A Research on Creativity in STEM Integrated Learning Environment Based on Task Specific Approach

（課程博士・様式７）（Doctoral qualification by coursework, Form 7）

学 位 論 文 要 旨

Abstract of Doctoral Thesis

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Abstract :

This study aimed to solve the research questions including: (1) How task specific approaches improve students' creativity in the extent of Torrance Tests of Creative Thinking that was applied to the area of integrative Science Educations or its STS approaches? (2) Is the students' creativity assessed differently in each area of STEM? (3) When students engage in the STEM independent practices, how do they follow the cascades of eight practices? Do they difference within/among groups? (4) What kinds of potential creative tasks do students show during their own cascade of inquiries (practices)? (5) If students realize the task specific divergent thinking, where & when do they apply it to their own inquiries (practices)?

To resolve those research questions above, the author employed mixed methods approach and utilized both quantitative and qualitative analyses. First, to answer to the questions (1) & (2), TTCT and Consensual Assessment Technique (CAT) were used and analyzed statistically on paired T-test as the quasi-experimental approach, and zero order correlations. In addition, to answer to the questions (4) & (5), both qualitative and quantitative approaches were used. For question (3), the author used zero order correlation tentatively, the difference of cascades were confirmed.

Those data were taken on the participants of the Future Scientists Program called Shizuoka STEM Junior Project who were 5th through 9th grades students. In the program, the participants engaged in the group inquiries (practices) and tried to develop their own questions/problems, and to solve it by themselves. The educators (including the author) kept their attitudes as a coach and intervened in participants' inquiries as less as possible. The participants recorded their reflections just after the each day practices. The reflections included where they used their creative/critical thinking, where they apply it their own inquiries (practices), and what practices they were going to do in the next time. The TTCT and CAT were done on the first and last time of the program.

From the results of TTCT, on the question (1), the participants' creativities were

improved significantly on the fluency, and uniqueness. Two master students and three undergraduate students evaluated the pre & post-tests. The inter-rater reliability was valid on coefficient α (pre: .80- .84; post: .43- .76). The paired T-test between pre and post-test showed the creativity in fluency and uniqueness was improved (two tailed; **p<.01; *p<.05, effect size= .81 - 1.52, and power (1-β err) > .90). However, the uniqueness of possible causes task and fluency and uniqueness of predicted consequences task were not improved (two tailed; *p<.05, effect size= .35 - .74, and power (1-β err) < .90).

On the other hand, the CAT showed, as predicted, the experts' assessments on the participants products were different each other from the result of zero ground correlations. Although this result does not depend on enough number of judges within those domains, the judges assessed differently even in the science domains. Thus, as Bear (1993) suggested the divergent thinking is not a single creativity factor throughout any domains and the "domain specific"; furthermore "task specific" approaches are needed.

However, the STEM educators do not have any frameworks to identify the creative tasks that are used in the STEM independent inquiries (practices), even if the process skills, sequences, or heuristics of (creative) problem solving had been suggested. Rather cascade of practices (Chin & Brown, 2000; Chin & Osborn, 2007; Pratt, 2013) should be examined. Thereby, the author tried to describe a case of students' cascade on STEM practices by explanatory qualitative approaches.

As the result of the explanatory approach, which answers the (3) question, the students' cascades of STEM practices are not necessarily follow the eight practices 1 to 8 as Pratt (2013) suggest and back and force on their own cascades. Thus, when the author examined the differences between students within those groups, they had different cascades among the members of each groups. In addition, from the result of coding of students descriptions on when and how they used the creative thinking in their own inquiries, the descriptions almost took place in the phase of 8 practices whose are possible creative tasks in STEM independent inquiries (practices). However, those tasks are more concrete and should not be described as STEM general tasks to be explained; rather it should be elaborated and be viewed for teachers to support the students' creative thinking in their own cascades of practices.

In conclusion, by resolving four research questions, the author found that the participants' independent inquiries (practices) in a STEM Integrated Learning Environment support the improvement of their creativity, but the experts in the different STEM domains assessed it differently. Furthermore, the participants' own STEM inquiries (practices) followed differently in the cascades of eight practices. Therefore, the tasks that the author found from the students reflections would be the candidates of application to the creative problem solving in the STEM learning.