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Benguet State University High School Students' Curiosity, Interest, and Perceptions on Interactive Manipulatives in Mathematics

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Abstract

The Benguet State University high school students perceive that their exposure to interactive manipulatives in mathematics can influence their interest to pursue a career path in Mathematics. They claimed that their interest and curiosity in the interactive manipulatives were increased after handling the different manipulatives. Further, the students also claimed that their academic performance in Mathematics could be enhanced, should these interactive manipulatives be used in their classes. Results are true to all students whether they intend to pursue a mathematics-related course or not. These results stemmed from 71 high school students who were asked, through a questionnaire, to give their views after their exposure to the different manipulatives. They were first asked to watch a demonstration of the mathematics manipulatives and were given time to manipulate the devices given some procedures and mathematical concepts as guides. The study suggests that students be exposed to interactive devices to enhance their academic performance in Mathematics and stimulate their interests in pursuing Mathematics related degrees. Likewise, in a setting where the availability of manipulatives is limited, educators should devise practical materials that students can use. Lastly, a quasi-experimental study may be done to verify the respondents' claim that their Mathematics performance can be enhanced when manipulatives are utilized in their classes.

KEYWORDS

Interactive manipulatives
Mathematics
Mathematics-related degree

Introduction

The strength of a nation is built on human resources developed by its educational institutions, which train the brain, provide the skill, and open a new world of opportunities and possibilities to the nation for economic growth, social justice, and poverty alleviation (Adentunde, 2007; Lauder et al., 2006). Equally, the country's economic progress relies heavily science and engineering and this demands a strong foundation in mathematics (Ogena & Tan, 2006 ; Pascua, 1993). As cited by Science Education Institute, Department of Science and Technology (SEI-DOST) and the Philippine Council of Mathematics Teacher Education (MATHTED), Inc. (2011), Mathematics is seen as "an essential tool for intelligent participation in a

technological society". As the level of mathematics needed in the workplace continues to increase, its study is indispensable in order to develop a "scientifically and technologically literate citizenry" (UP National Institute for Science and Mathematics Education Development [UP NISMED], 2001). This need is a basis of this study. It delves into the idea of using interactive manipulatives to persuade high school students to be attracted to mathematics-related degrees.

Generally speaking, manipulatives are any object that is used in teaching math to help the students see and understand the concept being taught. More specifically, manipulatives are defined as "physical objects that are used as teaching tools to engage students in the hands-on learning of mathematics". Examples of manipulatives include unifix cubes, counters, calculators, pattern blocks, tiles, plain wooden cubes, toothpicks, beans, bottle caps, skittles, base-ten blocks, and coins. Manipulatives are used to introduce, practice, or remediate a math concept in the classroom. "A good manipulative bridges the gap between informal math and formal math. However, to accomplish this objective, the manipulative must fit the developmental level of the student" (Smith, 2009).

Confucius once said, "I hear and I forget. I see and I remember. I do and I understand." Hence, when students can touch and move manipulatives or real things when learning new skills, their senses are involved in the learning experience. Students benefit when they are able to fully understand new concepts with concrete materials before they are expected to understand the same ideas with symbols. According to Golafshani (2013), mathematical instruction should begin with experiences that are real to students and function as symbols throughout their learning, and, clearly, manipulatives represent important tools in efforts to make mathematics more real. When students are provided with lasting sense of number and number relationships, and their learning is grounded and related to aspects of everyday life or to the use of concrete materials or manipulatives designed to reflect underlying mathematical ideas, it is most likely that they will show appreciation and interest to the concepts. In most cases, if students are interested in a certain area, it is most likely that they will also invest time in exploring further the given concepts. Interestingly, excitement and interest in mathematics can be transferred to students when they can see the real applications through manipulatives. This will help students see the critical role of math in different fields.

Several researches had shown that students exposed to manipulatives had demonstrated higher performance in Mathematics than those who were not (Kablan, 2016; Chang, 2008; Cain-Castons, 1996). However, it appears that locally, there are no studies conducted yet to measure the effect or impact of exposing students to interactive manipulatives in attracting them to pursue a Mathematics-related degree; hence, this study.

The study aimed to identify the level of students' interest and curiosity with interactive manipulatives. It also aimed to determine the extent of influence of the interactive manipulatives to students' interest to take mathematics – related degree and to mathematics performance of the students. Comparisons of the different levels when grouped according to their intended career path were also considered.

Conceptual Framework

The study conceptualization is rooted in the idea that students' exposure to interactive manipulatives entices their interest to pursue mathematics-related degrees. To verify the truth of the concept, the study determined the students' level of interest to take mathematics-related degrees after their exposure to different interactive manipulatives. The paradigm shows the coverage and direction of the study.

The independent variable is exposure to the various manipulatives. In the context of education, manipulatives are physical tools of teaching, engaging students visually and physically with objects such as coins, blocks, puzzles, markers, etc. (Study.com, 2015). In the study, manipulatives refer to the objects designed so that a learner can perceive some mathematical concepts by manipulating them. These manipulatives include but are not limited to the following: abacus, tower of Hanoi, geometric blocks and solid figures, algebra boards, magic cards, star lanes, improvised transit, and others. Manipulatives are objects designed to represent explicitly and concretely mathematical ideas that are abstract (Carbonneau & Marley, 2012; Moyer, 2001). They both have visual and tactile appeal

and can be manipulated by learners through hands-on experiences. Without these concrete references, students are often lost in a morass of abstract symbols for which they have no concrete connection or comprehension.

On the other hand, the dependent variables include the students' level of interest and curiosity to the different interactive manipulatives, the extent of influence of the interactive manipulatives to their academic performance, and their interest to pursue Mathematics-related degrees. These different levels and extent of interactive manipulatives influence are however based on students' views; hence, these are all as perceived by the participants.

Lastly, the students' intended career path was identified as the intervening variable. The intended career path refers to only two categories in the study: Mathematics-related and non-Mathematics-related degrees.

Methodology

Locale and Time of Study

The research was conducted at Benguet State University (BSU), La Trinidad, Benguet during the school year 2014-2015. All the 71 participants were 4th year High School students of the Secondary Laboratory School. Of the 71 participants, only 29 initially mentioned that they will take Mathematics-related degrees in College.

Data Collection

The study is a descriptive research. It utilized a survey questionnaire to gather the responses of the students. The Interactive Mathematics Manipulatives (IMMs) were displayed for viewing and were also demonstrated as part of the celebration of the Mathematics and Science Week Celebration. The 4th year high school students were invited to the exhibit. Viewing and manipulation of the different interactive manipulatives were done for a week. They were allowed to explore the mathematical concepts or problems using the manipulatives until they can figure out the correct answers. After the students were exposed to the IMMs, they were asked to answer a survey questionnaire consisting of questions on their level of curiosity and level of interest on IMMs. They were also asked perception questions on the influence of their exposure to interactive materials to their academic performance in Mathematics and interest to pursue Mathematics-related degrees.

Statistical Analysis

The study utilized weighted mean in determining the level of interest, curiosity and extent of influence of Mathematics manipulatives on the interest of students in pursuing a career track in Mathematics and the students' academic performance. The one sample t-test was used in comparing students' levels of curiosity, interest, and extent of influence with the average. The t-test for two independent samples was used to compare the students' level of students' curiosity, interest, and influence according to their intended career path.

The following Likert Scale was used to determine the students' level of interest, and curiosity toward the IMMs, and the extent of influence of IMM exposure on their career choices and their mathematics academic performance:

Scale	Range	Description	
5	4.21 – 5.00	Very Greatly Interested/Curious/ Influenced	VGI/VGC/ VGI
4	3.41 – 4.20	Greatly Interested/ Curious/Influenced	GI/GC/GI
3	2.61 – 3.40	Moderately Interested /Curious/Influenced	MI/MC/ MI
2	1.81 – 2.60	Slightly Interested/ Curious/Influenced	SI/SC/SI
1	1.00 – 1.80	Not Interested/ Curious/Influenced	NI/NC/NI

All the hypotheses were tested at $p = 0.05$ level.

Results and Discussion

Level of Curiosity

Table 1 presents the level of curiosity toward the interactive manipulatives. The computed mean of 3.98 reveals that students are greatly curious on the interactive manipulatives. This means that students exhibited a high level of curiosity about the interactive mathematics manipulatives they observed.

This is in consonance with the findings of Falk and Needham (2011) that people exposed to Science Center gave self reports that the Center had strongly influenced their science and technology understanding, attitudes, and behaviors. Results also agree with the work of Lee and Chen (2015), which established that manipulatives are effective means to engage students intellect regardless of their mathematical inclination.

Level of Interest

Table 1 further shows the level of interest of students in interactive manipulatives. Students were greatly interested in the observed interactive manipulatives as shown by the computed mean of 3.74. This level is significantly different from the hypothesized level of interest which is moderate. This can be attributed to the presence of concrete materials that students can observe, manipulate and relate this real applications (Brown et al., 2009; Tindall-Ford & Sweller, 2006).

The result validates Wilke and Straits (2002) statements that demonstration can stimulate interest and curiosity of learners. This is also in consonance with many findings as generalized by Morgan (2008) who stated that the use of manipulatives stimulate student interest and attention leading to improved motivation and engagement during classes.

Perceived Extent of Influence of the Interactive Manipulatives on Students' Interest to Pursue Mathematics-related Degree

Based on the computed mean value of 3.87, the students think that interactive manipulatives can greatly influence their interest to take a Mathematics-related degree (Table 1).

The result is significant at 0.05 level of significance which means that the students' view on the extent of influence of the interactive manipulatives on their interest to pursue Mathematics-related degree is indeed higher than the hypothesized level. This result indicates that students desire to take mathematics-related degree were further influenced when they experienced handling the interactive manipulatives. This view of the students may have stemmed from their concrete experience in solving mathematical problems with the aid of devices that they can manipulate in order to find the answer. This is aligned to the discovery of Moran-Zerda (2001) that experiencing interactive exhibits has a positive effect on students' desire to become scientists and engineers. It is similar to the observation of Azar (2010) that math manipulatives may influence children's education and career choices later in life and that perception of mathematics as seen through manipulatives is a strong predictor of career choice (Farmer, 2005).

Table 1

Level of Curiosity and Interest on and Perceived Influence of Interactive Mathematics Manipulatives, BSU High School Students, 2014-2015

Item	Weighted Mean	Description	*t*-value	*p*-value
Level of curiosity about interactive mathematics manipulatives	3.98	Greatly Curious (GC)	8.410*	0.000
Level of interest in interactive mathematics manipulatives	3.74	Greatly Interested (GI)	4.864*	0.000
Perceived extent of influence on interest of students to take mathematics-related degree due to interactive mathematics manipulatives	3.87	Greatly Influenced (GI)	6.217*	0.000
Perceived extent of influence of interactive mathematics manipulatives on Mathematics performance	4.20	Greatly Influenced (GI)	10.087*	0.000

*Significant

Perceived Extent of Influence of Interactive Manipulatives on Mathematics Performance

Finally, Table 1 also presents the level of influence of interactive manipulatives to mathematics performance of students. The computed mean value of 4.20 reflects the students' views that that their mathematics performance can be greatly influenced by the use of interactive manipulatives in class.

The students perceived that inclusion of concrete objects to illustrate abstract concepts in Mathematics can enhance their Mathematics performance. This is similar to the assertion of Driscoll (2005) and Golafshani (2013) that the use of manipulatives can be traced to Piaget's (1970) suggestion that children need experiences with models and instruments in order to grasp the mathematical concepts. Many studies also suggest that manipulatives improve children's long-term and short-term retention of mathematics. Cain-Caston's (1996) research indicates that using manipulatives helps improve the environment in math classrooms. When students work with manipulatives and then are given a chance to reflect on their experiences, not only is mathematical learning enhanced, but math anxiety is also greatly reduced. In addition, Chang (2008) found that children better understand math when they use concrete examples. Concrete examples in mathematics are best illustrated with the use of interactive manipulatives.

Moreover, Lee and Chen (2015) established that manipulatives effectively engage the intellect of students regardless of their mathematical inclination. Further, Morgan (2008) also stated that, the use of manipulatives stimulates student interest and attention leading to improved motivation and engagement during classes.

Comparison of Students' Perceptions to Encountered Interactive Mathematics Manipulatives when Grouped According to their Intended Career Path

Table 2 shows the comparison of students' interest level and curiosity level about interactive mathematics manipulatives; extent of influence of interactive devices on students' interest to pursue Mathematics-related degrees and on mathematics performance of students when grouped according to their intended career path.

In all the parameters identified, results show that there is no significant difference in the perceptions of the students when compared according to type of degree students intend to pursue. This result implies that students who intend to take non-mathematics degrees manifested equal level ofcuriosity and interest to interactive manipulatives with those students who

Table 2

Comparison of Students Perceptions to Interactive Mathematics Manipulatives when Grouped According to Intended Career Path

Item	Math-related	Non-Math Related	*t*-value	Significance level
Level of curiosity about interactive mathematics manipulatives	4.0	3.94	.435^{ns}	.668
Level of interest in interactive mathematics manipulatives	3.79	3.62	.222^{ns}	.826
Perceived extent of influence on interest of students to take mathematics-related degree due to interactive mathematics manipulatives	3.89	3.81	.240^{ns}	.812
Perceived extent of influence of interactive mathematics manipulatives on Mathematics performance	4.16	4.31	-.539^{ns}	.595

^{ns}-not significant

intend to take mathematics-related degrees. This level of interest and curiosity can be harnessed to keep the students actively involved in the subject content, following the idea of McFarland (2005).

Results also show that regardless of degree students intend to pursue, students' view on the extent of influence of interactive manipulatives to their mathematics performance and their career choice are the same. This result means that even students who intend to take non-Mathematics related degree believed that their performance in Mathematics can be enhanced when exposed to the use of manipulatives. There is also a likelihood that they will pursue a Mathematics-related degree.

Results are in consonance with the findings of Lyons et al. (2012) and Dabney et al. (2012) that participation of students in practical or out-of-school time (OST) activities such as exhibits, fairs and the like can persuade students to choose courses in Science, Technology, Engineering and Mathematics (STEM). Similarly, self reports of students also showed that utilization of demonstration to promote scientific understanding (Shepardson et al., 2012) could have a positive influence on academic performance (Lubrica, 2010). Furthermore, Carbonneau et al. (2013) reported that manipulatives in mathematics instruction produce a small to medium-sized effect on student learning compared with instruction that uses abstract symbols alone. Studies by Lazonder and Ehrenhard (2014) and Taraban et al. 2007 found that students perceived that knowledge level had increased after they were engaged in content-based inquiry science and hands-on activities.

Conclusions

The students were greatly curious and interested with the interactive mathematics manipulatives. Students also believed that their interest to pursue mathematics–related degree was amplified when they experienced handling the interactive manipulatives. Likewise, the students think that when the different interactive manipulatives will be utilized in their Mathematics classes, their performance is likely to improve. Overall, the students who intend to take non-mathematics degrees expressed equal level of curiosity and interest to interactive manipulatives with those students who intend to take mathematics or mathematics-related degrees. Further, both groups exhibited same views on the extent of influence of the interactive devices on their interest to pursue mathematics-related degrees after their exposure to the interactive manipulatives.

Recommendations

The study recommends that teachers venture into the use of interactive manipulatives to engage students' intellect regardless of their mathematical inclination. In this way, teachers could help students have a more positive relationship with math, which may influence their education and career choices later in life, especially towards math-related degrees. Events that showcase different interactive manipulative in mathematics, such as Mathematics exhibits and fairs, may be done, to attract students to pursue mathematics or mathematics-related career paths. Administrators can build upon this to increase the number of students enrolling in math-related degrees in the universities. Further, a quasi-experimental study may be done to verify the claim of the respondents that their performance in Mathematics can be enhanced when manipulatives are utilized in their classes.

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