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# Critical Thinking Trends of Secondary School Mathematics Teachers

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## ABSTRACT

It is known that individuals undergo mental procedure such as reasoning, analyzing the situation or evaluating the events they experience in their educational lives and daily lives. Critical thinking is defined as a path of thinking that aims at acquiring, comparing, using and evaluating knowledge in an original track as well as covering these mental processes. Critical thinking skills are associated with high-level mental processes such as problem solving, problem-making and reasoning, are also very important in terms of mathematics education. The point of this examination is to determine the degree of critical thinking propensities of mathematics teachers and to break down the critical reasoning temper regarding various factors. For this purpose, in-service mathematics teachers working in urban and rural schools situated in Assam were considered as subject of examination. Mathematics teachers were given a questioner evolved by the researchers to collect demographic information as well as their Critical thinking skills on mathematics teaching. In line with the data obtained, critical thinking tempers of the mathematics teachers were examined according to variables such as location of schools, gender and teaching experiences and each sub-dimension in the scale and the evaluations were made as to the critical thinking propensities of the mathematics educators based on the extracted results.

**KEY WORDS**: Critical thinking, Problem Solving, Problem Formation, Mathematics Teachers.

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## INTRODUCTION:

Individuals' events that take place in their environment through a process of mental gathering by gathering the data obtained in various ways allow them to make sense of and interpret these events. There are some high-level cognitive skills that are important in a number of decisions, including the mental processes mentioned here, and throughout the lifetime of individuals. Critical thinking, considered to be one of these cognitive skills, is defined as a way of thinking which aims to obtain, compare, use and evaluate information in a specific way.

According to Oxford English dictionary Critical thinking means "the process of thinking carefully about a subject or idea, without allowing feeling or opinions to affect you".Critical thinking is intelligent and sensible reasoning that is centered on choosing what to accept or do[1]. Critical thinking is trained; self-coordinated reasoning that epitomizes the culminations of reasoning suitable to a specific mode or space of thought[2]. Critical thinking is handy, capable reasoning that encourages decision making ability since it i) depends upon criteria, ii) is self-revising, and iii) is delicate to setting[3].Critical thinking may be perceived as an ability to gather access and use data effectively[4]. Critical thinking is an active organized mental process expecting to get ourselves and the occasions in our environment by applying what we learn, taking into account the opinions of others, in the awareness of our own thinking processes. Critical reasoning is a high-level reasoning, as it is attributed to the purpose, complex and judgmental problem-solving and decision-making associated with information processing[5].Critical thinking, reasoning in general, logical thinking, advanced thinking, intelligent behavior and creative thinking are the processes or forms of thinking.

Although there are different definitions of critical reasoning, it is recognized that there is a high extent of cognitive skills and that all individuals should have critical thinking masteriesto settle on precise and powerful choices for the duration of their lives. It is noteworthy that there are common issue solving and conclusion making processes in the definition of thinking skills.Critical thinking consists of three stages[6]. According to Ennis, in the first stage, critical thinking initiates with problem solving by associating with other individuals and the environment. Second stage is the task of reasoning takes place by establishing a relationship with the existing information, inferring through deduction and deduction. In the final stage, critical thinking results in a decision on whether the individual will believe or not.

Critical thinking, which is also associated with mental activities such as problem solving, problem formation and reasoning, is also very important in terms of mathematics education. In primary and secondary mathematics education programs, it is seen that the purpose of raising individuals with CT skills is emphasized. Lately there has been an expansion in the studies on critical thinking in the arena of education, particularly the significance of critical reasoning in teacher

education[7,8,9,10,]and in mathematics teaching[11,12,13,14]. In order for teachers to be successful in their professional lives and to conduct effective teaching, they have to have a high grade of CTdispositions and the mastery to prepare instructional environments that will bolster the improvement of critical reasoning abilities. Teachers with critical thinking skills support critical thinking in the classroom, contribute to the cognitive development of students and increase the positive attitude towards critical thinking.

Students who are prepared in basic reasoning abilities fundamentally improved emphatically in their execution than the individuals who were not prepared[15].The critical thinking abilities training help pupils in invigorating their scholarly ability and make them connected more in classroom tasks[16]. Critical thinking disposition (CTD) includes sex sub-dispositions or components: Receptiveness, inquisitiveness, systematicness, truth-chasing, analyticity, and self-sufficiency[17]. Descriptions of components of CTD are depicted in the table1.

Table1: Components of CTD and their meanings.

| Components | Description |
|---|---|
| Receptiveness | Be tolerant towards dialectical ideas and be delicate to the probability of their own mindset. |
| Inquisitiveness | Scholarly interest and interest to learn in spite of the way that the use of information isn't clearly clear. |
| systematicness | Being composed, tidy, centered, and painstaking in inquiry |
| Truth-chasing | Demeanor of being anxious to look for the best information in a given setting, valiant about posing inquiries, and genuine and objective about seeking after request regardless of whether the discoveries don't bolster one's personal circumstances or one's biased conclusions |
| Analyticity | Valuing the use of thinking and the utilization of proof to determine issues, envisioning potential applied or pragmatic troubles, and reliably being aware of the necessity to intercede. |
| Self-Confidence | Believing in the sound of your own reflective decisions and giving leadership to others |

In India, for the first time, the National Curriculum Framework (NCF) 2005 fused critical reasoning into the system. In NCF-2005, the idea of critical instructional method was presented in all components of school education, together with teacher education. Adolescents are critical eyewitnesses of their own conditions and needs, and ought to be members in talks and critical thinking identified with their training and future chances. Critical teaching method gives a chance to ponder fundamentally issues regarding their political, social, monetary and moral perspectives. It involves the acknowledgment of different perspectives on social issues and a guarantee to majority rule types of connection. This is significant in perspective on the various settings in which our schools work. A critical system encourages youngsters to see social issues from alternate points of view and see how such issues are associated with their lives.Barua and Chakrabartistudied on critical reasoning in the space of instruction and as indicated by them critical reasoning can help in obtaining information, improve hypotheses, and reinforce contentions[18]. They maintained that critical reasoning abilities can be utilized in uncovering false notions and awful thinking. Bhatia and Dash proposed instructive changes and clarifies the critical aspects of overseeing, and conveying

predominant estimation of the advanced education framework in India[19].Smitha conducted an investigation with an endeavor to reinforce the Computational Speed and Critical Thinking Ability of future teachers[20].Verma underscored on receiving an alternate sort of mathematics for engineering learners empowering them thinking critically and innovatively[21].

## OBJECTIVE OF THE STUDY

In this study, it is intended to decide the dimension of critical thinking propensities of mathematics teachers and to examine them in terms of various variables. The researchers have taken this investigation with an objective to estimate the grade of critical thinking propensities of in-service mathematics teachers.

## NULL HYPOTHESES

The following null hypotheses are proposed for testing within the scope of the study.

**$H_0^1$**: There is no huge distinction between the scores of CTpropensities of mathematics teachers according to gender.

**$H_0^2$**: There is no huge distinction between the scores of CTpropensities of mathematics teachers according to the location (Rural/Urban) of school.

**$H_0^3$**: There is there is no huge distinction between the scores of CT propensities of mathematics teachers according to teaching experiences.

## METHODOLOGY OF THE STUDY

This enquiry is a survey based descriptive study directed to explore the critical thinking propensities of in-service mathematics teachers. In this study, screening model is used to ascertain the current CT tendency of mathematics teacher. Scanning modelis a suitable model for research which aims to depict the circumstance as it exists[22]. The study group of the investigation included a total of 27 female and 23 male mathematics teachers instructing in secondary schools.25 mathematics teachers from rural and equal number of teachers from urban schools participated in the investigation. Teaching experience of teachers is subdivided into three groups: Less than 5 yrs, 5 to 10 yrs and More 10 yrs.

### *Data Collection Tools*

One research instrument was developed to collect information from selected mathematics teachers. The Mathematics Teachers' Critical Thinking Disposition Scale (MTCTDS)consists of two parts. Part-A is related to the demographic information of the participated teachers. Part-B of MTCTDS contains total 36 items. MTCTDS part-B has six measurements and each measurement contains six items. Five point Likert Scale technique is utilized in the exploration instrument MTCTDS part-B.

## FINDINGS

In this section, CT tendencies of in-service mathematics teachers and the findings of these trends are examined according to different variables. Descriptive statistics of the data obtained from MTCTDS applied to mathematics teachers are as follows:

**Table 2: Descriptive Statistics of Critical Thinking Trends of Mathematics Teacher**

| Components | N | Mean | Median | SD |
|---|---|---|---|---|
| Receptiveness (CT-R) | 50 | 2.74 | 3.00 | 1.121406 |
| Inquisitiveness (CT-I) | 50 | 2.74 | 3.00 | 1.174734 |
| systematicness(CT-S) | 50 | 2.56 | 2.50 | 1.072095 |
| Truth-chasing (CT-T) | 50 | 2.54 | 2.00 | 1.215713 |
| Analyticity (CT-A) | 50 | 3.18 | 3.00 | 1.223745 |
| Self-Confidence (CT-C) | 50 | 2.68 | 3.00 | 1.150687 |
| Total | | 2.74 | 2.75 | 1.159730 |

As can be seen in Table 2, the mean score of the in-service mathematics educators' critical thinking propensities was 2.74, median was 2.75 and the standard deviation was 1.15973.

The allocation of the scores of the mathematics teachers on the sub-scale CT-R of critical thinking propensities by the independent variables is as follows:

**Table 3: Receptiveness (CT-R)of mathematics teacher according to Gender, Domicile and Experiences**

| | Independent variables | | N | Mean | Median | SD |
|---|---|---|---|---|---|---|
| Receptiveness (CT-R) | Gender | Male | 23 | 2.739 | 3.000 | 1.09616 |
| | | Female | 27 | 2.741 | 3.000 | 1.16330 |
| | Location of school | Rural | 25 | 2.692 | 3.000 | 1.12318 |
| | | Urban | 25 | 2.792 | 3.000 | 1.14128 |
| | Teaching Experiences | Less than 5 yr | 16 | 2.75 | 3.00 | 1.06458 |
| | | 5 to 10 yr | 21 | 2.619 | 3.000 | 1.11696 |
| | | 10 yrs and above | 13 | 2.74 | 3.00 | 1.12140 |

Table 3 depicts that regarding CT-R sub scale, mean value of female teachers and male teachers are almost identical, teachers working in urban areas shows slightly higher critically thinking tendencies. Young teachers show higher CR-R.

The allocation of the scores of the mathematics teachers on the sub-scale CT-I of critical thinking propensities by the independent variables is as follows:

**Table 4: Inquisitiveness (CT-I) of mathematics teacher according to Gender, Domicile and Experiences**

| | Independent variables | | N | Mean | Median | SD |
|---|---|---|---|---|---|---|
| Inquisitiveness (CT-I) | Gender | Male | 23 | 2.565 | 2.000 | 0.89575 |
| | | Female | 27 | 2.889 | 3.000 | 1.36813 |
| | Location of school | Rural | 25 | 2.308 | 2.000 | 1.08698 |
| | | Urban | 25 | 3.208 | 3.000 | 1.10253 |
| | Teaching Experiences | Less than 5 yr | 16 | 2.812 | 3.000 | 1.04682 |
| | | 5 to 10 yr | 21 | 2.381 | 2.000 | 1.11696 |
| | | 10 yrs and above | 13 | 2.74 | 3.00 | 1.17473 |

Regarding sub-scale CT-I, female teachers show higher CT tendencies in mathematics teaching than male counterparts. There is a huge gap regarding location of schools in favorer of urban teachers. Teachers working less than 5 years are more inquisitive.

The allocation of the scores of the mathematics teachers on the sub-scale CT-S of critical thinking propensities by the independent variables is as follows:

**Table 5: systematicness (CT-S) of mathematics teacher according to Gender, Domicile and Experiences**

| | Independent variables | | N | Mean | Median | SD |
|---|---|---|---|---|---|---|
| systematicness(CT-S) | Gender | Male | 23 | 2.652 | 2.000 | 1.11227 |
| | | Female | 27 | 2.481 | 3.000 | 1.05138 |
| | Location of school | Rural | 25 | 2.808 | 3.000 | 1.16685 |
| | | Urban | 25 | 2.292 | 2.000 | 0.90789 |
| | Teaching Experiences | Less than 5 yr | 16 | 2.688 | 2.500 | 1.04682 |
| | | 5 to 10 yr | 21 | 2.238 | 2.000 | 0.88908 |
| | | 10 yrs and above | 13 | 2.56 | 2.50 | 1.07209 |

Regarding CT-S, males exhibit higher critical thinking tendencies. Rural mathematics teachers show higher CT-S. Similarly, experience does not show positive effect on CT-S.

The circulation of the scores of the mathematics teachers on the sub-scale Truth-chasing (CT-T) of critical thinking propensities by the independent variables is as follows:

**Table 6: Truth-chasing (CT-T) of mathematics teacher according to Gender, Domicile and Experiences**

| | **Independent variables** | | **N** | **Mean** | **Median** | **SD** |
|---|---|---|---|---|---|---|
| Truth-chasing (CT-T) | Gender | Male | 23 | 2.739 | 2.000 | 1.355708 |
| | | Female | 27 | 2.370 | 2.000 | 1.079464 |
| | Location of school | Rural | 25 | 2.423 | 2.000 | 1.270372 |
| | | Urban | 25 | 2.667 | 3.000 | 1.167184 |
| | Teaching Experiences | Less than 5 yr | 16 | 2.562 | 2.500 | 1.250000 |
| | | 5 to 10 yr | 21 | 2.381 | 2.000 | 1.244033 |
| | | 10 yrs and above | 13 | 2.54 | 2.50 | 1.215713 |

Regarding CT-T, urban and male teachers show more CT tendencies compared to their female colleagues.

The circulation of the scores of the mathematics teachers on the sub-scale Analyticity (CT-A) of critical thinking propensities by the independent variables is as follows:

**Table 7: Analyticity (CT-A) of mathematics teacher according to Gender, Domicile and Experiences**

| | Independent variables | | N | Mean | Median | SD |
|---|---|---|---|---|---|---|
| Analyticity (CT-A) | Gender | Male | 23 | 3.174 | 3.000 | 1.15413 |
| | | Female | 27 | 3.185 | 3.000 | 1.30198 |
| | Location of school | Rural | 25 | 3.269 | 3.000 | 1.11562 |
| | | Urban | 25 | 3.083 | 3.000 | 1.34864 |
| | Teaching Experiences | Less than 5 yr | 16 | 3.062 | 3.000 | 1.23659 |
| | | 5 to 10 yr | 21 | 3.286 | 3.000 | 1.41925 |
| | | 10 yrs and above | 13 | 3.18 | 3.00 | 1.22374 |

Table 7 depicts tendencies of mathematics in-service teachers regarding the sub-scale CT-A. Female educator shows slightly higher tendencies than male educators. Compared to urban teachers, rural school teachers are more analytic in mathematics teaching.

The circulation of the scores of the mathematics teachers on the sub-scale Self-Confidence (CT-C) of critical thinking propensities by the independent variables is as follows:

Table 8: Analyticity (CT-A)of mathematics teacher according to Gender, Domicile and Experiences

| | Independent variables | | N | Mean | Median | SD |
|---|---|---|---|---|---|---|
| Self-Confidence (CT-C) | Gender | Male | 23 | 3.174 | 3.000 | 1.19286 |
| | | Female | 27 | 2.259 | 2.000 | 0.94431 |
| | Location of school | Rural | 25 | 2.654 | 3.000 | 1.09333 |
| | | Urban | 25 | 2.708 | 3.000 | 1.23285 |
| | Teaching Experiences | Less than 5 yr | 16 | 2.875 | 3.000 | 0.95742 |
| | | 5 to 10 yr | 21 | 2.619 | 3.000 | 1.02353 |
| | | 10 yrs and above | 13 | 2.68 | 3.00 | 1.15068 |

The above table 8 shows that male mathematics educators are more self-Confident than female educators.

## *Testing of null hypotheses $H_0^1$.*

One way ANOVA test of CT-R, CT-I, CT-S, CT-T, CT-A, CT-C and MTCTDS regarding gender of mathematics teachers are carried out by applying R-Studio software. The values for this analysis are given in Table 9.

**Table 9: ANOVA test of CT-R, CT-I, CT-S, CT-T, CT-A, CT-C related to Gender**

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| Gender$`CT-R` | 1 | 2.241 | 2.2409 | 10.57 | 0.00211 ** |
| Residuals | 48 | 10.179 | 0.2121 | | |
| Gender$`CT-I` | 1 | 2.234 | 2.2338 | 10.53 | 0.00215 ** |
| Residuals | 48 | 10.186 | 0.2122 | | |
| Gender$`CT-S` | 1 | 0.08 | 0.0798 | 0.31 | 0.58 |
| Residuals | 48 | 12.34 | 0.2571 | | |
| Gender$`CT-T` | 1 | 1.473 | 1.4729 | 6.458 | 0.0143 * |
| Residuals | 48 | 10.947 | 0.2281 | | |
| Gender$`CT-A` | 1 | 0.149 | 0.1490 | 0.583 | 0.449 |
| Residuals | 48 | 12.271 | 0.2556 | | |
| Gender$`CT-C` | 1 | 1.989 | 1.9891 | 9.153 | 0.00398 ** |
| Residuals | 48 | 10.431 | 0.2173 | | |
| Gender$MTCTDS | 1 | 4.942 | 4.942 | 31.72 | 9.09e-07 *** |
| Residuals | 48 | 7.478 | 0.156 | | |
| Signif. codes: | 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1 | | | | |

CT-R, CT-F and CT-C are sub-scales that are significantly (0.01 level) connected to gender of mathematics teachers. MTCTDS is highly associated to teachers' gender as significance value is down from 0.001. Consequently, the null hypothesis $H_0^1$ is rejected.

## *Testing of null hypotheses $H_0^2$*

ANOVA test of CT-R, CT-I, CT-S, CT-T, CT-A, CT-C and MTCTDS regarding location of the schools of the teachers instructing mathematics are performed. The upshots for this scrutiny are depicted in Table 10.

**Table 10: ANOVA test of CT-R, CT-I, CT-S, CT-T, CT-A, CT-C related to Location**

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| Domicile$`CT-R` | 1 | 0.002 | 0.00185 | 0.007 | 0.933 |
| Residuals | 48 | 12.478 | 0.25996 | | |
| Domicile$`CT-I` | 1 | 1.155 | 1.1546 | 4.893 | 0.0318 * |
| Residuals | 48 | 11.325 | 0.2359 | | |
| Domicile$`CT-S` | 1 | 0.736 | 0.7364 | 3.01 | 0.0892 |
| Residuals | 48 | 11.744 | 0.2447 | | |
| Domicile$`CT-T` | 1 | 0.023 | 0.02274 | 0.088 | 0.769 |
| Residuals | 48 | 12.457 | 0.25953 | | |
| Domicile$`CT-A` | 1 | 0.01 | 0.00992 | 0.038 | 0.846 |
| Residuals | 48 | 12.47 | 0.25979 | | |
| Domicile$`CT-C` | 1 | 4.251 | 4.251 | 24.8 | 8.64e-06 *** |
| Residuals | 48 | 8.229 | 0.171 | | |
| Domicile$MTCTDS | 1 | 1.329 | 1.3294 | 5.722 | 0.0207 * |
| Residuals | 48 | 11.151 | 0.2323 | | |
| Signif. codes: 0 | '***' 0.001 | | '**' 0.01 | '*' 0.05 '.' | 0.1 ' ' 1 |

CT-C is a sub-scale that is significantly associated (0.001 level) to the location of schools. CT-I is also a noteworthy factor associated to the location of schools. MTCTDS is significantly affiliated to the location of schools (0.05 level). Therefore, the null hypothesis $\mathbf{H_0}^2$may be rejected and there exist a critical connection between MTCTD and location of mathematics teachers' schools.

## *Testing of null hypotheses $H_0^3$*

In the last stage of the analysis, it was examined whether there existnoteworthy distinction between the dimensions of critical thinking trend of mathematics teachers according to their teaching experience. One way ANOVA test of CT-R, CT-I, CT-S, CT-T, CT-A, CT-C and MTCTDS regarding the teaching adventures of mathematics educators are performed.The upshots for this scrutiny are depicted in the Table 11.

**Table 11: ANOVA test of CT-R, CT-I, CT-S, CT-T, CT-A, CT-C related to Experience**

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| Experience$`CT-R` | 1 | 2.798 | 2.7975 | 5.16 | 0.0276 * |
| Residuals | 48 | 26.022 | 0.5421 | | |
| Experience$`CT-I` | 1 | 0.403 | 0.403 | 0.681 | 0.413 |
| Residuals | 48 | 28.417 | 0.592 | | |
| Experience$`CT-S` | 1 | 0.128 | 0.1275 | 0.213 | 0.646 |
| Residuals | 48 | 28.692 | 0.5978 | | |
| Experience$`CT-T` | 1 | 0.095 | 0.0948 | 0.158 | 0.692 |
| Residuals | 48 | 28.725 | 0.5984 | | |
| Experience$`CT-A` | 1 | 0.032 | 0.0323 | 0.054 | 0.817 |
| Residuals | 48 | 28.788 | 0.5997 | | |
| Experience$`CT-C` | 1 | 0.379 | 0.3792 | 0.64 | 0.428 |
| Residuals | 48 | 28.441 | 0.5997 | | |
| Experience$MTCTDS | 1 | 0.21 | 0.2107 | 0.148 | 0.702 |
| Residuals | 48 | 68.21 | 1.4210 | | |

Table 11 reveals that there is no critical relation between MTCTD and teachers working experiences. Among all sub-factors, only CT-R has noteworthy affiliation to Experience. Therefore, the third null hypothesis $\mathbf{H_0}^3$may beabandoned.

## DISCUSSION AND CONCLUSION

The first result of this study is low level of CT tendencies of mathematics teachers. At the beginning of the study, although it is expected that the levels of critical thinking trend of the mathematics educators are to be at a larger amount, it is anticipated that the emphasis should be on the results. When the sub-dimensions of the critical thinking tendency are analysed, it is spotted that the highest average is only 3.18 which is obtained in case of sub-dimension Analyticity (CT-A). The lowest mean is obtained as 2.54 regarding the sub-dimension CT-T. Table 4 delineates that with respect to CT-R sub scale, mean estimation of female instructors and male educators are practically indistinguishable, educators working in urban zones demonstrate somewhat higher critically thinking inclinations. Youthful educators show higher CR-R. Concerning scale CT-I, female teachers show higher critical reasoning inclinations in mathematicsteaching than male teachers. There is a tremendous gap with respect to area of schools in favorer of urban educators. Educators working under 5 years are increasingly curious. With respect to CT-T, urban and male instructors show increasingly critical reasoning inclinations contrasted with their female colleagues. Table 7 portrays propensities of mathematics in-service instructors with respect to the sub-scale CT-A. Female teacher demonstrates somewhat higher propensities than male instructors. Contrasted with urban instructors, rural teachers are progressively logical in mathematics teaching. Table 8 demonstrates that male mathematics instructors are more self-assured than female teachers.

Another result obtained from the study is that CT-R, CT-F and CT-C are sub-scales that are fundamentally (0.01 dimension) associated with gender orientation of mathematics instructors. MTCTDS is profoundly related to teachers' gender orientation as significant score is down from 0.001. The critical thinking propensities of mathematics teachers show a critical distinction as indicated by location of high school. Regarding experiences of mathematics teachers of high schools, CT-R sub-domain is significantlyassociated. As a whole, experience does not connect to MTCTD. As indicated by the consequences of the examination, it can be thought that mathematics teachers' teaching experiences do not increase their critical thinking tendencies.

Critical thinking is a significant cognitive skill that influences individuals' perspective on events, their assessments of what is happening around them, and the decision-making process. For this reason, it is important that teachers who will train new generations are aware of this skill and think critically about this skill. Especially, it is aimed to be high in mathematics teacher candidates who are expected to be used in mathematical activities. Notwithstanding the quantitative studies conducted with the scale application, questions about the low dimension of critical thinking

propensities of the in-service and future teachers can be examined and suggestions can be made in depth. In addition, reflective thinking, which is important in mathematics teaching, and the relationship between thinking skills such as creative thinking and critical thinking may be investigated and practices can be made in future to support the development of these skills.

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