Relationship between Subject-matter Interest and Academic Achievement: A Study of Grade 7 Students at a Bilingual School in Thailand

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Abstract

This study investigated the subject-matter interests of middle school students in four core subjects (Science, Maths, English and Thai languages), and attempted to determine the relationship between subject-matter interests and academic achievement, and if there were any gender differences in these relationships. Correlational analysis was used to determine the relationship between subject-matter interest and academic achievement, and analysis of variance was used to determine gender differences. The subjects were 26 seventh-grade students (16 boys, 10 girls) of a bilingual school in Thailand. The levels of subject-matter interest in the four subjects were assessed using an interest questionnaire, covering only a limited number of components of interest: individual / situational interest, value and expectancy components. Academic achievement was assessed using standard national exams' scores in the four subjects of study. Results showed similar levels of interest and similar scores in the four subjects. Correlations between interest and academic achievement were found for Maths and Thai language, but not for Science and English language. Girls showed higher levels of interest and scores than boys in all four subjects. This study suggests that interest may not be a totally reliable predictor of academic success for all subjects, and that a more subject and age specific approach should be considered. The findings of the gender analysis are in contrast with those from established literature from Western countries, but similar to those from other developing countries. However, because of the small sample size and the special type of school, these findings should not be considered representative of the Grade 7 student population of Thailand. As such, this study should be considered more as a pilot study. It is recommended that further research needs to be done to see if these present findings would hold for Grade 7 students from different schools in different areas and / or socio-economic settings in Thailand, and for senior secondary students.

Keywords: Subject-Matter Interest, Academic Achievement, Gender Differences, Correlation

1. Introduction

It is often said that education is the future of a nation. Governments around the world often put education among their top priorities, and will dedicate important sums of their national budgets to it. Educational policies are regularly changed in order to improve the national level of education, and thus enable a country to develop a competitive economy at international level. Parents too put high expectations in the education of their children, and dedicate important amounts of money to provide their children with the best possible education, and thus give them the best chances to pursue the desired university study and succeed professionally in their future lives. In Thailand, most universities have admission exams in what are called the core subjects, namely Science, Maths, Thai language and English language. It is then particularly crucial to have a good education in these four core subjects, in order to be able to access the desired university study.

Many research has been dedicated to find the way to improve academic achievement. It is not obvious to determine and isolate one only factor for academic success, and this because of the complexity of many factors interacting simultaneously together in different contexts, and over a long period of time. However, among the various factors that can promote academic achievement, interest has been often considered as one of the most important (Harackiewicz and Hulleman, 2010). Many recent studies in Western countries have shown a decrease in interest and academic scores for most subjects along the school years (Desy et al., 2011; Frenzel et al., 2010; Gottfried et al., 2001). This negative trend seems to find confirmation in Thailand as well. A progressive worsening of the ONET exams' scores (Thai national standard exams) from primary to high school is reported at the researcher's school, and ONET exams' scores at national level have worsened over the past years as well (Education First, 2014).

The decline in interest is particularly problematic as it occurs when students are completing their education and are called to choose a future study or career. In many countries worldwide, secondary students

are asked to choose an educational track by grade ten. However, secondary students at that age may often not have a clear idea yet of their future study or career, and thus may have problems to take the best decision. It then becomes very important for schools to be able to offer some guidance to students as well as to parents.

Research has shown how interest has positive effects not only on various components of the learning activity, but also on the emotional and social spheres of the growing student (Harackiewicz et al., 2005). Research has shown that happiness and life satisfaction are important components of the well-being of a person (Lucas, 2007), and that pursuing activities and subjects that we find interesting play a major role in determining how fulfilled we feel with our lives, while the absence of such fulfillment leaves a person with a sense of unease and discontent (Sheldon and Elliott, 1999). The importance of interest for education appears then obvious, not only as a mean to improve academic achievement; but, almost more importantly and far reaching, as a vital mean to reach a more holistic development of the student.

The aims of the study were to assess the levels of interest in the four core subjects, to determine if there was a relation between subject-matter interest and academic achievement in those four core subjects, and if there are gender differences in these relationships. The results of the study could help schools and educators make decisions about school policies (curricula) and teachers' training, in order to increase students' interest in school subjects, and thus improve the academic achievement, especially in the critically important core subjects.

2. Literature Review

Early research introduced the concepts of individual and situational interest (Schiefele, 1974). Further research identified two main components of interest: feeling-related and value-related valences (Schiefele, 1991). From these concepts, two models were developed: the four-phase model of Hidi and Renninger (2006) and the three-phase POI theory of Krapp (2007). The Person Object Interest (POI) theory of Krapp can be considered a precursor of the four-phase model of Hidi and Renninger. The POI theory consists of a three-phase two steps model: where the first two phases represent the emergence of situational interest, and the last phase represents the consolidation of an individual interest. Interest is considered as a content-specific motivational variable, which undergoes permanent developmental changes. The object and the person interact with each other on a same level of importance, and such interaction is influenced by the environment (situation) in which the interaction occurs. Interest develops along the growing "self", and under a dual regulation system (cognitive-experiential self-theory). The four-phase model of interest development of Hidi and Renninger (2006) consists of four phases: each phase of interest is characterized by varying contributions of affect, knowledge, and value, and its length and character are influenced by individual experience, temperament, and genetic predisposition. The four phases represent a sequential, cumulative, and progressive development of interest. The four phases are divided into situational interest (beginning), and individual interest (later).

Interest has been soon identified as a process that can contribute to the learning and academic achievement of the students (Harackiewicz and Hulleman, 2010; Hidi, 1990). More recent research has shown that interest has also some important "side-effects". It promotes attention, recall, task persistence and effort (Hidi and Renninger, 2006; Hidi, 1990). It also plays a major role in determining how fulfilled one feels in ones lives (Sheldon and Elliott, 1999). So, interest can play a major role in the holistic growth of the student, far beyond the simple academic score. Different researchers have used different approaches and motivational frameworks to investigate the influence of interest on academic achievement. Some have used achievement goals and expectancy-value (Harackiewicz and Hulleman, 2010). Others identified student characteristics, home environment, and school context as the three main factors influencing achievement, suggesting to use cognitive factors, motivational factors, and specific preferences for subject areas as predictors of academic success (Schiefele et al., 1992). Some research, while maintaining the importance of cognitive abilities and home backgrounds as predictors of achievement, has shown the importance of attitudinal and affective variables, and of the academic engagement on academic achievement (Singh et al., 1998). Other research has emphasized the importance of the classroom environment (Heinze et al., 2005). Despite a general support for the influence of interest on academic achievement, some research has found little or no evidence for such influence (Goulart and Bedi, 2011; Koeller et al., 2001) even suggesting that interest and motivation are a consequence of success rather than vice-versa (Goulart and Bedi, 2011).

The preponderance of male over female students in STEM faculties (science, technology, engineering, and mathematics) has always been quite striking. The development of negative attitudes toward science and the quality of science instruction in the early ages has been used to explain this situation (Osborne et al., 2003). Desy et al. (2011) have shown that girls tend to have a more negative attitude toward science than boys, the gender gap becoming more evident at high school levels (Grade 9-12). Boys and girls both show a decline of interest in science from middle school to high school; but girls show less interest in science, despite often getting better scores than boys. In terms of college major choices, while males remain oriented toward Science and Math, females' interest switches toward medical and educational fields. In contrast, other research has suggested that gender differences appear already by the end of elementary level (Jones et al., 2000; Catsambis, 1995; Kotte, 1992). Some research has explained gender differences with the onset of puberty, when girls feel much more the stereotypic perceptions of their peers about areas of study (Kessel, 2005; Jones et al., 2000). Other research has suggested females to feel more the lack of relevance of science curricula to their lives and interests than males (Baram-Tsabari and Kaadni, 2009). Other research has stressed the influence of culture and traditional views of what is considered more appropriate for a boy or a girl (OECD, 2006). Finally, it must be noted, that some research in the United Kingdom has shown that the gender gap in interest for science subjects had already decreased, as confirmed by the growing number of female students enrolling in science faculties (Osborne et al., 2003).

3. Objectives

The objectives of this research were to see if there is a relationship between subject-matter interest and academic achievement in the four subjects of the study, and whether there were gender differences in these relationships.

4. Research Questions

The findings of this study were expected to answer two research questions as follows:

4.1 Are there any correlations between subject-matter interests and academic achievement in the four subjects of the study?

4.2 Are there any gender differences in these relationships?

5. Methods and Instruments

The research used a quantitative scientific methodology. The study had two objectives: first to determine the relationship, if any, between subject-matter interests and academic achievement, and second to determine whether there were any gender differences in these relationships. The first objective was investigated using a bivariate correlational analysis between subject-matter interest and academic achievement. The second objective was investigated using a bivariate analysis of variances between gender and subject-matter interest and between gender and academic achievement. Four "core" subjects were analyzed: Thai language, English language, Mathematics, and Science.

5.1 Research population

The present study took place in a private bilingual school in the northern outskirts of Bangkok. The participants of the study were 26 seventh-grade students from two mixed classes, and were composed of 16 boys, and 10 girls. The Grade 7 level was chosen, as these students had just taken the ONET test a few months earlier in the previous year (Grade 6). Only the students with at least 2 years of enrollment at this school were considered, to ensure that they had had enough exposure to a bilingual environment.

5.2 Research instruments

The research was carried out using two instruments. A questionnaire on school subject interests was used to assess the levels of subject-matter interest. The ONET exam scores of last academic year (February, 2015) were used to assess academic achievement.

The questionnaire contained five close-ended questions asking the students to indicate the levels of interest in the four subjects of the study. Science and Maths were on the front page (STEM subjects), English and Thai languages on the back page (under a Languages sub-section). A Likert-scale 1 to 5 was used (1 = very low, 2 = low, 3 = medium, 4 = high, and 5 = very high).

In designing the questionnaire, the priority was given to clarity and conciseness of the survey, with a wording deemed appropriate to the age and English fluency of the students. For each of the four subjects, five items (statements) were used, for a total of 20 items. It was obvious that it wouldn't be possible to cover all the different components of interest (intrinsic and extrinsic). The five items covered a limited number of the various components of interest. These components were: individual / situational interest, value, and expectancy components.

The five items were adapted from previous 6 surveys, whose authors are shown in brackets, and represent different components of interest. They are shown here below:

| 1) | I am interest in | individual interest (Fechner, 2009; Kier et al., 2013) |
|----|--|---|
| 2) | I like the topics of | individual interest (Fechner, 2009) |
| 3) | I like myclass. | individual interest (Fechner, 2009), situational interest |
| | | (Mitchell, 1993) |
| 4) | I think I can do well in | expectancy (Pintrich et al., 1991), self-efficacy (Kier et al., 2013) |
| 5) | The things we learn in are important to me. | value (Fechner, 2009; Pintrich et al., 1991; Schiefele et al., 1993) |

The questionnaire was in English language. The wording of the survey had been previously tested to ensure readability and understandability for that level.

The second instrument was the ONET exam scores of last academic year (February, 2015) in the four subjects of the study. The ONET exam is a Thai national standardized exam administered every year for Grades 6, 9 and 12 nationwide. This instrument is in Thai language, except for the English exam, which is in English. The ONET scores were retrieved from the school's database archive.

5.3 Reliability of instruments

The reliability of the questionnaire was verified by calculating the Cronbach's alpha coefficient of the interest questionnaire's items for each subject (five items each subject; Table 1). The ONET exam is a Thai national standardized exam, whose validity and reliability have been approved by the Thai Ministry of Education.

6. Results

In order to investigate the relationship between subject-matter interests and academic achievement in the four subjects of the study (Science, Math, English and Thai languages), a questionnaire on those subjects was administered. Then the interest-levels in those subjects were correlated to the ONET exam scores (February, 2015) in those same subjects. The interest questionnaire was also used to investigate the relationships between gender and subject-matter interest and between gender and academic achievement in the four subjects of the study.

6.1 Relationship between subject-matter interest and academic achievement

The study gave contrasting results on the relationship between subject-matter interest and academic achievement (Research question 4.1). The means of interests (Table 1) showed no apparent relationship with the means of the scores (Table 2), the four subjects having similar values for both of them, with the noticeable exception of the English score, much higher than the other subjects.

| Subject | Nr. of items | Means | Standard deviation | Cronbach's alpha |
|---------|--------------|-------|--------------------|------------------|
| Science | 5 | 3.55 | 0.77 | 0.841 |
| Maths | 5 | 3.3 | 0.91 | 0.855 |
| English | 5 | 3.65 | 0.87 | 0.810 |
| Thai | 5 | 3.68 | 0.70 | 0.804 |

 Table 1 Means, standard deviations, and reliabilities of Interests

For social studies, a minimum Cronbach's alpha coefficient of 0.7 is commonly used, as being considered an acceptable value (e.g. Nunnally and Bernstein, 1994). A value between 0.8 and 0.9 is considered to be good (George and Mallery, 2003).

Table 2 Mean of means and standard deviations for Score

| Subject | Means | Standard deviation |
|---------|-------|--------------------|
| Science | 60.27 | 12.62 |
| Maths | 58.65 | 21.84 |
| English | 90.10 | 5.02 |
| Thai | 55.62 | 11.51 |

Correlational analysis, on the other hand, showed positive correlations for Mathand Thai language, but negative correlations for Science and English language. Only the correlation between interest and academic achievement for Thai language was found to be statistically significant, with a moderate strength (r = 0.43-0.41; Table 3).

| Table 3 Correlational analysis results | | | | | |
|--|----|-------------|--------------|-------------|--------------|
| Subject | N | Pearson's | Significance | Spearman's | Significance |
| Subject | IN | coefficient | (2-tailed) | coefficient | (2-tailed) |
| Science | 26 | -0.820 | 0.690 | -0.004 | 0.984 |
| Maths | 26 | 0.189 | 0.356 | 0.098 | 0.635 |
| English | 25 | -0.235 | 0.259 | -0.267 | 0.197 |
| Thai | 26 | 0.428* | 0.029 | 0.406* | 0.039 |

*Correlation is significant at the 0.05 level (2-tailed)

6.2 Gender differences in subject-matter interests and academic achievement

The study showed no significant differences between genders for both interest and score (Research question 4.2). Descriptive statistics (means) showed higher levels of interest for girls than for boys, except for Math with the same level. Similarly, girls systematically scored better than boys in all four subjects. However, the gender analysis showed that none of the differences in interest levels and scores between boys and girls in the four subjects of the study were statistically significant (Significance p > 0.05), with the only exception of interest in Thai language, where the differences between boys and girls were found to be statistically significant (Significance p < 0.05; Table 4).

| Subject | t- test Significance | Welch t-test | Mann-Whitney test |
|---------|----------------------|--------------|-----------------------------|
| Subject | (2-tailed) | Significance | Asymptotic Sign. (2-tailed) |
| Science | 0.204 | 0.191 | 0.153 |
| Math | 1.000 | 1.000 | 0.832 |
| English | 0.124 | 0.098 | 0.132 |
| Thai | 0.025 | 0.026 | 0.041 |

 Table 4: Gender analysis tests for Interest

7. Discussion

7.1 Correlation between interest and academic achievement

Descriptive statistics (means) showed no obvious relationships between interest and score. The levels of interest were very close (3.3 - 3.7; Table 1), and so were the scores (60 - 56), except for English (90) (Table 2). Correlational analysis showed contrasting results, with negative correlations for Science and English language, and positive correlations for Math and Thai language, the latter being statistically significant (Table 3). This is in contrast with the findings of most of the literature (Harackiewicz and Hulleman, 2010; Hidi,

1990), which suggest that higher levels of interest in a subject lead to higher scores in that same subject. These contrasting results could be explained by the young age of the students and the poorly developed interest levels in school subjects at that age. At the same time, research has provided a quite large number of varied factors that could determine the motivation of a student to strive to do well in a subject, and therefore achieve good scores. Some of them are: the classroom environment, the role of the teacher, the role of the parents and their socioeconomics, the type of school, the cultural background, to name just a few.

Interest – score scatter plots show that Science and English language have students with low levels of interest and quite high scores, but also students with high levels of interest and low scores. This could indicate that low levels of interest do not necessarily lead to low scores, and conversely high levels of interests do not necessarily lead to high scores.

7.2 Correlation between gender and interest

The descriptive statistics have shown quite marked differences in interest levels between boys and girls; the girls having higher interest levels in all subjects with the exception of Maths having the same level. However, correlational analysis showed that the differences in interest levels between boys and girls were statistically significant only for Thai language (Table 4).

This is in contrast with the findings of most research (Desy et al., 2011; Frenzel et al., 2010; Miller et al., 2006; Sjoberg, 2000; Jones et al, 2000, Catsambis, 1995; Kotte, 1992), which found boys to have higher interest in Maths and Science than girls. It must be said however, that the very large majority of the research has been carried out in Western developed countries. More recent research in developing countries have shown quite opposite results, with girls having same or higher interests in science subjects (Baram-Tsabari and Kaadni, 2009; Sjoberg, 2000). This could be explained by cultural differences between developed and developing countries, as it is evident with the typical stereotype of the male "crazy scientist", so common in western cultures with long scientific traditions, and less common in developing countries with more recent scientific traditions.

The young age of the students could explain the less developed and "genderized" interests. Also the pre-puberty age of the students, may explain that girls don't feel yet the peer pressure of their girl classmates to accommodate to more suitable feminine "roles", as suggested in previous research (Kessel, 2005; Jones et al., 2000). It must be noted, that some research in the United Kingdom has shown that the gender gap in interest for science subjects had already decreased, as confirmed by the growing number of female students enrolling in science faculties of British universities (Osborne et al., 2003).

7.3 Correlation between gender and score

Descriptive statistics have shown little differences in the scores between boys and girls, except for Thai language. It can be noted, that girls scored better than boys in all four subjects. Inferential statistics (gender analysis) showed that none of the differences in scores between boys and girls were statistically significant.

This again is in contrast with the findings of most research (e.g. Sjoberg, 2000), which assume boys to have higher scores in Maths and Science than girls. Again, the young and pre-puberty age of the students could explain that they don't have developed yet any strong dislike for any particular subject.

8. Implications

The study showed students with low interest levels in a subject obtaining very high scores in that subject, as well as students with very high interest levels obtaining low scores in that very same subject. It is generally believed, based on research carried out mostly in Western countries, that high interest levels in a subject will automatically lead to high academic achievement in that subject. However, this study shows that this assumption doesn't always hold for the four core subjects of the study. For the Grade 7 students of this study, interest doesn't correlate directly with academic achievement.

It would appear that high achievers, irrespectively of their subject-matter interest levels, will achieve. Research has provided a quite large number of factors that can influence academic achievement. Some of them are: the classroom environment, the role of the teacher, the role of the parents and their socioeconomics, the type of school, the cultural background, to name just a few. This study may confirm the importance of factors such as motivational factors and home environment on academic achievement.

The study found negative correlations between interest and academic achievement for English language and Science. These results may prompt schools and educators to rethink the influence of subjectmatter interest on academic achievement, especially in the case of young learners where the interest for school subjects may still not be well defined, and may be susceptible of changing in the future. These observations should also be considered by the schools when counseling parents on students' future studies or careers.

The study may also somehow confirm the findings of some research that suggested that school interventions had very little effect on academic achievement altogether (e.g. Goulart and Bedi, 2011). Yet, some research has suggested the importance of interest on various aspects of the learning activity. Thus, it still remains important for teachers to help low achievers to increase their interest in each of their subjects, as it may increase their motivational levels and self-confidence, and improve learning habits, among other factors. However, interest alone may still not be a guarantee of academic achievement, and conversely the apparent absence of interest may not necessarily imply academic failure.

9. Limitations

This study involved a small sample size (26 students), and was carried out in a demonstration bilingual school in a suburban wealthy neighborhood, and therefore its findings can't be considered representative of the Grade 7 student population of Thailand.

The interest survey used only 5 items and some components of interest, and therefore it doesn't account for other important components of interest. Also, the correlational and gender analysis used only 2 variables at the time (interest-achievement and gender-interest/achievement), and thus don't account for the possible contributions of other variables in those relationships.

10. Conclusions

This study intended to determine if there was a correlation between subject-matter interest and academic achievement in four core subjects, and if there were any gender differences in these relationships. The research gave contrasting results.

Correlations between interest and academic achievement were found for Math and Thai language, the latter being statistically significant. Students with high interest levels in Math and Thai language had high achievement scores in those subjects. However, in the case of Science and English language, some students with high interest levels in those subjects had low achievement scores, and some students with low interest levels had high achievement scores. This is in contrast with the findings of most research, which suggest that higher levels of interest in a subject lead to higher scores in that same subject.

This study suggests that interest may not be the most reliable predictor of academic success for all subjects, and that the influence of interest on academic achievement should be considered on a more specific subject and age level. Some factors that may account for these findings are the young age of the students and the consequent poorly developed school subject interests, the personality and gender of the teacher, or the expectations of the family.

Gender analysis gave poor results. For score, none of the differences between boys and girls were found to be statistically significant, and for interest, only the difference in interest in Thai language was found to be statistically significant. In terms of interest levels and scores, girls showed higher values than boys in all subjects. This is in contrast with most research from Western countries, which suggest boys to have higher interest and scores in Science and Maths than girls, but is similar to results from some research from developing countries. The study also showed that gender differences in interest in Science and Maths are not significant at Grade 7 level. This confirms the findings of some research suggesting that gender gap in those subjects' starts developing later at middle – high school levels.

It is recommended that further research to be done to see if these present findings would hold for Grade 7 students from different schools in different areas and / or socio-economic settings in Thailand, and for senior secondary students.

11. References

Baram-Tsabari, A., and Kaadni, A. (2009). Gender dependency and cultural independency of science interest in an open and distant science learning environment. The International Review of Research in Openand Distributed Learning. 10 (2): 1-17.

- Catsambis, S. (1995). Gender, race, ethnicity, and science education in the middle grades. Journal of Research in Science Teaching. 32: 243-257.
- Desy, E.A., Peterson, S.A., and Brockman, V. (2011). Gender differences in science-related attitudes and interests among middle-school and high-school students. Science Educator. 20 (2): 23-30.
- Education First (2014). Education First's annual English Proficiency index 2014. Retrieved November 6, 20015, from http:// www.bangkokpost.com
- Fechner, S. (2009). Effects of context-oriented learning on students and academic achievement in Chemistry education. Band 95. Berlin: Logos Verlag.
- Frenzel, A. C., Goetz, T., Pekrun, R., and Watt, H. M. G. (2010). Development of mathematics interest in adolescence: Influences of gender, family, and school context. Journal of Research on Adolescence. 20 (2): 507-537.
- George, D., and Mallery, P. (2003). SPSS for Windows step by step: A simple guide and reference.11.0 update. 4th ed. Boston: Allyn & Bacon.
- Gottfried, A. E., Fleming, J. S., and Gottfried, A. W. (2001). Continuity of academic intrinsic motivation from childhood through late adolescence: A longitudinal study. Journal of Educational Psychology. 93: 3-13.
- Goulart, P., and Bedi, A. J. (2011). The impact of interest in school on educational success in Portugal. IZA. DP No 5462: 1-32.
- Harackiewicz, J. M., and Hulleman, C. S. (2010). The importance of interest: The role of achievement goals and task values in promoting the development of interest. Social and Personality Psychology Compass. 4 (1): 42-52.
- Harackiewicz, J. M., Durik, and A. M., Barron, K. E. (2005). Multiple goals, optimal motivation, and the development of interest. In S. M. Laham, J. P. Forgas, and K. D. Williams. Eds. Social motivation: Conscious and unconscious processes. New York: Cambridge University Press, 21-39.
- Heinze, A., Reiss, K., and Rudolph, F. (2005). Mathematics achievement and interest in mathematics from a differential perspective. ZDM. 37 (3): 212-219.
- Hidi, S., and Renninger, K. A. (2006). The four-phase model of interest development. Educational Psychologist. 41 (2): 111-127.
- Hidi, S. (1990). Interest and its contribution as a mental resource for learning. Review of Educational Research. 60: 549-571.
- Jones, M. G., Howe, A., and Rua, M. J. (2000). Gender differences in students' experiences, interests, and attitudes toward science and scientists. Science Education. 84: 180-192.
- Kier, M. W., Blanchard, M. R., Osborne, J. W., and Albert, J. L. (2013). The development of the STEM Career Interest Survey (STEM-CIS). Research in Science Education. 44: 461-481.
- Kessel, U. (2005). Fitting into stereotype: How gender-stereotyped perceptions of prototypic peers relate to liking for school subjects. European Journal of Psychology of Education. 20 (3): 309-323.
- Koeller, O., Baumert, J., and Schnabel, K. (2001). Does interest matter ? The relationship between academic interest and achievement in mathematics. Journal for Research in Mathematics Education. 32 (5): 448-470.
- Kotte, D. (1992). Gender differences in science achievement in 10 countries. Frankfurt: Peter Lang.
- Krapp, A. (2007). An educational-psychological conceptualization of interest. International Journal of Educational and Vocational Guidance. 7: 5-21.
- Lucas, R. E. (2007). Personality and the pursuit of happiness. Social and Personality Psychology Compass. 1: 168-182.
- Miller, P. H., Blessing, J. S., and Schwartz, S. (2006). Gender differences in high-school students' views aboutscience. International Journal of Science Education. 28 (4): 363-381.
- Mitchell, A. (1993). Situational interest: its multifaceted structure in the secondary school Mathematics classroom. Journal of Educational Psychology. 85 (3): 424-436.
- Nunnaly, J. C., and Bernstein, I. H. (1994). Psychometric theory. 3rd ed. New York: McGraw-Hill.
- OECD (2006). Global Science Forum: Evolution of student interest in Science and Technology studies. Policy Report. Paris, France: OECD Publications.
- Osborne, J., Simon, S., & Collins, S. (2003). Attitude toward science: A review of the literature and its implications. International Journal of Science Education. 25 (9): 1049-1079.

- Pintrich, P. R., Smith, D. A. F., Garcia, T., and McKeachie, W. J. (1991). A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ). National Center for Research to Improve Postsecondary Teaching and Learning, Ann Arbor: The University of Michigan.
- Schiefele, H. (1974). Lernmotivation und Motiviernen [Motivation to learn and acquisition of motives]. Muenchen: Ehrenwirth.
- Schiefele, U, Krapp, A, Wild, K., -P., & Winteler, A. (1993). Der "Fragebogen zum Studien interesse" (FSI). Diagnostica. 39: 335-351.
- Schiefele, U, Krapp, A, and Winteler, A. (1992). Interest as a predictor of academic achievement: A metaanalysis of research. In The role of interest in learning and development. K. A. Renninger, S. Hidi and A. Krapp, eds. Hillsdale: Lawrence Erlbaum, 183-212.

Schiefele, U. (1991). Interest, Learning, and Motivation. Educational Psychologist. 26 (3 & 4): 299-323.

Sheldon, K., and Elliott, A. (1999). Goal striving, need satisfaction, and longitudinal well-being: The selfconcordance model. Journal of Personality and Social Psychology. 76: 482-497.

Singh, K., Granville, M., and Dika, S. (1998). Mathematics and Science achievement: effects of motivation, interest, and academic engagement. The Journal of Educational Research. 95 (6): 323-332.

Sjoberg, S. (2000). Science and scientists: The SAS study. Acta didactica, Bologna: Iperbole.