MEASURING ATTITUDES ABOUT MATHEMATICS: USING A SEMANTIC DIFFERENTIAL

MEDINDO ATITUDES EM RELAÇÃO À MATEMÁTICA: USANDO UM DIFERENCIAL SEMÂNTICO

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ABSTRACT

At all educational levels, students' attitudes towards mathematics are important, including elementary and junior and senior high school preservice teachers'. In this study, a semantic differential (rating scale) was administered to four different groups of students in order to ascertain their attitudes toward mathematics. The four groups included preservice elementary and high school teachers; and liberal education college and high school students. Semantic differential enabled the researchers to distinguish diversity in groups' attitudes. Findings in this study show that the high school students assessed exhibit the most negative attitudes towards mathematics, whereas preservice elementary teachers reported more positive attitudes towards mathematics than previous research in this area has indicated.

Keywords: attitudes; mathematics; preservice elementary teachers; preservice high school mathematics teachers; high school students.

RESUMO

Em todos os níveis de ensino, as atitudes dos estudantes em relação à matemática são importantes, incluindo os professores de educação fundamental e de ensino médio. Neste estudo, um diferencial semântico (escala de avaliação) foi aplicado a quatro diferentes grupos de estudantes, a fim de verificar suas atitudes em relação à matemática. Os quatro grupos incluíam professores de ensino fundamental e médio e alunos de licenciatura e do ensino médio. O diferencial semântico permitiu que os pesquisadores pudessem distinguir a diversidade nas atitudes dos grupos. Descobertas neste estudo mostram que os estudantes do ensino médio avaliados apresentam as atitudes mais negativas em relação à matemática, enquanto os estudantes de licenciatura para o ensino fundamental relataram atitudes mais positivas em relação à matemática do que as pesquisas anteriores nesta área indicaram.

Palavras-chave: atitudes; matemática; professores em formação para o ensino fundamental; professores de matemática em formação para o ensino médio; alunos do ensino médio.

1. Introduction

A student's attitude towards mathematics refers to how much they like or dislike it, how much they engage or try not to engage in mathematics, how important or unimportant they think it is, and how they consider their own mathematical ability. According to Hourigan, Leavy, and Carroll (2016), "attitude can be defined as a predisposition that is learned in order to respond in a consistent way, either in a favourable or unfavourable manner, towards a specific object" (Hourigan, et al., 2016, p. 320). This definition includes the important three components to attitude: it is learned, it causes one to respond in a certain manner, and it is consistent (Leder, 1987). In addition, attitudes can be represented as degrees of positivity, such as "positive," "moderately positive," "neutral," or "negative" (Mata, Vonteiro, & Peixoto, 2012).

In mathematics education, students' attitudes towards mathematics play a crucial role (Mcleod, 1989; Tapia & Marsh, 2004; Philipp, 2007). A strong relationship exists between students' academic success in mathematics and attitudes towards the subject (Aschcraft & Kirk, 2001; Cooper & Robinson, 1991; Jackson, 2015; McCleod, 1992; Leder, Pehkonen, & Torner, 2002; Muis & Foy, 2010; Schenkel, 2009; Sherman & Christian, 1999, Tapia & Marsh, 2004; Van der Sandt, 2007; Yasar, 2016). The relationship goes both ways, attitudes leading directly to achievement (Ma & Kishor, 1997; Yasar, 2016) and achievement leading to attitudes (Ma & Xu, 2004). This relationship and the fact that attitudes are *learned* elevate the importance of attitudes to that of the mathematics content itself (Code, Merchant, Maciejewski, Thomas, & Lo, 2015). For, "one is likely to achieve better in a subject that one enjoys, has confidence in or finds useful" (Mata, Monteiro, & Peixoto, 2012, p. 2).

Apprehending students' attitudes is relevant to try to help them improve in that sense (Chamberlin, 2010; Hammouri, 2004; Ren, Green, & Smith, 2016). Ma and Xu (2004) state: "An initial effort to improve attitude (in late junior or early senior high school grades) can have a far-reaching impact into the circle of attitude and achievement" (Ma & Xu, 2004, p. 277). Some students even perform below their actual ability, because of their attitude (Lipnevich, MacCann, Krumm, Burus, & Roberts, 2011).

Research has shown that girls view mathematics more negatively than boys (Frost, Hyde, & Fennema, 1994; Leder, 1995), and fewer girls have pursued mathematics-related subjects. However, Yasar (2016) found that high school students were neutral towards the topic, and found no gender differences in attitudes. Furthermore, students' negative attitudes towards mathematics increase when they leave elementary school (McLeod, 1994), although some studies continue to find positive attitudes among high school students (Mata, Monteiro, & Peixoto, 2012).

Attitudes contribute to the motivation to pursue mathematics as a major or to take mathematics classes (Guzey, Harwell, & Moore, 2014; Maltese & Tai, 2011). Elementary teachers often have a low opinion of mathematics and teaching mathematics, and are anxious about the subject (Bursal & Paznoka, 2006, Haycock, 2001; Jackson, 2015; Wilkins, 2010). In fact, Wilkins (2010) found that elementary teachers rated mathematics as their least favorite subject to teach, and that they wanted to spend less time teaching mathematics than teaching other topics.

However, although a negative attitude towards mathematics can continue into adulthood (Houssart, 2009), it can be changed, sometimes rapidly (Hannula, 2002). It is important to have an instrument that is easy to manage and score, for classroom teachers and higher education professors to use to measure attitudes toward mathematics (Authors, 2016). In previous work, we piloted a semantic differential to that end (Authors, 2016). In the current study, we use the semantic differential to compare the attitudes of a variety of students towards mathematics. We agree with the idea that simply labeling a group of students as negative and another as positive is not very informative (Di Martino & Zan, 2003), and so we have both a 7-point scale (very negative, negative, moderately negative, neutral, moderately positive, positive, and very positive) to rate, and also the confidence intervals will allow us to look for particular differences amongst groups (e.g., is a group negative about doing mathematics but positive about its usefulness).

2. Research Questions

1) On a scale from very negative to very positive, what is the rating of preservice elementary teachers, preservice high school mathematics teachers, liberal arts majors, and high school students in regards to mathematics?
2) Can we discern any differences in the attitudes of preservice elementary teachers, preservice high school mathematics teachers, liberal arts majors, and high school students?

3. Method

3.1 Sample

The sample consisted of four groups of students. Three of the groups were students at a mid-sized university in the Midwest who were enrolled in the Spring 2017 semester in courses taught by one of the authors. One author teaches mathematics courses (to both preservice elementary and preservice high school mathematics teachers) and the other author teaches sociology courses (the liberal arts majors). The fourth group consisted of high school students in the same city, which includes extensive medical facilities and three institutions of higher education (a private college, a community college, and the university involved).

The preservice elementary teachers (n = 48) were enrolled in a mathematics content course entitled Mathematics for Elementary Education Majors II, the second in a two-part series that only elementary education majors take. The content of this particular course was geometry, probability, and statistics. All of these students were on track to become elementary school teachers.

The preservice high school mathematics teachers (n = 10) were enrolled in a mathematics content course entitled Foundations of Mathematics and Geometry, a course required for teaching majors. The content of this particular course was an introduction to proofs in mathematics and geometry. All of these majors were on track to become high school mathematics teachers.

The liberal arts majors (n = 40) were students enrolled in two different sociology courses. The vast majority of these students were in majors that were not mathematics intensive.

The high school students (n = 20) lived in the same city as the college students, but were enrolled in a local private high school. They were students in either geometry or Algebra II. Due to the nature of the private school, the students come from families where education is highly valued, and nearly 100% of the students will eventually go to college.

3.2. Instrument

A semantic differential is a rating scale made up of polar adjectives to represent the connotative meaning of a concept. The rating scale was developed by Charles E. Osgood in the 1950s, and used extensively during the 1960s (Osgood, Suci, & Tannenbaum, 1957). It is still used today in disciplines such as psychology and sociology (Ploder & Eder, 2015), and is "especially suitable for measuring emotional and behavioural aspects of the attitude" (Chráska & Chrásková, 2016, p. 821). Semantic differentials can measure attitudes about mathematics as effectively and much more efficiently as short answer questions or Likert-type instruments (Authors, 2016; McCallon & Brown, 1971; Scharf, 1971; Shannon, 1979).

The instrument was a semantic differential created and pilot tested previously by the authors (Authors, 2016). The authors developed the scale through an iterative process, beginning with a list of adjectives about mathematics provided by college students, to administering the scale to a variety of students and asking for written comments, and then continuing to revise the scale and repeat this process. (The final scale is presented in the annex.)

4. Analysis of Instrument

To score the semantic differential, each blank was counted as one through seven, with one at the negative end. An average was found for each individual, and recorded on the following scale,

0 – 1.99 very negative
2 – 2.99 negative

3 – 3.99 moderately negative
4 – 4.99 neutral
5 – 5.99 moderately positive
6 – 6.99 positive
7 very positive.

To compare the results amongst groups, 95% confidence intervals around the mean for each item for each group were created. Confidence intervals that do not overlap constitute significant differences.

5. Results

The preservice elementary teachers had an average rating of 4.57, a neutral rating. Only one of the students averaged to a negative rating, 14 averaged in the moderately negative category, 14 averaged in the neutral category, while 16 students were in the slightly positive category, and the final 3 students were in the positive category.

The preservice secondary mathematics teachers had an average of 5.29, in the moderately positive category. Three students had averages in the neutral category and one student had an average in the positive category.

The liberal arts majors had an average of 4.11, in the neutral category. Five students had averages in the negative category, 15 students in the moderately negative category, 10 students in the neutral category and the final 10 students had an average in the moderately positive category.

The high school students had an average of 3.80, in the negative category. One student averaged in the very negative category, 5 students in the negative, 5 students in the moderately negative, another 5 in the neutral category, and the final 4 were in the moderately positive category.

The 95% confidence intervals for these mean scores are given in Figure 1. We can see that the mean rating for the preservice high school mathematics teachers is significantly higher than the other three means. The other confidence intervals overlap, although the preservice elementary teachers' and the high school students' confidence intervals overlap only slightly.

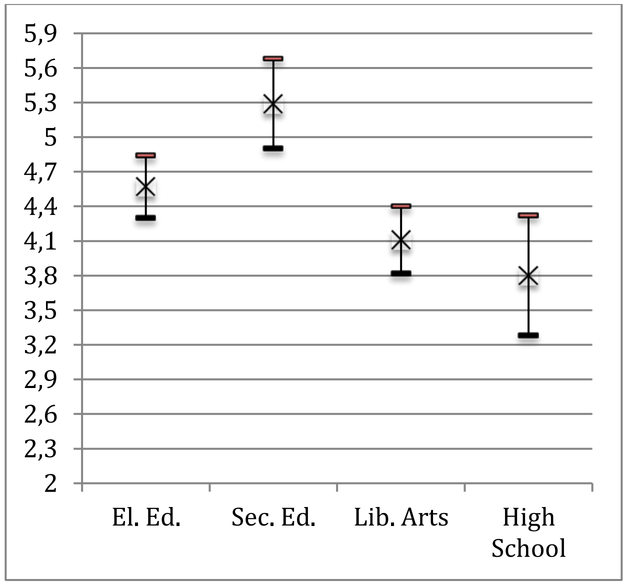

Figure 1: Confidence intervals for the overall mean

In order to look at individual responses, we provide first an overview of the averages per item for each of our groups. Figure 2 presents a visual of the preservice elementary teachers' average scores per item. We can instantly see the higher scores on the important and essential nature to mathematics.

Challenging	__: __: __: X: __ : __ : __	Cinch
Boring	__: __: __: __: X : __ : __	Interesting
Confusing	__: __: __:X: __ : __ : __	Clear
Unimportant	__: __: __: __: __ : X : __	Important
Time consuming	__: __: X: __: __ : __ : __	Quick
Dreadful	__: __: __: X: __ : __ : __	Fun
Unrewarding	__: __: __: __: X : __ : __	Rewarding
Complicated	__: __: X: __: __ : __ : __	Uncomplicated
Difficult	__: __: __: X: __ : __ : __	Easy
Complex	__: __: X: __: __ : __ : __	Simple
Unstimulating	__: __: __: X: __ : __ : __	Exciting
Frustrating	__: __: __: X: __ : __ : __	Encouraging
Not necessary	__: __: __: __: __ : X: __	Essential
Stressful	__: __: __: X: __ : __ : __	Pleasant

Figure 2: Preservice elementary teachers' average scores

Figure 3 gives a visual of the preservice high school mathematics teachers' average scores per item. We can quickly see a more dispersed response than the preservice elementary teachers, and more high ratings overall.

Challenging	__: __: X: __: __ : __ : __	Cinch
Boring	__: __: __: __: __ : X : __	Interesting

Confusing	__: __: __: __: X : __ : __	Clear
Unimportant	__: __: __: __: __ : X : __	Important
Time consuming	__: __: X: __: __ : __ : __	Quick
Dreadful	__: __: __: __: X : __ : __	Fun
Unrewarding	__: __: __: __: __ : X : __	Rewarding
Complicated	__: __: X: __: __ : __ : __	Uncomplicated
Difficult	__: __: __: X: __ : __ : __	Easy
Complex	__: __: X: __: __ : __ : __	Simple
Unstimulating	__: __: __: __: __ : X : __	Exciting
Frustrating	__: __: __: __: X: __ : __	Encouraging
Not necessary	__: __: __: __: __ : X : __	Essential
Stressful	__: __: __: __: X: __ : __	Pleasant

Figure 3: Preservice secondary mathematics teachers' average scores

Figure 4 gives a visual of the liberal arts majors' average scores per item. Once again, the high scores on importance and essential are easily visible, but overall this shows lower scores.

Challenging	__: __: X: __: __ : __ : __	Cinch
Boring	__: __: __: X: __ : __ : __	Interesting
Confusing	__: __: __: X __ : __ : __	Clear
Unimportant	__: __: __: __: __ : X : __	Important
Time consuming	__: __: X: __: __ : __ : __	Quick
Dreadful	__: __: __: X: __ : __ : __	Fun
Unrewarding	__: __: __: __: X : __ : __	Rewarding
Complicated	__: __: X: __: __ : __ : __	Uncomplicated
Difficult	__: __: X: __: __ : __ : __	Easy
Complex	__: __: X: __: __ : __ : __	Simple
Unstimulating	__: __: __: X: __ : __ : __	Exciting
Frustrating	__: __: X: __: __ : __ : __	Encouraging
Not necessary	__: __: __: __: __ : X : __	Essential
Stressful	__: __: X: __: __ : __ : __	Pleasant

Figure 4: Liberal arts majors' average scores

Finally, Figure 5 gives a visual of the high school students' average scores per item. These results do not show the high scores on importance or essentiality that the others did.

Unmotivating	__: __:X: __: __ : __ : __	Motivating
Difficult to explain	__: __: __: X: __ : __ : __	Easy to explain
Boring	__: __: X: __: __ : __ : __	Interesting
Confusing	__: __: __: X: __ : __ : __	Clear
Unimportant	__: __: __: __: X: __ : __	Important
Time drags	__: __: X: __: __ : __ : __	Time flies
Dreadful	__: __: __: X: __ : __ : __	Fun

Unrewarding	__: __: __: X: __ : __ : __	Rewarding
No pattern or logic	__: __: __: __: X : __ : __	Pattern or logic clear
Difficult	__: __: X: __: __ : __ : __	Easy
Unstimulating	__: __: __: X: __ : __ : __	Exciting
Frustrating	__: __: X: __: __: __ : __	Encouraging
Not necessary	__: __: __: X: __ : __ : __	Essential
Stressful	__: __: X: __: __: __ : __	Pleasant

Figure 5: High school students' average scores

However, making too many comparisons in this format may not be clear. Therefore, next we examine the confidence intervals item by item. For the adjectives "unmotivating" versus "motivating", the confidence intervals of both liberal arts majors and high school majors overlap. The remaining confidence intervals do not overlap. The preservice high school mathematics teachers' average was highest (mean = 5.6), the preservice elementary teachers' average next (mean = 4.08), the liberal arts majors' average was much lower (mean = 3.725), and the high school students' average was the lowest (mean = 3.45). See Figure 6 for a graphical display of the confidence intervals.

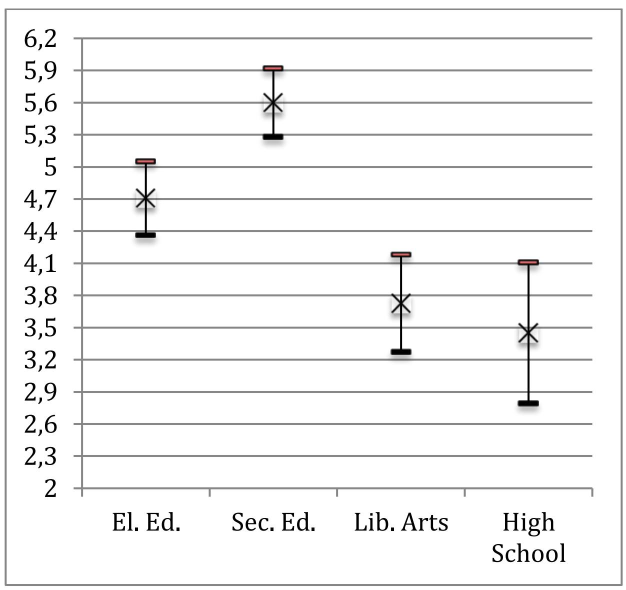

Figure 6: Unmotivating versus motivating

On the second item, "difficult to explain" versus "easy to explain", all four groups had confidence intervals that overlapped. The means were different, with preservice elementary teachers having the highest mean (mean = 4.313), high school students the second highest (mean = 3.8), preservice high school mathematics teachers were next (mean = 3.7) and the liberal arts majors having the lowest (mean = 3.475). It is worthwhile noticing that the preservice elementary teachers thought that mathematics was easier to explain, and one can think whether they are considering elementary mathematics only. See Figure 7 for a graphical display of the confidence intervals.

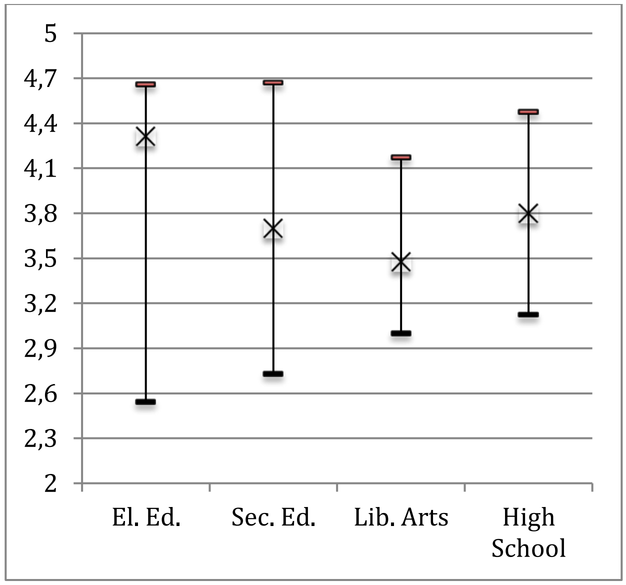

Figure 7: Difficult to explain versus easy to explain

For the item "boring" versus "interesting", the confidence intervals for the preservice high school mathematics teachers did not overlap with the others, but all the other confidence intervals overlapped. The mean of the preservice elementary teachers (mean = 4.333) is outside the confidence interval of the liberal art majors (mean = 3.6), as well as the high school students (mean = 3.5). The preservice high school mathematics teachers' mean (mean = 6) is much higher on this question. See Figure 8 for a graphical display of the confidence intervals.

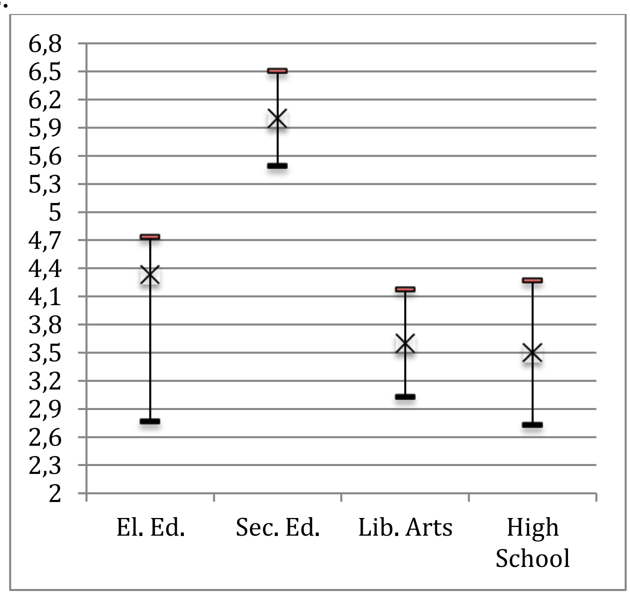

Figure 8: Boring versus interesting

For the category "confusing" versus "clear", the preservice high school mathematics teachers' (mean = 4.9) confidence interval does not overlap with the liberal arts majors' (mean = 3.55) confidence interval. All other confidence intervals overlap, with preservice elementary teachers (mean = 4.313) and the high school students (mean= 3.65) slightly higher than the liberal arts majors. See Figure 9 for a graphical display of the confidence intervals.

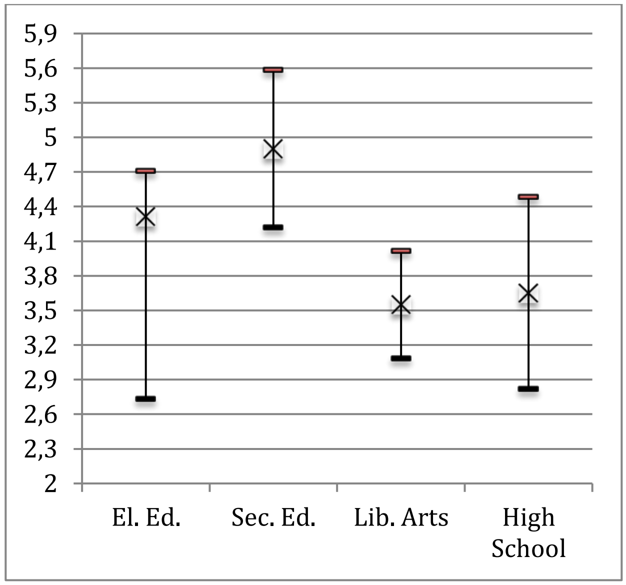

Figure 9: Confusing versus clear

For the category “unimportant” versus “important”, all means (preservice elementary teachers’ mean = 5.479, preservice secondary mathematics teachers’ mean = 6.2, liberal arts majors’ mean = 5.75, high school mean = 5.4) were pretty high, and all confidence intervals overlapped. The preservice elementary teachers had a rather larger range of scores on this item. See Figure 10 for a graphical display.

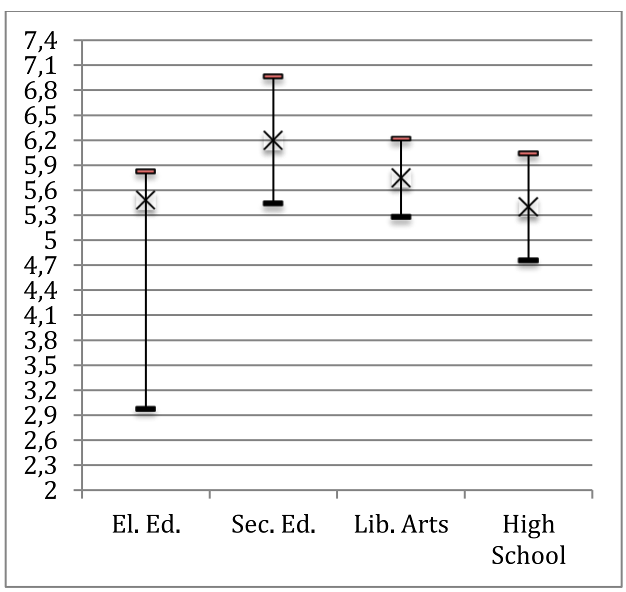

Figure 10: Unimportant versus important

For “time dragging” versus “time flying”, the confidence intervals for the preservice high school mathematics teachers (mean = 5.4) does not overlap with the confidence interval for the liberal arts majors (mean = 3.4) or the high school students (mean = 3.35). The confidence interval for the preservice elementary teachers (mean = 4.208) does overlap with all the others, but it is also a rather large interval, only overlapping at the bottom of the preservice high school mathematics teachers’ interval. See Figure 11.

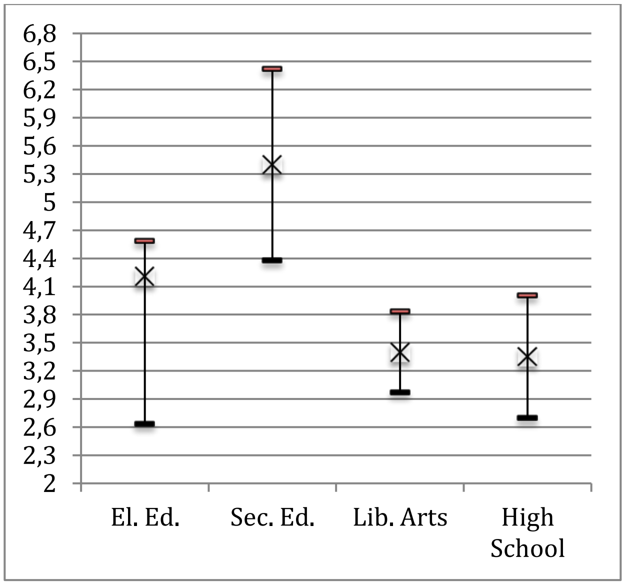

Figure 11: Time drags versus time flies

For the adjectives “dreadful” versus “fun”, we once again see the preservice high school mathematics teachers (mean = 5.3) not overlapping with the liberal arts majors (mean = 3.425) or the high school students (mean = 4.05). The preservice elementary teachers (mean = 4.458) just barely overlap with the preservice high school mathematics teachers. See Figure 12.

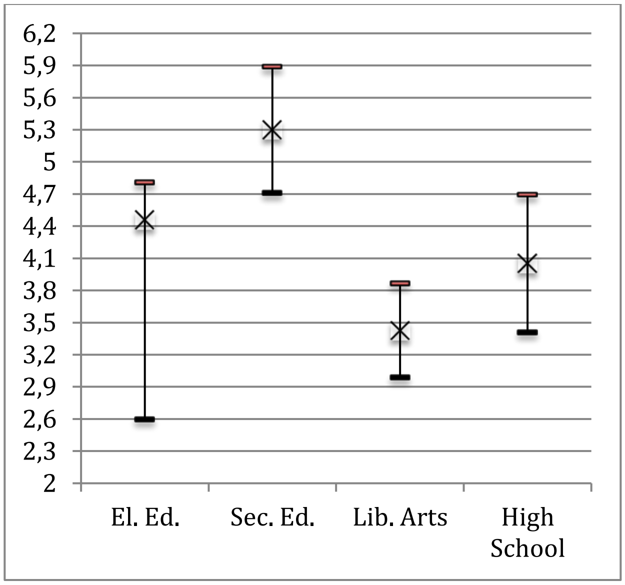

Figure 12: Dreadful versus fun

For "unrewarding" versus "rewarding", the preservice high school mathematics teachers (mean = 6.1) do not overlap with any other group. The preservice elementary teachers (mean = 5.083) do overlap with the liberal arts majors (mean = 5.275) and the high school students (mean =4.3). See Figure 13.

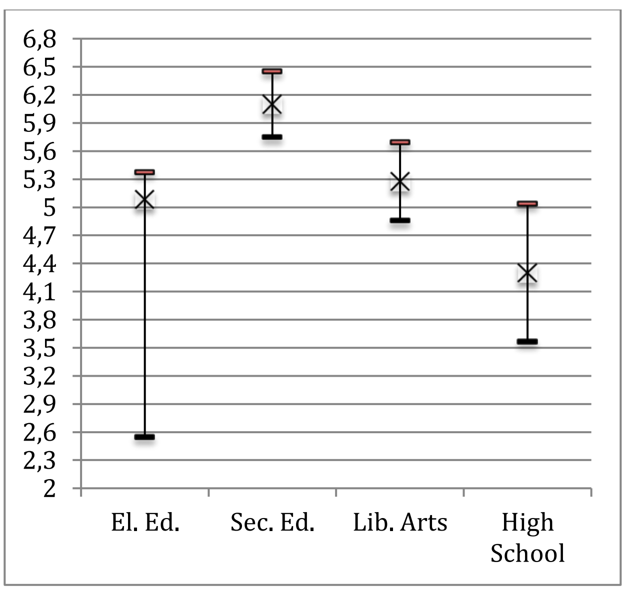

Figure 13: Unrewarding versus rewarding

For "no pattern or logic" versus "pattern or logic clear", we see much more overlap between the confidence intervals of the preservice high school mathematics teachers (mean = 6) and the liberal art majors (mean = 5.675) than we have in the past. The preservice elementary teachers have a very long confidence interval, with the mean (mean =5.438) near the top, and the high school students (mean = 4.6) overlap with the preservice elementary teachers. See Figure 14.

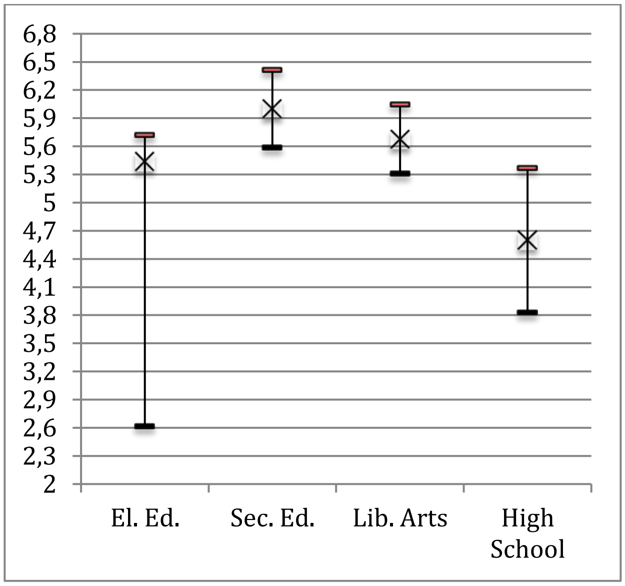

Figure 14: No pattern or logic versus pattern or logic clear

For "difficult" versus "easy", the preservice high school mathematics teachers (mean = 5) once again do not overlap with the liberal art majors (mean = 3.55) or the high school students (mean = 3.35) but have some overlap with the preservice elementary teachers (mean = 4.125). See Figure 15.

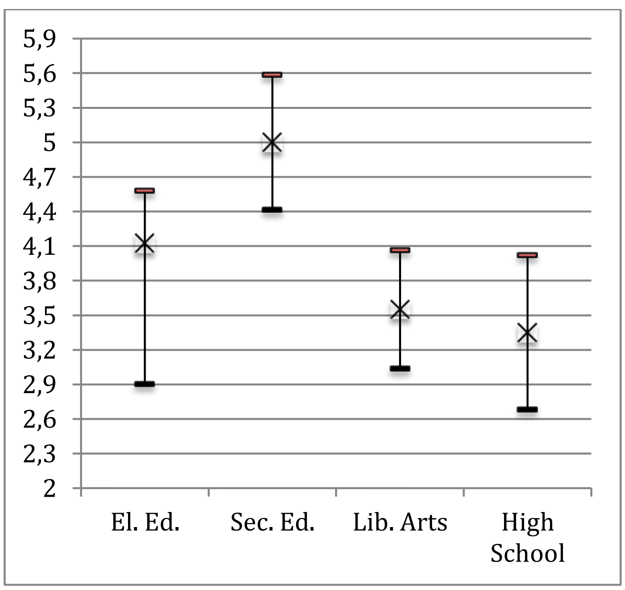

Figure 15: Difficult versus easy

For the adjectives "unstimulating" versus "exciting", we see the same pattern of the preservice high school mathematics teachers (mean = 5.5) not overlapping with the liberal arts majors (mean =3.725) and the high school students (mean = 3.5), but this time also not overlapping with the preservice elementary teachers (mean = 4.292). Thus, the preservice high school mathematics teachers find mathematics more exciting than the other groups. This seems reasonable, as this is the only group comprised of students who have chosen mathematics as a major. See Figure 16.

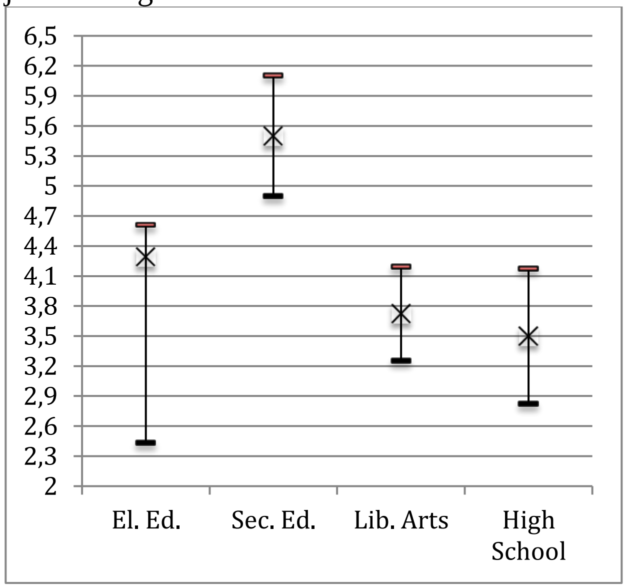

Figure 16: Unstimulating versus exciting

The four groups strongly agreed on the adjectives "frustrating" versus "encouraging". The preservice high school mathematics teachers (mean = 4.2) overlap with the preservice elementary teachers (mean = 3.938), the liberal arts majors (mean = 3.325), and the high school students (mean = 2.9). See Figure 17.

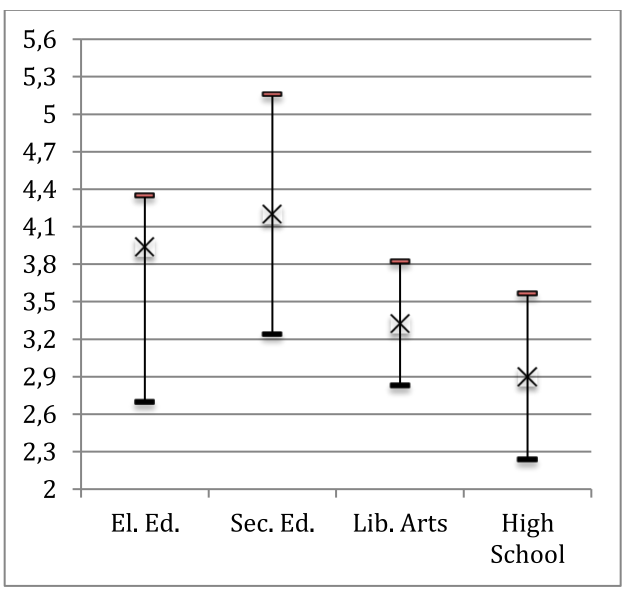

Figure 17: Frustrating versus encouraging

For “not necessary” versus “essential”, we see agreement between the preservice high school mathematics teachers (mean = 5.9) and the liberal arts majors (mean = 5.75). The preservice elementary teachers (mean = 5.292) overlap with the high school majors (mean = 4.25). See Figure 18.

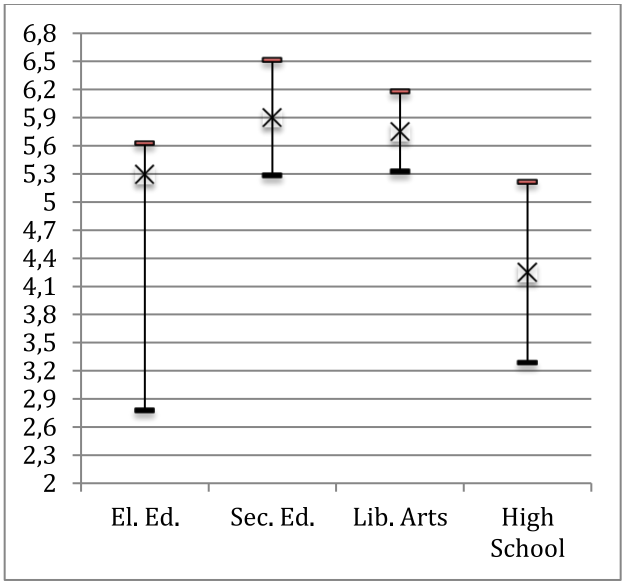

Figure 18: Not necessary versus essential

Finally, for “stressful” versus “pleasant”, there is overlap of all groups. The preservice high school mathematics teachers are the highest (mean = 4.2), but the preservice elementary teachers are close behind (mean = 4.2). The mean for the liberal arts majors (mean = 3.3) is lower, but the confidence intervals overlap, and the mean for the high school students is the lowest (mean 3.15), but again overlapping. See Figure 19.

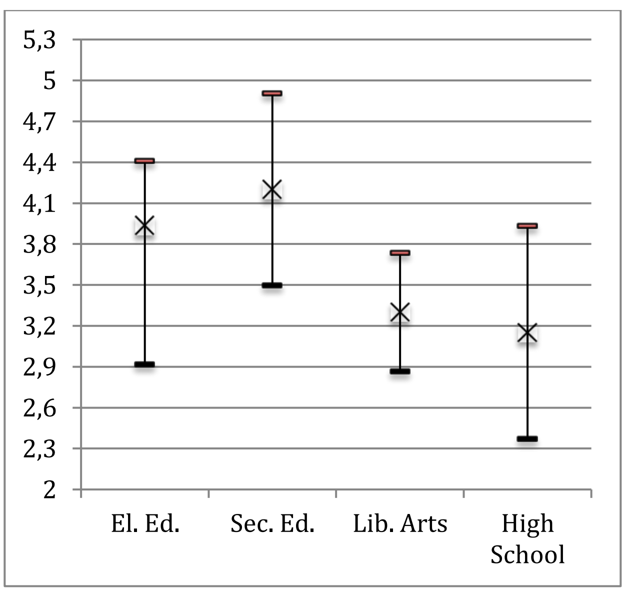

Figure 19: Stressful versus pleasant

6. Discussion

The high school students were the least positive, and then the liberal arts and preservice elementary teachers were neutral, and finally the preservice high school mathematics teachers were moderately positive. When we compare this study to past research, we find quite different results. Rather than a neutral high school attitude (Yasar, 2016) that becomes increasingly negative (Houssart, 2009; McLeod, 1994), we find the high school students to be the least positive group.

Preservice high school mathematics teachers' average was significantly higher than the other groups. In fact, the preservice high school mathematics teachers were the most different from the other groups of students. The preservice high school mathematics teachers had significantly higher means than all the other groups on three items:

- unmotivating versus motiving
- boring versus interesting
- unrewarding versus rewarding

In addition, on the following four items, the preservice high school mathematics teachers had significantly higher means than the liberal arts majors and the high school students, although not the preservice elementary teachers:

- time drags versus time flies
- dreadful versus fun
- difficult versus easy
- unstimulating versus exciting

The preservice high school mathematics teachers also had a significantly higher mean than the liberal arts majors on the "confusing" versus "clear" item. The preservice high school mathematics teachers had significantly higher means than the high school students on two additional items:

- no pattern or logic versus pattern or logic clear
- not necessary versus essential

The preservice elementary teachers had a significantly higher mean than both the liberal arts majors and the high school students on the item "unmotivating" versus "motivating". The liberal arts majors' mean was significantly higher than the high school students on the "not necessary" versus "essential" item. This result also differs from past research, as viewing mathematics as essential is not a negative attitude. However, such view is not leading these majors to a math career. Thus, our results differ on both the level of positivity, and on the very results (Jackson, 2015; Ma & Xu, 2004; Mata, Monteiro, & Peixota, 2012; Ren, Green, & Smith, 2016).

7. Limitations

The number of students in each of our categories differed, with some sample sizes being smaller than others. Of course, there is compensation for this in the formula for the confidence intervals. In addition, the subjects are all from the same geographic location. The instrument may also have limitations in measuring how students interpreted certain adjectives.

8. Concluding Comments

The semantic differential revealed that preservice high school mathematics teachers are more positive towards mathematics than the other students. Although that might be an obvious conclusion, it is more interesting to note that on many issues, including the importance of mathematics, there was no significant difference between the preservice high school mathematics teachers and the preservice elementary teachers. So, the preservice high school mathematics teachers found mathematics more motivating, interesting, and rewarding than preservice elementary teachers, but there were no significant differences on their feeling towards whether times flies when doing mathematics, or whether mathematics was fun, or easy, or exciting. Conversely, the preservice elementary teachers do not find mathematics more dreadful, difficult, unstimulating, or that time does not pass, than the preservice high school mathematics teachers do. Thus, we can highlight the conclusion that preservice elementary teachers were more neutral in their ratings than they were negative, and in some areas, such as the importance of mathematics, they held quite positive views. This differs from previous research that suggests that we need to convince elementary teachers of how important mathematics is (Mata, Monteiro, & Peixota, 2012).

Another important conclusion, but less encouraging, is that the high school students were significantly below the other groups at numerous items, including the necessity of mathematics. In fact, the liberal arts majors had a significantly higher rating for the necessity of mathematics than the high school students did. The statistically significant finding that preservice high school mathematics teachers are more motivated to pursue mathematics versus other majors is probably not that important. However, the way students view the essential nature of mathematics has considerable importance. Another important conclusion is that the high school students saw mathematics rather negatively. Besides, as they consider that mathematics is not so important, high school students found that mathematics does not follow any pattern or logic. This reveals an outstanding area of concentration (the high school level), which seems to differ from research that suggests it is at the elementary level that students begin to dislike mathematics (McLeod, 1994). Although Ma and Xu (2004) agree that it is the late junior or early senior high school level that needs attention, they also suggest that the poor attitude from that time continues into college, but our study suggests otherwise.

In a way, these two main conclusions are at odds with the mathematics education community. It has long been argued that if elementary teachers were more positive about mathematics, students would also have a more positive attitude, and would want to pursue mathematics. It appears that progress is being made on elementary teachers' attitudes towards mathematics, but there is not progress on high school students' attitudes in that sense. It may be possible that the desired relationship between more positive teachers to more positive students is yet to be fulfilled, and we will see this result in the future, when the more positive teachers have been in place for a longer period of time. However, it is also possible that more positive teachers cannot influence their students to such an extent. Other relationships, such as those between parents and students, might be the key.

9. Further Study

Most of the limitations of the study could be overcome by repeating it with possibly larger samples from different locations. If the results held in the replication study is confirmed, this would be very relevant for the field. The study could also be extended to different types of samples, such as particular majors, for example, music versus physics.

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Annex.

Rate “Math” by placing an X in one of the boxes for each dimension.

Unmotivating	__: __: __: __: __ : __ : __	Motivating
Difficult to explain	__: __: __: __: __ : __ : __	Easy to explain
Boring	__: __: __: __: __ : __ : __	Interesting
Confusing	__: __: __: __: __ : __ : __	Clear
Unimportant	__: __: __: __: __ : __ : __	Important
Time drags	__: __: __: __: __ : __ : __	Time flies
Dreadful	__: __: __: __: __ : __ : __	Fun
Unrewarding	__: __: __: __: __ : __ : __	Rewarding
No pattern or logic	__: __: __: __: __ : __ : __	Pattern or logic clear
Difficult	__: __: __: __: __ : __ : __	Easy
Unstimulating	__: __: __: __: __ : __ : __	Exciting
Frustrating	__: __: __: __: __: __ : __	Encouraging
Not necessary	__: __: __: __: __ : __ : __	Essential
Stressful	__: __: __: __: __: __ : __	Pleasant