# *The Relation Between Mathematics Education Software and Mathematics Thinking Style*

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**Abstract**
In this study the mathematics thinking styles and the need for using mathematics education software for students of the Department of Mathematics and Computer Science and the Department of Business at the Modern College of Business and Science has been identified. The study was conducted among 101 college students during the 2022-2023 academic year. To this end, a questionnaire was used to identify students' preferences when attempting to solve a mathematical problem while the instructor is teaching them. According to the findings, there is a statistically significant difference between students from the two departments in terms of their preference to deal with mathematics concepts. More precisely, the preference of students from the Business department is visual thinking style, and they have a willingness to be taught by use of mathematical education software. Moreover, it is seen that Mathematics Thinking Styles are significantly different according to the students' seniority levels. A statistically significant difference has been observed in the scores of willingness to use mathematics software in favor of the Business department. Finally, the Mathematics Thinking Styles scores do not show any statistically significant differences in terms of the CGPA of students.

Keywords: Mathematics Thinking Styles, Math Education Software, Mathematics Education

## 1. Introduction

According to the theory of construction of knowledge which was originally introduced by Bodner (1986), students as individuals have their own mental process in order to form information obtained and interpret lessons. In particular in the field of mathematics education, Ernest (2004) argued that the subjective knowledge is not a passive process but it is actively constructed by cognizing the subject. In this respect, there are different classifications of the ways that students understand and solve mathematics questions. One of the most recent studies which has derived attention of educational researchers is Borromeo Ferri's classification of thinking styles (Borromeo Ferri, 2003, 2004). Accordingly, there are three styles of mathematics thinking, namely visual, analytic and integrated. A student with visual thinking style is characterized by preferences for understanding mathematical notions and relations through "holistic representations, and his/her internal imagination is mainly affected by connection with experimental cases" (Borromeo Ferri, 2003, 2004). A student with analytic thinking style are able to understand mathematical concepts through existing symbolic or verbal representations and prefers to deal with math problems in a sequence of steps, and a student with integrated thinking style has the capability of combination of analytical and visual thinking. Shahbari (2020) studied Mathematics Thinking Styles in the context of modeling process of students and showed that students with visual thinking style have the ability of building a bridge between real world problems and their mathematical knowledge. Risnanosanti (2017) characterized mathematics thinking styles of Mathematics of third year students and showed that students who prefer analytic thinking styles have better achievement than those who have visual styles. In the case of Mathematics Education software, Sevimli (2016) compared students' thinking styles in traditional classes with students in a class with a Computer Algebra System and demonstrated that students in the traditional group give more weight to procedural skills, whereas students in the Computer Algebra System group give more weight to conceptual skills. In another study, Huincahue et al. (2021) implemented a quantitative approach among Chilean students of specific school age and found that students whose preference in solving mathematics problems is compatible with analytical thinking style are more superior in school. In addition to school level, the Mathematics Thinking Styles have been investigated among university level students too. For instance, Nadrah et al. (2019) studied Mathematics Thinking Styles of engineering students in one of universities in Malaysia focusing on their Algebraic knowledge, and showed that the actual behaviour of students when dealing with algebraic problems is more visual rather than analytical style. In another study, Moutsios-Rentzos et al. (2010) investigated both undergraduate and postgraduate students' thinking styles and showed that senior level students prefer flexibility in thinking.

As a matter of fact, a precise knowledge on Mathematics Thinking Styles of students will help instructors to design and implement relevant learning activities and proper approaches such as geometric, algebraic and numerical techniques that beneficial to students, and due to existence of daily interactions in the educational processes, therefore, the more of knowledge of learners' thinking styles, the more improvement in learning process. Indeed, a comprehensive knowledge on thinking styles develops instructors' ability to identify various techniques beyond their own preferences with respect to their students' preferences. Having considered the above-mentioned facts along with the important role of digital educational technologies in the 21$^{st}$ Century, this research aims to highlight the importance of Mathematical Thinking Styles focusing on different majors of studies along with the relationship with the willingness of using mathematics education software.

## 2. Objectives

The main purpose of this research was to identify students' mathematics thinking styles and preferences and to find potential relationship between thinking styles and use of mathematics education software.

## 3. Methodology

The study's participants were undergraduate students from two different departments, namely, Mathematics and Computer Science Department and Business Department at the Modern College of Business and Science in Muscat, Sultanate of Oman.

The study sample consists of 101 (69 female, 32 male) students enrolled in 2022-2023 academic year.

| | |
|---|---|
| Gender | Female - Male |
| C.GPA | (Free numerical answer in scale of 4) |
| Major of Study | Business Department<br>Mathematics and Computer Science Department |

**Table 1: General question**

The data was collected through the convenient sampling method, from students registered in Calculus, Linear algebra, and Discrete Mathematics courses. It is worth pointing out that students from Business Department have two mathematics courses, namely, Basic Calculus and Basic Statistics and Probability, and these two courses are provided as Freshman level courses, but various mathematics courses are provided at different levels of seniority in Mathematics Computer Science Department. The Mathematics Thinking Styles Scale (MTS), the usage of Mathematics Education Software and a personal information form created by the researchers were used for the data collection process of the study. The original form of the Mathematics Thinking Styles was constructed by Borromeo Ferri (2003, 2004, 2015). It is worth recalling that the term "Style" is not translated as an ability, but rather, it is defined as a preferred way of using the abilities one has. This means that thinking styles can be changed during the time and based on other environmental factors. Borromeo Ferri (2015). The original form of the thinking style contains 3 main items and 6 subdimensions. Scores to be obtained from each item of the scale range from one to four. Higher points refer to higher levels of presence for the relevant thinking style. The thinking style with the highest score is described as the most frequent thinking style adopted by an individual.

The MTS was updated as to have 3 items with 12 subdimensions by researchers. Moreover, one item regarding willingness to use Mathematics Education software was added to the form. The scales were scored from 1 to 4 where 1 means "Not at all like me", 2 means "Not like me", 3 means "Fairly like me", 4 means "Very like me".

There were 36 students (35.6%) out of the total number of students were from the Business Department and 65 students (64.4%) were from Mathematics and Computer Science Department. A total of 39.2% of the students were Freshman, 28.4 % were Sophomore, 19.6% of students were Junior level and 12.7% were Senior level students.

| | |
|---|---|
| Freshman | 39.2% |
| Sophomore | 28.4% |
| Junior | 19.6% |
| Senior | 12.7% |

**Table 2: Seniority Level of students**

The collected data were statistically analyzed through SPSS. Results of the analyses conducted on the original forms of the scales were explained under the respective titles.

## 4. Results

According to results in table 1, there are statistically significant differences (at 1% level of significance) in the measures of group work and willingness to use of educational software between students in the Business department and Mathematics and Computer Science department. In both the two measures, students from the Business department have relatively higher levels compared to students from Mathematics and Computer Science department. As for the remaining measures including those of analytic, visual, and procedural, no statistically significant differences have been indicated between students belonging to the two departments as far as these measures are concerned.

## 5. Conclusion

As the first objective, the authors identified students' Mathematics Thinking Styles (MTS) and their preferences when dealing with mathematics concepts and problems. Also, the researchers investigated students' willingness to use mathematics education software and examined the relationship between MTS and the use of educational software. The results revealed that the thinking style of students of Business Department is the Visual Thinking Style, and they prefer to use mathematics education software in their mathematics courses, whereas in Mathematics and Computer Science Department students prefer the integrated MTS, and therefore they have flexibility in terms of learning mathematical concepts. It can be concluded that instructions based on graphical and geometric approaches could mostly benefit students with Business-based majors, according to their Visual Thinking Styles. In this respect, the rapid growth of educational software in the field of mathematics education benefits instructors to consider that as an essential part of mathematics education. In particular, Latifi et al., (2021) showed the efficiency of GeoGebra software in teaching Differential Equation for students with Integrated Thinking Style. For non-mathematics majors, Marchisio et al., (2022) conducted a mathematics education project focusing on students participated the first year of a biotechnology program and identified the role of software in problem-solving approaches. In addition to the above-mentioned results, the authors found evidence that students from the Business Department prefer to solve mathematics problems in groups. Future studies could investigate the Mathematics Thinking Styles in relation with Rational and Experiential Thinking Styles, as investigated by Coşkun (2018). As for limitations of this study the research questionnaire employed may have limited the resulting outcomes and as such it is suggested that future studies in this line consider using other scales.

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