

Frequency of Performance-Based Assessments in Secondary School Computer Studies and Its Influence on Students' Innovation Capacity in Kandara Sub-County, Kenya

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Abstract

The central purpose of carrying out this study was to establish the extent to which the frequency of Performance-Based Assessments (PBAs) in secondary school Computer Studies influences students' innovation capacity. A correlational research design was used to conduct the study. Stratified sampling using proportional allocation and random sampling were used to select a total of 313 Computer Studies students from a target population of 1561 students. Data on the frequency of PBAs and students' innovation capacity was collected through Computer Studies Students questionnaire whose Cronbach Alpha coefficient, α for internal consistency was 0.817. Pearson moment correlation and simple linear regression were used to analyze data inferentially. The study found a low frequency of PBA use in Computer Studies in the secondary schools which had negatively influenced students' innovation capacity. The study recommends an increased frequency of PBAs in the subject's curriculum implementation and close monitoring of Computer Studies PBAs implementation in order to ensure that teachers implement them more often.

Keywords: Performance-Based Assessments, innovation, innovation capacity, secondary school, Computer Studies

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1. Introduction

There is undoubted evidence that the type of assessments used in the learning continuum have a lot of bearing to the level of student learning. According to Lamprianou & Athanasou (2009), there is nothing more central to the students' learning experience than assessment. The type of assessment students know will be used to assess them is a key determinant of when they "switch on" to a lesson and when they "switch off." In a similar breath, Kearney & Perkins (2014) find strong linkages between these backwash effects of assessments and student learning outcomes. They urge educators to capitalize on them by using assessments such as PBAs that enhance desired learning outcomes. In the perspective of this paper, a key question arise, which is: does the frequency of PBAs use in secondary school Computer Studies contribute to Computer Studies students' capacity to innovate, and if it does, to what extent?

In light of the aforesaid, this paper observes that one of the overriding goals of secondary school Computer Studies is producing students who are able to use a computer to develop procedures or formulas for solving problems, design hardware and software that tackle day-to-day tasks and problems in the society. However, in Kenya despite the integration of PBAs (class based practicals and projects) in the subject's curriculum implementation in order to enhance achievement of this goal, there are few computing innovations from secondary school students hitherto (Kenya ICT innovation Forum report, 2015; Kenya Institute of Curriculum Development, 2009). Against this background, there are no systematic empirical studies to indicate the extent to which the frequency of the use of the assessment technique influences acquisition of innovation skills.

2. State-of-the-Art Review

In the recent past, due to the infiltration of computers in all sectors of the economy and numerous societal problems that require computational solutions (Atiqah, 2019), various Computer Studies/Science curricula in the globe have sought to engender the innovation capacity of students in this discipline (Computer Studies Teachers Association (CSTA) 2013, 2011; Care & Kim, 2018). There is clear evidence that those countries that have aligned their Computer Studies curricula to foster student innovation capacity have succeeded in becoming technologically competitive (Gal-ezer & Stephenson, 2014). This assertion is upheld by Atiqah (2019) who find creativity, critical thinking, problem solving and innovation skills to be very valuable skills for individuals who effectively function in the highly digitalized 21st Century economy.

In this study, innovation capacity is defined as the ability of a Computer Studies student to create valuable novel or substantially improved computing ideas, products or problem solutions and implement them. This skill, just like any other skill, requires a favorable environment for its nurture and successful actualization. Literature on environments that foster students' innovation capacity suggest that, such a setting should be one where students are encouraged to make the decision to innovate by making them feel free to play with ideas, their new ideas accepted and getting awarded for the same (Smith & Smith, 2010; Rosen, 2013). Further, in this setting there is constant engagement in solving authentic (real-world) or contextualized tasks that tap into students' higher order skills such as logical thinking, creativity and collaboration (Partnership for 21st Century Learning, 2019).

PBAs have been proposed as assessment techniques that have tremendous potential in creating the foregoing settings in the learning continuum (Darling Hammond, 2006; Kearney & Perkins, 2011; Lai, et. al, 2014). This is because of their inherent ability to create a model where the techniques and approaches used to obtain the end product extensively count when judging the quality of student learning (Baird, Andrich, Hopfenbeck & Stobart, 2017; Koné, 2015; Price, Light & Pierson, 2014). Further, in line with social constructivism, they lay emphasis on higher order thinking skills and how the skills are applied in real-world simulated situations (James, 2008; Vygostky, 1978). By use of PBAs, instruction and assessment become seamless thus bridging the gap between what students are taught and what is faced in the real world. This way, student acquisition of the much desired higher order skills namely: problem solving, logical thinking, creativity and ultimately innovation is enhanced (Esther et.al, 2018; Kirmizi & Komec, 2016; Levy & Murnane, 2013).

According to Kearney & Perkins (2011), due to the growing need for professionals with strong capacity to innovate, interest in the variables involved in nurturing students' innovation capacity is also on the rise. In the computing field, Varjani (2015) has proposed the indicators to measure innovation capacity to be: the number of start-up companies registered with new computing ideas, number of ICT incubators established by the government or private sector, percentage of students pursuing computing careers to number of computing-based companies, percentage of computing innovation promotion initiatives, number of computing related patents and intellectual property. These indicators are all in tandem with OECD indicators for measuring Science, Technology and Innovation (OECD, 2016).

Past studies involving computing innovations have customized the aforesaid indicators to their respective contexts. For instance, Avvisati, Jacotin, & Vincent-Lancrin (2013) tailored them to higher education institutions context in order to establish how the institutions' graduates contribute to innovation economies. Similarly, they were also tailored to the university context by Martin, Potocnik & Fras (2015) in studying determinants of undergraduates' innovation behaviors. However, Koutrompis, Leiponen & Thomas (2015) used them as they are to study the status of ICT innovation in Europe. This current study tailored the Varjani indicators to the secondary school level. The resultant indicators were: number of students who had developed new computing ideas, student participation in computing innovation promotion initiatives, and number of computing products/ideas patents and intellectual property.

The recognition of the worth of frequent use of PBAs to nurture higher order skills among learners has become a central theme in most studies involving recommendations for policy changes in education (Kearney & Perkins, 2014; Lamprianou & Athanasou, 2009; Kearney & Perkins, 2011). Studies by Tanner and Jones (2003) have shown that frequent classroom assessments are associated with better learning or content retention. They have argued that frequent assessment provides instant feedback on students' progress and identifies the missing skills. Thence the more regular the measurement, the speedier the teacher adjusts instruction to ensure that students are making optimum progress.

Israeli high school Computer Science curriculum puts a lot of weight on practical activities and less computing theory. Learners are required to solve many practical tasks through regular performance assessments (Benaya, Zur, Dagiene & Stupuriene, 2017). Gal-ezer & Stephenson (2014) note that use of such model of Computer Science education in these schools has been instrumental in creating a culture of innovation among students. This has led the country to emerge a world's top frontrunner in technical innovation.

In Turkish primary and secondary school education, the use of PBAs is compulsory across all subjects (Kirmizi & Komec, 2016). In order to establish student opinions and attitudes towards PBA use in Turkish schools, Güven and Demirçelik (2013) conducted a survey among 6th, 7th and 8th grade students in these schools. Majority of students in the survey opined that the frequent use of performance tasks in their learning had enhanced their creativity and equipped them with valuable competencies.

Kellaghan & Greaney (2003) notes that, in most African countries various attempts have been made to enhance the quality of assessments in high school Computer Studies over the years. However, studies show that assessments that place high level of weight on attainment of lower order thinking skills cognitive skills and that pay less attention to practical skills are still prevalent. In Nigeria, for instance, Osadebe & Ojukonsin (2018) found that the use of assessment structures that accurately assess the skills outlined in the subject's syllabus to be considerably limited and experimental. The study established that this was among the issues militating against the attainment of the subject's goals. In Ghana, Acquah (2012) conducted a study aimed at establishing the status of

ICT implementation in the country's schools. His study found that the frequency of ICT practical lessons on the schools' time table was inadequate. As a result, most ICT teachers would frequently assess abstract concepts which were easier and faster to score.

In Kenya, a summative evaluation carried out by KICD in 2009 on the secondary school curriculum discovered that learners were burdened with frequent theory based assessment tests. As a result, learners were not adequately stimulated to strive for innovations for the enhancement of industrialization and modern technology as envisaged by the 2002 curriculum revision objectives (KICD, 2009). These findings were corroborated by Munyiri (2014) who found that 41.8% of teachers sampled in Mathira East Sub County secondary schools did not make use of extended assessment tasks that leverage real-world contexts such as projects and group-work.

Although the evaluation by KICD was a key insight on the status of Kenyan secondary school curriculum implementation, evaluating all technical subjects as one unit weakened the results obtained therewith. Each subject in the technical category has its own unique curriculum objectives; therefore it becomes difficult to explicitly associate these results with any single subject in the category. Similarly, the aforesaid study by Munyiri (2014) studied all subjects in the secondary school curriculum. This study set out to address these gaps by focusing on one technical subject, that is, Computer Studies.

3. Problem Statement

Computer Studies students' innovation capacity is so central to their readiness for the technologically-suffused 21st Century life and computing careers. Effective use of PBAs in secondary school Computer Studies has been proposed to be a critical variable in influencing Computer Studies students' innovation capacity. On this ground, the Kenyan Secondary School Computer Studies course syllabus recommends the use of PBAs to enable acquisition of students' innovation abilities. Despite the implementation of this recommendation, reports from the Kandara sub-county secondary schools show low computing innovation activity among the students. This portends a risk on the quest of ICT curricula in promoting acquisition of ICT innovation abilities to spur economic development in the long run. However, there are no systematic empirical studies to indicate the extent to which the prevailing frequency of the use of the assessment technique influences Computer Studies students' capacity to innovate. It is against this backdrop that this study set out to find out the influence of the frequency of PBAs in Computer Studies on students' innovation capacity in Kandara sub-county, Murang'a County, Kenya.

4. Methodology

4.1 Research Design

This was a quantitative study that adopted a correlational research design. This design was found suitable for this study because the researcher wanted to find out the nature of the study's central relationship and explain it without manipulating the variables in question (Creswell, 2012).

4.2 Target population and Sample Size

The study targeted 1561 Form Two, Three and Four Computer Studies students of the year 2020, in the secondary schools in Kandara sub-county. This data was per the Kandara Sub County Director of Education department secondary school enrolment records as at January, 2020. Out of this population, a total of 313 Computer Studies students were selected using stratified sampling using proportional allocation and random sampling. Stratified sampling was used to guarantee a sample that is as representative as possible. This is because there were disparities in the number of Computer Studies students across the schools. Random sampling was used to eliminate biasness in the selection process (Orodho, Nzabwirwa, Odundo, Waweru & Ndayambaje, 2016).

4.3 Instrumentation

The study used a Computer Studies students' questionnaire to gather data. It was structured with closed-ended, contingency and matrix questions. Fraenkel & Wallen (2009) noted that this type of questionnaire is appropriate when dealing with respondents who may have problems in expressing their impressions and ideas adequately in words. Further, it allows consistency in the responses being sought enabling easy analysis. The questionnaire had four sections. Section A captured personal information, section B consisted of closed-ended questions that sought data on indicators of student's innovation capacity, section C sought data on the frequency of the use of PBAs while section D consisted of 6 positively stated items on the influence of the frequency of the use of PBAs in Computer Studies on their innovation capacity. The items in section D were scored on a 5-point likert scale where where 1 was strongly disagree, 2 was disagree, 3 was neutral, 4 was agree and 5 was strongly disagree.

4.4 Data Analysis

Data obtained from the filled instruments was analysed using descriptive statistics namely: frequencies, means and standard deviation. The data was also analyzed using inferential statistics namely correlation and simple linear regression. Pearson's product-moment correlation coefficient was computed and used to determine the degree of

association between variables. The analyzed data was then presented using tables and scatter plots.

5. Results and Discussion

Students' Innovation Capacity

This study considered Computer Studies innovation capacity as the dependent variable. The indicators of this variable were: students' participation in computing innovation forums, level of competition the innovation reaches and the number of students who had sought for patents or intellectual property for their innovations. To obtain the score for students' innovation capacity the first three indicators were scored on a scale of 1-2 where 1 was a dissenting response to the question posed whereas 2 was for an affirmative response. The fourth indicator was scored on a scale of 1-5 where 1 was for not applicable response, 2 sub county level, 3 county level, 4 regional level and 5 for national level. This data was summarized in table 1.

Table 1: Computer Studies Students' Innovation Capacity Indicators Summary

| Indicator | Mean | Std. Dev |
|---|-------------|-------------|
| Students who had ever developed an ICT innovation | 1.33 | 0.47 |
| Student seeking for patents and intellectual property rights for ICT innovations. | 0.38 | 0.57 |
| Student participation in computing innovation forums. | 1.25 | 0.44 |
| Level of competition the ICT innovation reaches | 1.25 | 0.60 |
| Mean (Students' innovation capacity rating) | 1.05 | 0.45 |

Researcher's Field data, 2020

From table 1, it is evident that indicator 1 (whether students had ever developed an ICT innovation) scored highest with a mean score of 1.33, followed by indicator 3 (whether students had participated in computing innovation forums) & indicator 4 (level of competition the ICT innovation reaches) both with a mean score of 1.25. Indicator 2 (whether students had sought for patents and intellectual property rights for ICT innovations) scored lowest with a mean score of 0.38. The average score for students' innovation capacity was 1.05 on a scale of 1-5. This low score was a clear suggestion that the students' innovation capacity was quite low.

Frequency of the Use of Performance-Based Assessments in Kandara Sub-County Secondary School Computer Studies

To determine the frequency of PBAs, the frequency of practical exercises was scored on a scale of 1- 5 where 1 was never, 2 once a week, 3 twice a week, 4 thrice a week and 5 four times a week. Frequency of projects was scored on a scale of 1- 5 where 1 was never, 2 once a month, 3 twice a month, 4 thrice a month and 5 four times in a month. The data was summarized in table 2.

Table 2: Frequency of PBAs in Secondary school Computer Studies in Kandara Sub County

| Item | N | Mean | Std. Dev |
|---|------------|-------------|-------------|
| Frequency of practical exercises use | 313 | 2.88 | 0.81 |
| Frequency of Projects assessments use | 313 | 1.39 | 0.69 |
| Mean (Frequency of PBAs use - $\bar{x}/10$) | 313 | 2.14 | 0.54 |

As table 2 shows, it is clear that the frequency of practical exercises is higher (mean score of 2.88) than that of project assessments (mean score of 1.39). This is a clear indication that the frequency of PBA use in the schools' Computer Studies is relatively low. These findings reflect Munyiri (2014) who found that 41.8% of teachers sampled in Mathira East Sub County secondary schools did not make use of extended assessment tasks that leverage real-world contexts such as projects and group-work.

Students' Perceptions on the Influence of the Frequency of PBAs in Secondary Schools Computer Studies on their Innovation Capacity

To determine this, respondents were asked to indicate their level of agreement or disagreement with 6 positively stated items on the influence of the frequency of PBAs in their schools' Computer Studies on their innovation capacity. Each item was scored on a 5-point likert scale where 1 was strongly disagree, 2 was disagree, 3 was neutral, 4 was agree and 5 was strongly agree. The maximum score for a fully filled section was 30 while the minimum was 6. The data obtained was descriptively analyzed and the results presented in table 3.

Table 3: Students' responses on the influence of the frequency of PBAs in their schools' Computer Studies on their innovation capacity

| Item | Strongly Disagree | | Disagree | | Neutral | | Agree | | Strongly Agree | | Mean | Std. dev |
|--|-------------------|------|----------|------|---------|------|-------|------|----------------|-----|------|----------|
| | n | % | n | % | n | % | n | % | n | % | | |
| Frequency of project-based assessments is sufficient to improve my creativity skills in handling computer -based tasks | 119 | 38.0 | 149 | 47.6 | 27 | 8.6 | 16 | 5.1 | 2 | 0.6 | 1.83 | 0.84 |
| Frequency of project-based assessments is sufficient to sharpen my logical thinking skills in handling computer -based tasks | 120 | 38.3 | 145 | 46.3 | 28 | 8.9 | 14 | 4.5 | 6 | 1.9 | 1.85 | 0.90 |
| Frequency of project-based assessments is sufficient to improve my ability create new ICT products | 115 | 36.7 | 150 | 47.9 | 34 | 10.9 | 11 | 3.5 | 3 | 1.0 | 1.84 | 0.82 |
| Frequency of practical exercises is sufficient to improve my creativity skills in handling computer -based tasks | 126 | 40.3 | 77 | 24.6 | 16 | 5.1 | 67 | 21.4 | 27 | 8.6 | 2.34 | 1.41 |
| Frequency of practical exercises is sufficient to sharpen my logical thinking skills in handling tasks using computers | 106 | 33.9 | 114 | 36.4 | 24 | 7.7 | 54 | 17.3 | 15 | 4.8 | 2.23 | 1.22 |
| Frequency of practical exercises is sufficient to improve my ability to create new ICT products. | 114 | 36.4 | 130 | 41.5 | 20 | 6.4 | 36 | 11.5 | 13 | 4.2 | 2.05 | 1.12 |

Source: Researcher's Field data (2020)

A low rating of the influence of the frequency of PBAs on the respondents' innovation capacity was reported. An overwhelming majority of the respondents (85.6%) felt that the frequency of project-based assessments in their schools' Computer Studies were not sufficient to improve their creativity skills in handling tasks using computers. Similarly, a high number (84.6%) opined that the frequency was insufficient to sharpen their logical thinking skills in handling tasks using computers as well as improving their ability to come up with new ICT products.

On the part of the influence of frequency of the use of practical exercises in Computer Studies, more than a third (64.9%) felt that it was not adequate to improve their creativity skills in handling tasks using computers whereas more than three quarters (80.3%) of the respondents felt that it was not adequate to sharpen their logical thinking skills in handling tasks using computers. A high number (77.9%) were of the opinion that this frequency was inadequate to improve their ability to come up with new ICT products.

Generally, the students rated the influence of the frequency of the use of PBAs in Computer Studies on their innovation capacity with rather low scores. In a scale of 1-5, the overall average rating of the influence of frequency of the use of PBAs in Computer Studies on their innovation capacity was 2.02. These findings corroborate KICD (2009) summative evaluation of technical subjects that revealed that the subjects' implementation was characterized with assessments that did not make learners to strive for innovations as envisaged in the curriculum objectives.

Correlation Analysis of the Influence of the Frequency of PBAs on the Innovation Capacity of Computer Studies Students

In order to determine the strength of association between frequency of PBAs and the students' innovation capacity, the data on the two variables was correlated. The findings are shown in table 4.15.

Table 4: Correlation between the ratings of Frequency of PBA use on the Students' Innovation Capacity

| | Students' innovation Capacity | PBA frequency ratings |
|---|-------------------------------|-----------------------|
| Students' innovation Capacity | Pearson Correlation | 1 |
| | Sig. (2-tailed) | .504** |
| | N | .000 |
| Rating on the influence of the PBA frequency on Students' Innovation Capacity | Pearson Correlation | 1 |
| | Sig. (2-tailed) | .504** |
| | N | .000 |
| | | 313 |

** . Correlation is significant at the 0.01 level (2-tailed).

The results in table 4 indicated that there was a significant association between the frequency of PBA use in Computer Studies and the students' innovation capacity, at $r=0.504$, $p=0.000$. The correlation coefficient, r obtained depicted a positive correlation between the two variables. This implies that changes in both variables take place in the same direction. As observed in table 3 a low rating of the influence of the frequency of PBA use in Computer Studies on students' innovation capacity was reported ($M= 2.02$ out of the possible score of 5). This corresponded to a low score for students' innovation capacity which was 1.05 out of the possible score of 11. This indicates that the low frequency of PBAs in Computer Studies had negatively influenced the students' innovation capacity.

Regression Analysis of the Influence of the Frequency of Performance-Based Assessments on the Innovation Capacity of Computer Studies Students

To ascertain the magnitude of variation between frequency of PBA use and Computer Studies students' innovation capacity simple linear regression was done. Prior to generating the regression model, a scatter plot was generated in order to check whether a linear relationship existed. This is shown in figure 1.

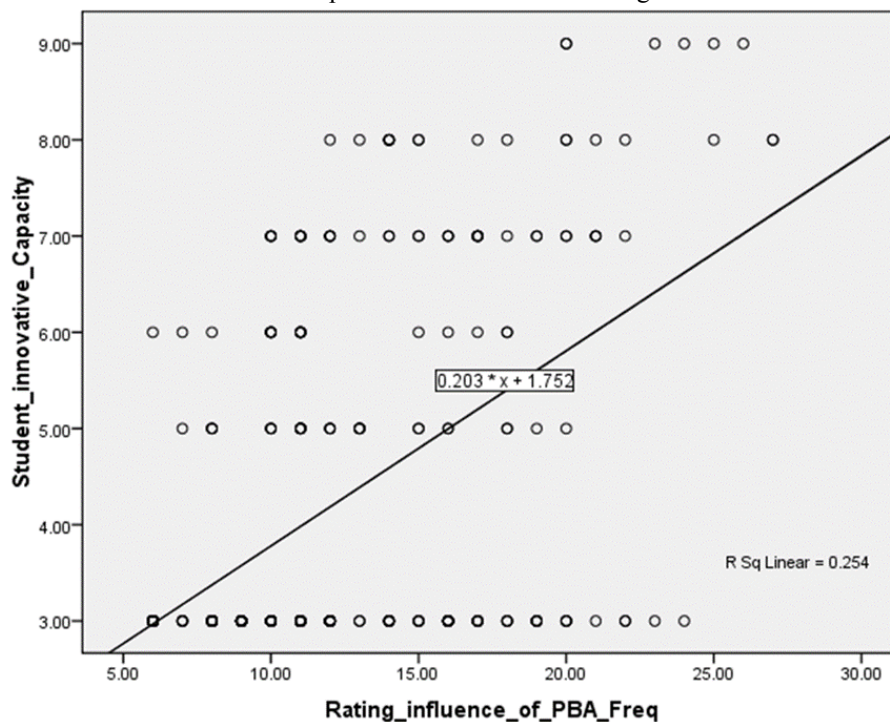


Figure 1: Scatter plot on the influence of the frequency of PBA use on students' innovation Capacity

The scatter plot showed that indeed there was a linear relationship between the two variables thus a regression analysis was appropriate. The two variables were then linearly regressed and regression model summary is shown in table 5.

Table 5: Influence of the Frequency of PBA use on Students' Innovation Capacity Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Coefficients | | | | |
|-------|-------------------|----------|-------------------|----------------------------|--------------|------------|------|--------|------|
| | | | | | B | Std. Error | Beta | t | Sig |
| 1 | .504 ^a | .254 | .252 | 1.58704 | 1.752 | .255 | .504 | 6.866 | .000 |
| | | | | | .203 | .020 | | 10.292 | .000 |

a. Predictors: (Constant), Rating on the influence of PBA Frequency

b. Dependent Variable: Student innovation Capacity

The resulting model from the summary was:

$$Y = 1.752 + 0.203X + \epsilon$$

where Y is Student Innovation Capacity
 X is Frequency of PBAs
 ϵ is equal to 0.255

The model obtained in table 5 revealed that Frequency of PBA use in Computer Studies accounted for 25.4% of the variations in the students' innovation capacity. Further, an increase in the frequency of PBA use in Computer Studies will result to an improvement of 0.203 units in the students' innovation capacity. However, the slope is not very steep implying that there are other unmeasured intervening variables that have a significant influence on the ability of the predictor variable (frequency of PBA use in Computer Studies) to predict students' innovation capacity.

6. Summary of Key Findings

The study revealed a relatively low frequency of PBA use in the sampled secondary schools with an overall mean rating of 2.14 out of 10 being reported. A comparison of the two PBA paradigms showed that practical exercises were more prevalent than project assessments.

With regard to how the frequency of PBA use relates to Computer Studies students' innovation capacity, the correlation analysis indicated a positive association between the two variables ($r = .504$, $p=0.000$). As to what extent the two variables relate, the regression analysis revealed that the frequency of PBA use in Computer Studies accounted for 25.4% variations in the students' innovation capacity. The low rating on the frequency of PBA use was found to be corresponding to a low student innovation capacity.

7. Conclusions and Recommendations

Based on the foregoing findings, two conclusions can be inferred. One, frequency of PBA use in Computer Studies is a key predictor of the students' innovation capacity. Two, low frequency of PBA use in Computer Studies negatively influences students' innovation capacity. The study therefore recommends increased frequency of PBAs in the subject's curriculum implementation, and close monitoring of the implementation of PBAs in Computer Studies to ensure that teachers implement them more often. Additionally, studies on other variables that may influence the students' innovation capacity can be done.

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