Teacher Education Students' Cognitive Developmental Stages

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Abstract. *This study concerned with the cognitive developmental stages of 72 Mathematics majors and 72 non-Mathematics majors teacher education students of the Pangasinan State University Bayambang Campus, Philippines who were enrolled during the first semester of the school year 2015-2016. Specifically, this study purported to determine and compare the cognitive developmental stages between the Mathematics and non-Mathematics majors and among the second year, third year, and fourth year students. It further determines the interaction effect of students' cognitive developmental level. The 144 samples were drawn from the second, third and fourth year teacher education students. There was equal number of samples drawn by major course and by year level. Results showed that the students majoring in Mathematics and in non-Mathematics courses generally are concrete operational thinkers. However, the Mathematics major differs significantly in their cognitive developmental stage when compared with that of the non-Mathematics majors. The former tend to have higher cognitive developmental level than the latter are middle concrete operational thinkers; teacher education students in all curriculum year level, viz., second year, third year and fourth year are late concrete operational thinkers. Students in these year levels have comparable cognitive developmental stage; and the students' major course and year level have interaction effect to their cognitive developmental stages. The third year Mathematics majors have the highest cognitive developmental stage while the third year non-Mathematics has the lowest stage.*

Keywords: *teacher education, cognitive development, mathematics*

INTRODUCTION

Every educator who is highly concerned with the maximum attainment of educational goals is faced with a problem on the effectiveness of teaching-learning conditions. This problem is deeply rooted in the intellectual differences of the students such that the pedagogues are constantly in search of the instructional materials and processes best suited to meet majority of the students' needs. Hence, at the outset, teaching-learning processes should start from what the students know and the level of their understanding.

In line with this, Gauvain and Cole [1], succinctly postulated that the individual can receive valuable information via language or via education directed by an adult only if he is in a stage where he can understand this information. That is, to receive the information he must have the structure which enables him to assimilate such information. This is why one cannot teach higher learning, like mathematics, for an instance, to a five year old child. He obviously does not have the structures which would enable him to understand.

Piaget as cited by Bearison [2], maintained that the acquisition of knowledge comes about through qualitatively different modalities at different levels of cognitive development. This is a critical point of instruction because it prescribes a match between the form of instruction and the individual's level of development. It is obviously implied therefore that there is an utmost need to evaluate the individuals' cognitive development in order to plan a better curriculum for them and consequently to effect better teaching-learning situations.

The developmental stages viewpoint not only has remained a dominant one in psychology but has gained a steadily increasing importance in the thinking of educators, as apparent both from attempts made to construct school curricula fitted to developmental levels and to analyze existing courses in the term. At this point, Rowel and Hoffman [3] stated that any attempt to adapt curricula to the developmental levels of the intended population must be applauded as an important step toward improving the quality of educational system, particularly if it is combined with appropriate methodological education of the teachers.

In line with this, Lawson [4], indicated that the successful employment of curriculum materials appropriate to specific level of student intellectual development depends at least in part, on the fact that some underlying predominant mode of cognitive functioning does exist. If no such predominant mode of cognitive functioning exists, then curriculum decisions based upon "general" levels of intellectual development are compromised.

Hence, adapting the curricula and the teaching-learning processes to the developmental stage of the students is only a partial solution. To some, the problem still remains for the teachers to identify the mental development of each individual who faces him. As essential component of any successful teaching situation is the awareness by the teacher of the learners' level of comprehension so that the teaching is meaning, but this awareness is not so easy to achieve as the need for it is obvious.

The work of Piaget and his colleagues has provided a conceptual framework within which knowledge of some principles of intellectual development would enable educators to define the level at which the individuals are functioning. As such, the present study was focused on the cognitive developmental stages which are particularly derived from the theory of Jean Piaget.

OBJECTIVES OF THE STUDY

The study purported to determine and compare the cognitive developmental stages of the second, third and fourth year teacher education students of the Pangasinan State University, Bayambang Campus who are Bachelor of Secondary Education (BSEd) majoring in Mathematics and non-Mathematics majors/courses. Specifically, the study aimed to determine the profile of the teacher education students on their cognitive developmental stages based on their performance in the Piagetian Task Instrument; determine the extent of the cognitive developmental stages between the Mathematics and non-Mathematics major students compare; determine the extent of cognitive developmental stages of the students in the different year levels compare; and determine if there is an interaction effect between the students' major course and year level to their cognitive developmental stages.

METHODS

The descriptive-inferential method of research was used in this study since it aimed to describe and compare the cognitive developmental stages of majoring in Mathematics and students majoring in non-Mathematics courses in the Pangasinan State University Bayambang Campus during the first semester of the school year 2015-2016. The subjects of the study were the second, third and fourth year teacher education students majoring in Mathematics and non-Mathematics courses. From the total number of 364 enrollees in the second, third and fourth year college level, 72 students majoring in Mathematics and 72 students majoring in non-Mathematics courses were drawn at random. Proportionate samples to the number of samples majoring in Mathematics were drawn from students majoring in Social Studies, English, Filipino, Music, Arts and Physical Education (MAPE), Biological Science, Technology and Livelihood Education (TLE), and Physical Science. Ten Piagetian tasks, two concrete operational tasks and eight formal operational tasks taken from the evolved Piagetian Task Instrument were used to measure the students' cognitive developmental stages. This was focused on the comparison of the cognitive developmental stages between the students, majoring in Mathematics and non-Mathematics courses and by year level. The selection of samples was done using the systematic design. The lists of students majoring in the particular subject area per year level were secured from the specialization instructors and were utilized in determining the students to be taken in as sample. Alternate samples were selected in a case when the selected samples were not around during the testing period.

To investigate the students' cognitive developmental stages, ten selected written Piagetian tasks were employed and administered to the samples of the study. These Piagetian tasks were based on previously employed and recommended tasks by Piaget and Inhelder [5] and which were further developed and used by Walker [7]. Walker, et al., [8] pointed out that traditionally, the stage of Piagetian cognitive development exhibited by an individual has been identified by using a Piagetian Task Instrument (PTI). The PTI is a set of problems or tasks requiring recognizable reasoning patterns for solution. The conventional examination is given via a "one-to-one" interview. The results of examinees' performance on the tasks presented during the interview are then evaluated to determine the cognitive skills of the individual tested. The tasks included in most interviews require a demonstration of formal thought pattern as specified by Piaget and Inhelder [5]. However, the interview delivery which requires approximately 30 minutes, is therefore unsuitable for assessing large number of students in a relatively short time. This particular limitation prompted several investigators the development of a written PTI which can be administered to a large number of students in a short period of time. Lawson, Walker and Shepherd [4] were among those who tried to develop written PTI's. The written PTI's were subsequently validated and both had estimated reliability of 0.78. Piagetian tasks to be included in this study were therefore taken both written PTI's which were primarily based on the tasks of Inhelder and Piaget [5].

The Piagetian Task Instrument included in this study consisted of ten items, two of which were designed to determine concrete operational thought and the rest to determine formal operational thought. The tasks that comprise the PTI of this study were selected because they meet the requirements of formal operational thought as specified by Inhelder and Piaget [5]. Each basic element of formal operational thought as indicated by Flavell [6], were presented twice in the various tasks. Elements included were control of variables, proportional logic, combinatorial logic, and hypothetic-deductive reasoning. Conservation tasks were included for the concrete operational thinkers and early formal operational thinkers.

In determining the level of cognitive development of the second, third and fourth year students majoring in Mathematics and non-Mathematics courses, the simple frequency count, percentage and mean were employed. The normality of the distribution of the subjects was tested using standard deviation, coefficient of variation and index of skewness. The two-way analysis of variance was utilized in testing the significance of the difference in the levels of cognitive development between the Mathematics and non-Mathematics majors, and among students grouped by year level. The same statistical test was used in testing the significance of the interaction effect of the students' major course and year level to their cognitive developmental stages.

RESULTS AND DISCUSSION

Profile of the Teacher Education Students' Cognitive Developmental Stages

To provide a better picture of the teacher education students' characteristics, a profile on their cognitive developmental stages based on their performance in the Piagetian Task Instrument (PTI) is hereby presented and discussed. Table 1 shows the percentage distribution of the students' cognitive stages by major course and by year level.

It could be gleaned from the table that students, in general, belonged to the two upper cognitive developmental stages, to wit: concrete operational level (PTI score ≤ 5) and formal operational level (PTI score ≥ 5). Among the students majoring in Mathematics 79.17 % and 20.83% belonged to concrete operational level and formal operational level, respectively, while among the students majoring in courses other than Mathematics, 88.89 % and 11.11% belonged to the former and latter cognitive development stages, respectively.

Table 1. Percentage Distribution of Teacher Education Students' Cognitive Developmental Stages Major and by Year Level

Major Course/ Year Level	Level of Cognitive Development					
	Concrete Operational		Formal Operational		Total	
	N	%	N	%	N	%
Math Major						
Second Year	23	92.0	2	8.0	25	100
Third Year	14	60.86	9	39.14	23	100
Fourth Year	20	83.33	4	16.67	24	100
Sub-Total	**57**	**79.17**	**15**	**20.83**	**72**	**100**
Non-Math Major						
Second Year	19	82.61	4	17.39	23	100
Third Year	23	92.0	2	8.0	25	100
Fourth Year	22	91.67	2	8.33	24	100
Sub-Total	**64**	**88.89**	**8**	**11.11**	**72**	**100**
Total Group						
Second Year	42	87.5	6	12.5	48	100
Third Year	37	77.08	11	22.92	48	100
Fourth Year	42	87.5	6	12.5	48	100
Grand Total	**121**	**84.03**	**23**	**15.97**	**144**	**100**

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In other words, the ratio of concrete operational thinkers to formal operational thinkers is about four to one among the Mathematics major, students and eight to one among the non-Mathematics majors. These data suggest that regardless of the area of specialization or major courses, a large percentage of the teacher education students were functioning at the concrete operational level than at the formal operational level.

In terms of the year level, the same table reveals that there was equal percentage of second year and fourth year students who belonged to the formal operational level (12.5%) and who belonged to the concrete operational level (87.5%). On the other hand, there was a little more number of third year students who belonged to the formal operational level compared to the other year levels. About two out of nine (22.92%) students belonged to this cognitive level while the rest (77.08%) belonged to the concrete operational level. On the whole, i. e., regardless of year level the percentage of teacher education students who belonged to the formal operational level (15.97%) is very much less than the percentage of those (84.03%) who belonged to the concrete operational level.

To give a better picture of the characteristics of the teacher education students, Table 2 presents a more detailed profile on their cognitive developmental stages by major course and year level.

It could be surmised from Table 2 that among the teacher education students majoring in Mathematics, the third year students had the greatest mean (X=4.87) followed by the fourth year students (X=4.04). The second year students got the least mean (X=3.36). Such indicates that the third year and second year Mathematics majors seemingly had the highest and lowest cognitive developmental level, respectively. Categorizing the values, however, would redound to a finding that all the computed mean scores fell under the category, late concrete operational level. This was supported by the computed mean (X=4.07) of the total teacher education students majoring in Mathematics which was categorized under the same cognitive developmental stage.

The same table shows that among the teacher education students majoring in courses other than Mathematics, the second year students got the highest mean score (X=3.96) followed by the fourth year students (X=3.29) and the third year students (X=3.04). Just like the Mathematics majors, the non-Mathematics majors, of all year levels had mean scores which fell under the concrete operational level; however, the fourth year and third year students were categorized further under late concrete operational level, while the second year students were categorized under middle concrete operational level. The mean (X=3.42) of the entire group generally fell under the late concrete operational level.

Taking the totality of the students by year level and further disregarding their area of specialization or major courses, the third year students got the highest mean score (X=3.92) followed by the fourth year (X=3.67) and the second year students (X=3.65).

Table 2. Profile of Teacher Education Students' Cognitive Developmental Stage By Major Course and Year Level

Major Course/ Year Level	N	X	SD	CV	SK	Sk .05
Mathematics						
Second Year	25	3.36	1.38	41.07	.20	.91
Third Year	23	4.87	1.82	37.37	.36	.94
Fourth Year	24	4.04	1.90	47.02	.66	.93
Sub-Total	**72**	**4.07**	**1.79**	**43.98**	**.60***	**.55**
Non-Mathematics						
Second Year	23	3.96	1.55	39.14	.69	.94
Third Year	25	3.04	1.59	52.30	.18	.91
Fourth Year	24	3.29	1.63	49.54	- .13	.93
Sub-Total	**72**	**3.42**	**1.62**	**47.51**	**.17**	**.55**
Total Group						
Second Year	48	3.65	1.48	40.55	.11	.67
Third Year	48	3.92	1.92	48.98	.38	.67
Fourth Year	48	3.67	1.79	48.77	- .01	.67
Grand Total	**144**	**3.74**	**1.78**	**46.25**	**.51***	**.40**

*N = Sample size per group; X= mean; SD = standard deviation; CV = coefficient of variation; SK= index of skewness; Sk.05=critical value of skewness; *=significant at the .05 level*

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The above findings, the teacher education students of all year levels had mean scores which fell under the late concrete operational level. On the whole, irrespective of major courses and year level, the students had an overall mean score of 3.74 which fell under late concrete operational level. It is highly indicative, therefore, that students of any major course and year level function at the late concrete operational level. The above findings further implied that a large percentage of adolescents and young adults have not entered the formal operational level yet, and that these individuals who were supposed to be in this stage were functioning at a lower stage, that is, the concrete operational level. This finding likewise concluded that not all college students are at the formal operational level, the stage where they are expected to function and belong since their college studies require advanced mental structures to cope with the advanced cognitive strategies.

The extent of variability of the PTI scores of the Mathematics and non-Mathematics majors by year level are also presented in Table 2. Evidently, the fourth year Mathematics majors had the greatest variability, (CV=47.02) compared to that of the second year (CV=41.07) and the third year (CV=37.37) Mathematics majors. This is with reference to the overall variability (CV=43.98) of the Mathematics majors. The fourth year Mathematics majors' PTI scores were 14.49%, 25.82% and 6.91% more variable than the PTI scores of the second year majors, of the third year majors and of the overall Mathematics majors, respectively. Moreover, the index of skewness (Sk=.66) of the fourth year Mathematics majors tells that the distribution of the PTI scores was relatively skewed to the right. This means that a greater number of these students tended to mass towards the lower end of the PTI distribution of scores. The distribution, however, was still found to be normal since the computed index of skewness failed to reach the critical value (Sk.05 = .93) at the 0.05 level of significance.

With regards to the distribution of PTI scores of the second year and third year Mathematics majors, the indices of skewness (.20 and .36, respectively) show that the distributions were slightly tailed to the right but were considered insignificant since they failed to reach the respective critical values (Sk.05 =.94 and .93) at the 0.05 level. This shows that the distribution of scores for each of this year levels was considered normal.

Taking the index of skewness of the entire Mathematics majors, the computer value (Sk.05 = .60) was, however greater than the critical value (Sk.05 = .55) at the 0.05 level, and this was considered significant. This implies therefore that there was a marked slight positive skewness of distribution of PTI scores of the entire Mathematics majors. It implies further that there were more students whose PTI scores that were lower than the average score and the distribution tended to mass at the lower scale of the late concrete operational level. As reflected in the previous discussions, the PTI scores of the Mathematics student major in each year level followed a normal distribution. However in the above discussion, the PTI scores of the entire Mathematics majors were slightly skewed to the right. This is so because the PTI score of an individual student was now compared to all scores of the Mathematics majors from all year levels, not just to same year level. This implies that the performance in the PTI of the students were similar or close to each other within same year level but were not that close across year levels.

Among the non-Mathematics group, the third year students had the largest variability (CV=52.30) in the distribution of PTI scores followed by the fourth year (CV=49.54) and the second year students (CV=39.14). Comparing the computed coefficients of variation of the individual year levels to that of the entire non-Mathematics majors (CV=47.51), the coefficient of variability of the second year students was much less. Hence, the distribution of scores tended to be less variable. Specifically, it was 17.61% less variable than the variability of the total group. On the other hand, the distribution of scores of the third year and fourth year non-Mathematics majors were 10.01% and 4.27% respectively, more variable than that of the total group.

Pertaining to the index of skewness, the computed value (Sk=.69) of the second year students, however, was the largest compared to that of third year students (Sk=.18) and that of the fourth year students (Sk= -.13) who are majoring on courses other than Mathematics. This means that there was a tendency of the students to have score massed at the lower and of the distribution. The computed indices of skewness, however, were found to be insignificant when computed to the respective critical values at the 0.05 level of significance. Hence, the PTI scores were still considered to be distributed normally. The same findings was found for the entirety of the non-Mathematics majors. The computed index of skewness (Sk=.17) was far behind the critical value (Sk.05 = .55) and therefore reveals a normal distribution of PTI scores regardless of year level.

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In comparing the variability of PTI scores, among the second, third and fourth year students irrespective of major courses taken, the data in the same table show that the third year and fourth year students almost had the same amount of spread (CV=48.98 and 48.77, respectively), and were greater than the amount of variability (CV=46.25) of the entire group of 5.90% and 5.45% respectively. The second year students, on the other hand, had the least variability (CV=40.55) which was 12.32% less variable than that of the entire group. This implies that their PTI scores were not so spread out or, in other words, were close to each other. In terms of skewness, the data show that all the year levels had relatively small skewness. All indices of skewness failed to reach the critical value, thus the distribution of the PTI scores tended to approach normality. In other words, the PTI scores of the students per year level were normally distributed. Consequently, the cognitive developmental stages of the students per year level follow a normal curve of distribution.

However, taking the PTI scores of the students as a whole, i. e., disregarding their year level and major course, the computer coefficient of variation (Sk= .51) was found out to be significant at the 0.05 level (Sk.05= .40); this indicates that the distribution was skewed to the right. This further indicates that more students had PTI scores which were lower than the average score. In other words, the PTI scores of the students tended to mass at the lower end of the cognitive developmental level, that is, at the middle concrete operational level.

It was pointed out earlier that the mean scores of both the Mathematics majors (X=4.07) and non-Mathematics majors (X=3.42) generally fell under the late concrete operational level. Apparently the mean score of the former was greater than that of the latter. It should also be noted that in the previous discussion, the non-Mathematics majors were taken as one group. At this point, a more detailed discussion on this particular group is called for to give a clear understanding on the distribution of their PTI scores and a clear view on which specific non-Mathematics major course nearly approaches the cognitive developmental level of the Mathematics majors.

Table 3 presents the non-Mathematics student Majors' level of cognitive development. It could be gleaned from the table that among the non-Mathematics majors, students majoring Biological Science had the greatest mean score (X=3.90) followed by those majoring Social Studies (X=3.79) and English (X=3.75). All mean scores fell under late concrete operational level. On the other hand, students majoring in Filipino (X=2.67), MAPE (X=2.80), TLE (X=3.00), and Physical Science (X=3.12) had the least mean scores. These mean scores fell under middle concrete operational level.

In terms of variability of scores, students majoring in English and MAPE had the least indices of variation (CV=36.27 and 36.79, respectively), while students majoring in TLE and Physical Science had the greatest coefficients of variability (CV= 61.00 and 55.45, respectively). The first two major groups were respectively 18.80% and 22.56% less variable than the entire groups while the last two major groups were respectively 28.39% and 16.71% more variable than the entire group. It is indicative that based on the above values, the spread of the distributions for the first two major groups were not so widespread compared to that of the last two major groups. In terms of the indices of skewness, the distributions of PTI scores of students majoring in Social Studies (Sk= -.10), English (Sk= -.45), and Filipino (Sk= -.38), MAPE (Sk= -.20) and Biological Science (Sk= -.22) were negatively skewed while the distribution of PTI scores of students majoring in TLE (Sk= .28) and Physical Science (Sk= .41) were positively skewed. The indices of skewness of all major course, however, failed to reach the respective critical values, thus, the distribution of PTI scores were considered normal.

Table 3. Non-Mathematics Major Students' Level of Cognitive Development

Major Field	Sample Size	Mean (X)	SD	CV	Sk	SK .05
Social Studies	19	3.79	1.87	49.34	-.10	1.03
English	12	3.75	1.36	36.27	-.45	1.25
Filipino	6	2.67	1.03	38.58	-.38	1.66
MAPE	10	2.80	1.03	36.79	-.20	1.35
Biological Science	10	3.90	1.85	47.44	-.22	1.35
TLE	7	3.00	1.83	61.00	.28	1.56
Physical Science	8	3.12	1.73	55.45	.41	1.47
Total	**72**	**3.42**	**1.62**	**47.51**	**.17**	**0.55**

Legend: SD=Standard Deviation; CV= Coefficient of Variation; Sk=Skewness

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Table 4. Table of Two-Way Analysis of Variance

Source of Variance	df	SS	MS	F- ratio	p
Within Groups	138	321.21	2.72		
Between Groups					
Factor 1 (Major Course)	1	15.34	15.34	5.63	p < .05
Factor 2 (Year Level)	2	2.18	1.09	0.40	p > .05
Interaction 1 x 2	2	35.76	17.88	6.57	p < .01
Total	143	429.49			

df=	degrees of freedom	F.05	(factor 1)	=3.92
SS=	sum of squares	F.05	(factor 2)	=3.07
MS=	mean square	F.05	(factor 1 x 2)	=3.07
p=	probability of occurrence			

On the whole, the students majoring in Biological Science having had the greatest mean value had cognitive developmental stage nearest to that of the students majoring in Mathematics. This is probably so because the two subject areas are interrelated. It is often said that Mathematics is the language of science for the former is always a part and parcel of the latter.

Comparison of Students' Cognitive Developmental Stages by Major Course and Year Level

In the previous discussion, it was noted that students majoring in Mathematics and non-Mathematics courses and who belong to different year levels had different cognitive developmental stages. To find out whether there exist significant differences in the cognitive developmental stages of students grouped by major course and year level, the data were treated statistically using the two-way analysis of variance test. Table 4 shows the table of two-way Analysis of Variance.

It could be surmised from the table that the F-ratio (F=5.63, p < .05) showing the comparison of the cognitive developmental stages between the teacher education students majoring in Mathematics and non-Mathematics courses was greater than the critical F-value (F.05=3.92), therefore was considered significant at the 0.05 level of significance. Hence, the null hypothesis which states that there is no significant difference in cognitive developmental stages between Mathematics and non-Mathematics majors was rejected in favor of the research hypothesis.

The Mathematics majors had mean score of 4.07 while the non-Mathematics01 had mean score of 3.42 in the Piagetian Task Instrument. While both mean scores fell under the same category; i. e, late concrete operational level, the mean score of the former is significantly higher than that of the latter, that is, the mean score of the former nearly approached the formal operational level. This means that more Mathematics majors had higher cognitive developmental stage compared to the non-Mathematics majors. This is probably so because Mathematics courses require higher understanding of abstract contents, consequently require higher level of mental structure to cope up with the content requirements.

In terms of the comparison of the students' cognitive developmental stages by year level, the same table provides as F-ratio of 0.40. With two (2), 138 degrees of freedom, this value failed to reached the critical F-ratio at the 0.05 level of confidence (F.05= 19.49). This value fell within the region of acceptance of the normal curve of distribution. It is indicative, therefore, that the null hypothesis which states that there exists no significant difference in the cognitive developmental stages among students of different year levels are accepted. This means that whatever difference in the cognitive developmental stages among the second year (X=3.65), third year (X=3.92) and fourth year (X=3.67) resulted from mere chance. This means further that the cognitive developmental stages of the students in the three curriculum year levels were comparable and did not deviate much from each other. In general, teacher education students of all year levels belonged to late concrete operational level. In a nutshell, students' year level did not affect their cognitive developmental stage. This may be so because these students belonged to almost the age bracket, to wit, late adolescent stage.

Interaction of Major Course and Year Level To Students' Cognitive Development Stages

To find out if year level and major course have combined effect on the students' cognitive developmental stages, the interaction effect of the first two variables to the latter variable was likewise computed using the F-test. With reference to Table 5, the computed F-ratio (F=6.57) for the interaction of major course and year level to the students' cognitive developmental stages had less than .01 probability of

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occurrence. This suggests that the computed F-ratio was not only significant at the set alpha level, namely, 0.05 level of significance, but was highly significant for it exceeded the critical value at the 0.1 level. This further suggests that the null hypothesis which states that there is no interaction effect of major course and year level on students' cognitive developmental stages was rejected with 99% level of confidence.

To determine which sub-groups differed significantly in their cognitive developmental stages, t-test for independent samples was employed. The summary of data is shown in the following table.

A closer look at the table 5 reveals that four paired groups out of fifteen possible pairs had mean differences that were significant. These paired groups were as follows: between second year Mathematics majors and third year Mathematics majors ($t=3.27$, $p < .01$), between third year Mathematics majors and third year non-Mathematics majors ($t=3.73$, $p < .01$), between third year Mathematics majors and fourth year non-Mathematics majors ($t=3.15$, $p < .01$), and between second year non-Mathematics majors and third year non-Mathematics majors ($t=2.03$, $p < .05$). Other paired groups of students had computed t – values which had probability of occurrence greater than .05, hence were considered insignificant. This means that the mean scores between these groups did not differ significantly with each other. This means further that their cognitive developmental stages were comparable.

The same table shows that in each of the paired groups whose t-value was found to be significant, the third year Mathematics majors obtained a greater mean score (X=4.97) than their counterparts, viz., second year Mathematics majors (X=3.30), third year non-Mathematics majors (X=3.04) and fourth year non-Mathematics majors (X=3.29). This signifies that the third year Mathematics majors whose mean scores fell nearly to formal operational level had the highest cognitive developmental stage compared to the three groups of students who were considered to have lower cognitive developmental stages, i. e., middle concrete operational level.

Between the second year non-Mathematics majors and third year non-Mathematics majors, the former had greater mean score (X=3.96) which was categorized as late concrete operational level compared to their counterpart whose mean score (X=3.04) was categorized as middle concrete operational level. It is highly indicative, therefore, that the former had higher cognitive developmental stage than the latter. The interaction effect of major courses and year level to the students' cognitive developmental stage is likewise viewed in Figure 1.

Table 5. Summary of T-Values Showing the Comparison of Students' Cognitive Developmental Stages When Grouped By Major and By Year Level

Group	X^1	X^2	X diff	t-Value
2M-3M	3.36	4.87	1.51	3.27**
2M-4M	3.36	4.04	0.68	1.43
2M-2NM	3.36	3.96	0.60	1.42
2M-3NM	3.36	3.04	0.32	0.76
2M-4NM	3.36	3.27	0.07	0.16
3M-4M	4.87	4.04	0.83	1.53
3M-2NM	4.87	3.96	0.91	1.84
3M-3NM	4.87	3.04	1.83	3.73**
3M-4NM	4.87	3.29	1.58	3.15**
4M-2NM	4.04	3.96	0.08	0.16
4M-3NM	4.04	3.04	1.00	2.00
4M-4NM	4.04	3.29	0.75	1.46
2NM-3NM	3.96	3.04	0.92	2.03*
2NM-4NM	3.96	3.29	0.67	1.44
3NM-4NM	3.04	3.20	0.25	0.54

Legend:

2M	=	second year Math	2NM	=	second year non-Math
3M	=	third year Math	3NM	=	third year non-Math
4M	=	fourth year Math	4NM	=	fourth year non-Math
X^1	=	mean of first group	X^2	=	mean of second group
X diff	=	mean difference			
*	=	significant at the 0.05 level			
**	=	significant at the 0.01 level			

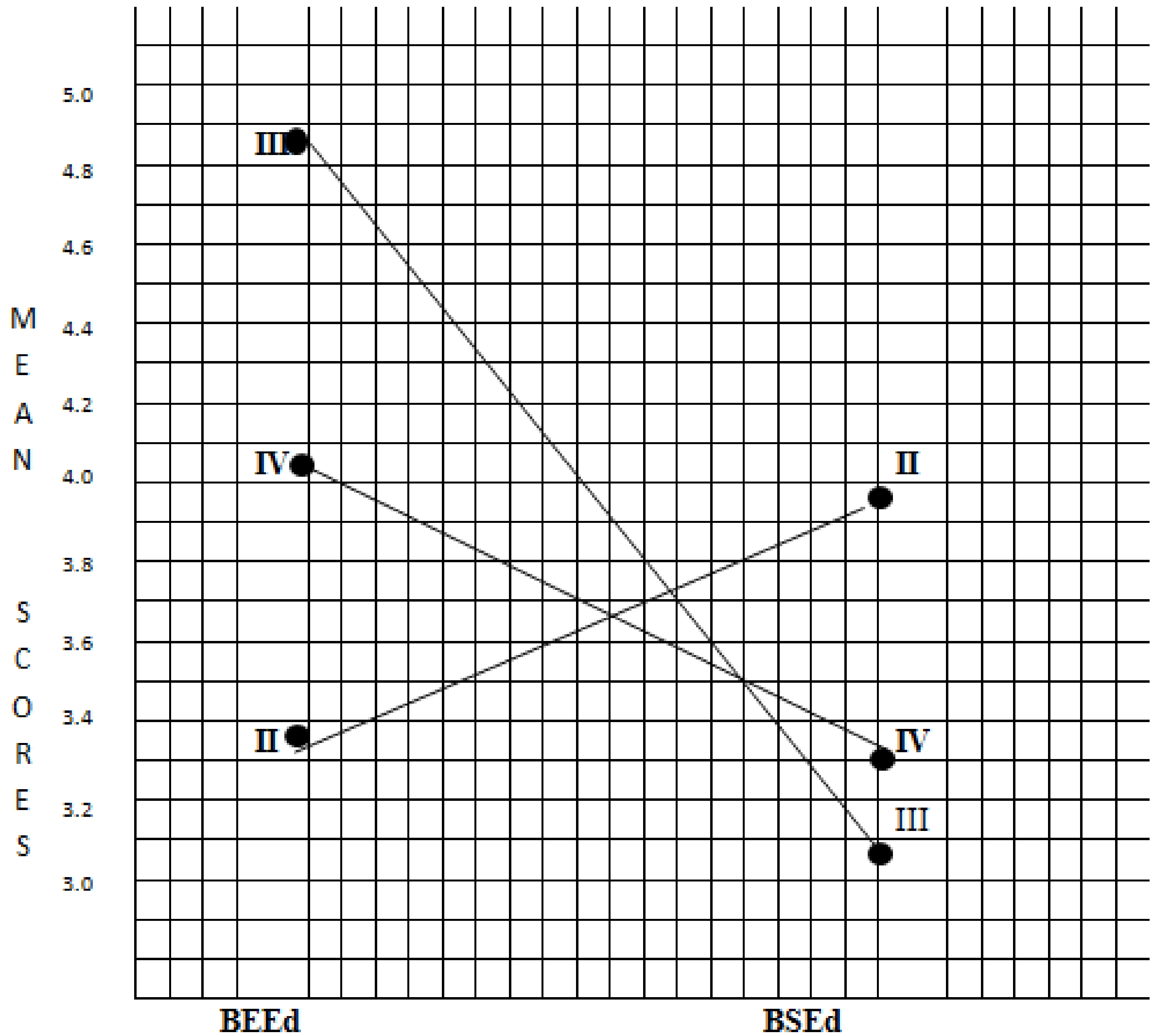

Figure 1. Graph Showing the Interaction Effect of Degree Program and Year Level to Student's Cognitive Developmental Stages

It is reflected in Figure 1 that the lines showing the mean scores between Mathematics majors and non-Mathematics majors per year level intersected with each other. This, therefore, manifests an existence of intersection between major course and year level to the students' cognitive developmental stages. As shown, the mean score of the third year Mathematics majors was higher than those of other groups while the mean scores of the third year non-Mathematics majors was considered the least. The data in the figure, henceforth, supported the above-mentioned findings.

Probably, more third year precocious students or students with higher level of thinking were motivated to take Mathematics as their course because the revised curriculum has just been approved by the time they were to take their major course. Probability, they believed that the revised curriculum could meet their intellectual needs. Another possibility is, most of these students were generally interested in the subject content area that they tended to take and meet in the same major course. On the other hand, the less precocious students' probability think that they could not meet the content requirements in Mathematics, hence flocked to non-Mathematics areas. This may explain why they had the lowest cognitive development.

Implications

Piaget's cognitive developmental stages serve as convenient instrument for tracing the course of logical thoughts among individuals. The findings and

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conclusions drawn from this study gave several implications to education. However, although the findings reported in this study are by no means conclusive to all colleges, particularly those who are offering teacher education, they do imply some misgivings and necessary improvements in our teacher preparation programs. It was shown in the present investigation that the pre-service teacher education students are generally concrete operational thinkers and therefore find difficulty to actualize formal operational tasks or concepts that involve ratio and proposition, propositional reasoning, hypothetic-deductive reasoning, probability and combinatorial logic. When such pre-service teachers go into the classroom to teach, they in all likelihood, memorize these formal concepts and transmit them verbatim to the learners. This is highly possible since these pre-service teachers are unable to comprehend in the first place these formal concepts that are expected of them, specifically in Math and Science courses. We should take note that college work emphasizes higher level of cognitive abilities and the inquiry approach to teaching. The result is that these students who are in the concrete operational level tend merely to memorize concepts and fail to internalize and actualize them and when they go to the field for actual teaching, they would do the same as they undergone their education and would in a way fail to promote logical reasoning to their prospect students. There is then a need to redouble our efforts in improving our teacher education program. Toward this end, we have to conceive of logical reasoning more broadly than simply the mere transfer of learning without taking into consideration whether the concepts are internalized and actualized or not.

With this framework, Kuslan and Stone [9], has suggested that teachers need to concentrate on identifying their students' reasoning patterns for by becoming aware of reasoning pattern to understand a particular course, a teacher can both identify the conceptual emphasis and demands of the subject matter, and help students develop more advanced reasoning patterns than the patterns they use currently. At this point, this research study implies that the work of Piaget and his followers could provide an ample means to arrive at a resolution to determine the intellectual capacities of the learners. It was hoped that teachers could learn from the methods used in this study some ideas in diagnosing students' difficulties and in assessing the development and acquisition of other related concepts. Hence, to identify the reasoning required of the student in a course, the teacher must be clear about the meaning and implications of students' cognitive developmental stages so that alternative approaches to improve and enrich teaching could be set up.

The above implications although many liberal arts and education majors function at a formal operational level in some areas, their thinking in science and mathematics is often concrete operational. As a result of the inability of professors to adapt their methods to the thinking level of their students, many graduates participate in a mindless certification process, receiving degrees though intellectually deprived. Nevertheless, many of these graduates then become teachers despite serious emotional blocks and negative attitudes towards learning particularly in the areas of science and mathematics. Moreover, many of them are convinced that questions from teachers and the answers are found in the teacher's lecture or are neatly organized in a textbook. This cycle of "mindless memorization" should then be put to a stop.

The difficulty of teaching within Piaget's framework is that it requires not only a depth of understanding of individual development, but also of subject matter and teaching methods. The curriculum implications point to the need for a careful distinction between the concepts we wish to teach and the examples we choose to illustrate the concepts.

Generally, the practical implications of the results of this study are less clear than the demonstrated theoretical importance of the four processes that Piaget strongly believes to contribute to or responsible for transition to higher levels of intellectual development. Every classroom therefore should make adequate provision for individual's involvement through physical, experiences, social interaction and equilibration with adequate time (maturation) to reflect on ideas and consider them.

On the whole, the direct implications of Piaget's theory lie on curriculum development, study concepts and materials, and teacher's role in the attainment of facilitated intellectual growth.

CONCLUSION AND RECOMMENDATION

Based on the statistical findings, the following conclusions may be inferred: (1) Mathematics and non-Mathematics courses generally are concrete operational thinkers. However, the Mathematics majors differ significantly in their cognitive developmental stage when compared with that of the non-Mathematics majors. The former tend to have higher cognitive developmental level than the latter; (2) Teacher education students in all curriculum year level, viz., second year, third year and fourth year are late concrete operational thinkers. Students in these year levels have comparable cognitive developmental stage; and (3) The students' major course and year level have interaction effect to their cognitive developmental stages. The third year Mathematics majors have the highest cognitive developmental stage while the third year non-Mathematics majors have the lowest stage. Based on the above findings and conclusions the following recommendations were drawn: (1) Piaget suggested that instruction should be structured around the cognitive developmental levels of the students. Hence, individuals preparing to teach and who are at present teaching should acquire an understanding of Pigeatian developmental theory to aid them in providing students more appropriate instructions (contents, materials, and processes); (2) The ability to properly determine students' cognitive level is necessary for effective planning and sequencing of instruction. Hence, teachers in the field could make use of the Piagetian Task Instrument evolved in this study in testing the students' modality of thoughts/logical thinking; and (3) The individual progresses and grows according to his own individual pattern. Hence, better techniques of handling different concepts and better approaches to teaching based on a fuller knowledge of students' differences in intellectual development should be further explored and developed; and (4) Mathematics and Science courses are believe to be highly content-oriented courses. It is therefore imperative that there should be a criteria set, e. g., screening test in the selection of students who are majoring in these courses. The Piagetian Task Instrument used in this study may be utilized as the test in screening the students who wish to take Mathematics or Science as their major course.

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