the development of students' understanding, interaction among students, where discussion is a tool for exchanging ideas [7].

3.2. Contribution of formative assessment to habits of mind

The contribution of formative assessment to habits of mind is sought through regression tests. Based on the regression test results the value of R square was 0.571. This shows the combined effect of feedback, peer assessment and *self-assessment* all together on habits of mind at 57.1%.

The contribution of the formative assessment for each indicator of habits of mind is only seen in the components of the formative assessment that have a correlation to the formation of habits of mind: the peer assessment and self assessment.

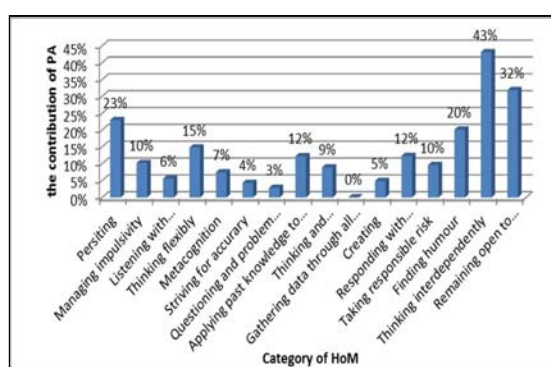


Figure 1. The contribution of peer assessment to habits of mind

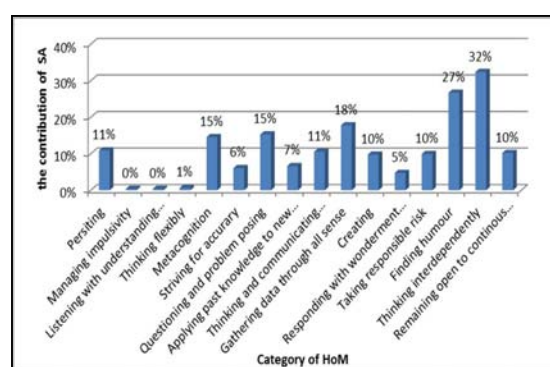


Figure 2. The contribution of self assessment to habits of mind

Figures 1 and Figure 2 explain the significant contribution of the components of the formative assessment of peer assessment and self assessment to the formation of habits of mind. Peer assessment and self assessment both contributed the most in the formation of thinking interdependently habit ie at 43% and 32% respectively. Peer assessment does not contribute at all to the gathering of data through all senses categories. While the self assessment does not contribute to the category managing impulsivity and listening with understanding and problem posing. Formative assessment strategies provided in the form of discussions and presentations on both theoretical and practical lessons during one semester learning have trained students to have the desire to share ideas and work in a team. Some research on formative assessment has proved its superiority, Formative Assessment can give a sense of confidence, form intelligent behavior, and generate optimistic feelings [13-15].

Finding humor is a habits of mind category that is also formed, with a peer assessment contribution at 20%, and self assessment at 27%. This considerable contribution shows that formative assessment has made students to have a sense of humor when interacting with their friends.

4. Conclusion

Based on the research result it can be concluded that there is a correlation between formative assessment and the formation of habits of mind. Of the three components of the formative assessment only the feedback component has no correlation. The strongest correlation is owned by the peer assessment component.

The influence or contribution of formative assessment on the formation of habits of mind is 57.1% ($R^2 = 0.571$). The value of the contribution is the value of the combined contribution of the components of the formative assessment. The contribution of formative assessment to the formation of

habits of mind also demonstrates the effectiveness of formative assessment in forming the habits of mind.

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