Chapter 2
Expectancy-Value Perspectives on Choice of Science and Technology Education in Late-Modern Societies

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Introduction

"Am I clever enough? Am I really interested? Do I enjoy working with mathematics problems? Is science "me" – am I comfortable with an identity as a science student? Will this study lead to an exciting career and high wages? How much time and effort will it demand?" These are questions that young people considering a higher education in science, technology, engineering or mathematics (STEM) might ask themselves. Their answers to these questions lead them towards or away from STEM studies beyond school. The IRIS project aims to understand young people's choices to participate in – or not participate in – STEM education.

In this chapter, we present the Eccles et al. expectancy-value model of achievement-related choices (Eccles et al. 1983; Eccles and Wigfield 2002) and argue as to why it provides helpful perspectives for understanding young people's choices about participation in STEM. Sociological theories on late-modernity offer additional insights into how STEM-related choices are negotiated in rich, developed societies where participation problems are most pronounced (Bøe et al. 2011). Identity development is a particularly important part of young people's lives, according to such theories, and must be taken into consideration when understanding their educational choices. The Eccles et al. model acknowledges the importance of identity. However, a more thorough discussion of identity development related to educational choice is provided by Holmegaard and colleagues in Chap. 3.

This chapter is partly based on an article by Bøe et al. (2011) which presented the Eccles et al. model in more depth and demonstrated how a large body of research

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literature on young people's relationship to STEM could be interpreted in the light of this model, combined with perspectives on late modernity, to inform the discussion about STEM-related choices.

The Eccles et al. Expectancy-Value Model of Achievement-Related Choices

Young people's educational decision-making is a complex process, and many approaches have been taken to understand it. In psychology, theorists have, for example, linked educational choices to individuals' personality types (Costa et al. 1984; Head and Ramsden 1990). In sociology, educational and vocational behaviour have been understood as products of socio-economic factors such as social class (Ball et al. 2002; Bourdieu and Passeron 1990). Other approaches to academic motivation include self-efficacy theory (Bandura 1997), intrinsic and extrinsic motivation (Ryan and Deci 2000), interest development (Hidi and Renninger 2006; Krapp 2005), attribution theory (Weiner 1985), and expectancy-value theory. The Eccles et al. expectancy-value model of achievement-related choices (Eccles et al. 1983) (Fig. 2.1) is founded in social psychology, and incorporates social, psychological and cultural aspects that affect young people's motivational behaviour.

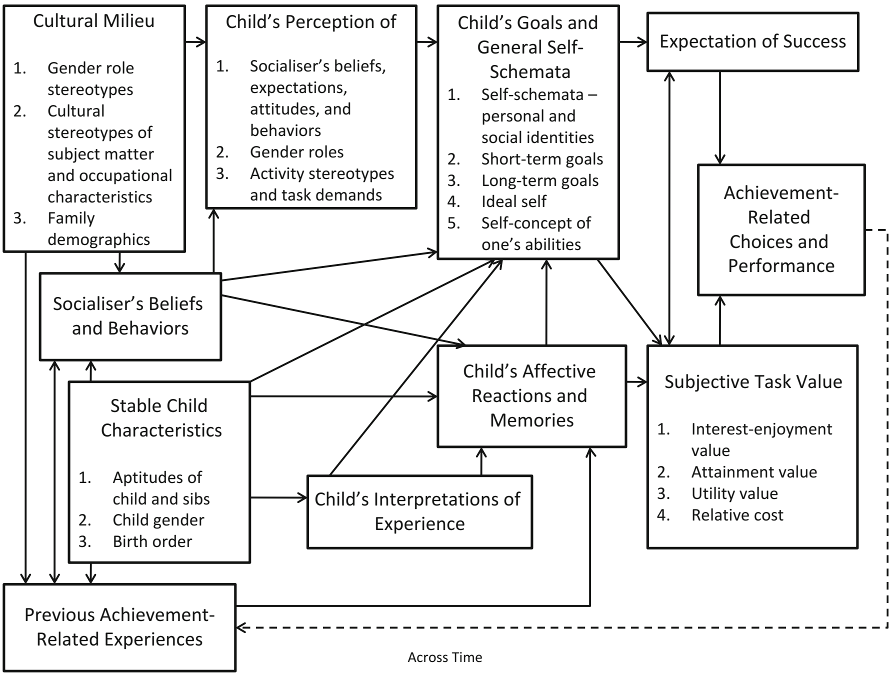

Fig. 2.1 Eccles and Wigfield (2002) expectancy-value model of achievement-related choices

The underlying premise of expectancy-value theory is that choice, persistence and performance can be explained by individuals' beliefs about how well they will perform in a particular activity and the extent to which they value the activity, that is, the subjective value they attach to the activity (Wigfield and Eccles 2000). The Eccles et al. model predicts that students are most likely to choose courses they think they can master, and that have high subjective value for them (Eccles et al. 1999). This is represented in the model through the boxes in the rightmost end of Fig. 2.1, where expectation of success and subjective task value represent the components that directly influence choice (referred to below as the "agency-related" components of the model). Subjective task value is further subdivided into interest-enjoyment value, attainment value, utility value, and relative cost. These will be presented in more detail later in this chapter and related to empirical findings from science education research.

Eccles et al. (1999) previously showed that both expectation of success and subjective value predict career choices. A specific focus on differences between the sexes is often seen, for example in studies of women's educational and occupational choices in relation to physical sciences, engineering and applied mathematics (Eccles 1994; Eccles et al. 1999). According to the model, young people's thoughts about their identity and identity development affect the expectation of success and the subjective values that they attach to different educational options (Eccles 2009).

An example of how the model has been used is the longitudinal study by Simpkins et al. (2006) of the links between mathematics and science choices and expectations and values. They collected data among 227 young people: in fifth grade the students reported on participation in various activities, and in sixth and tenth grade they reported on their expectations of success and subjective values related to mathematics and science. The study found that participation in activities predicted expectations and values, which in turn predicted enrolment in high school mathematics and science courses. Another example of possible uses of the model is provided by Denissen et al. (2007). They studied intraindividual coupling between academic achievement, interest and self-concept of ability in approximately 1,000 children between grades 1 and 12. They found that individuals tended to feel competent and interested in areas where they achieved well, and that the strongest coupling was between interest and self-concept of ability. They also observed an increase in the coupling across time.

Among the strengths of the model are that it is comprehensive, inclusive and based on empirical evidence. It is comprehensive in the sense that it includes different levels of influential factors: for example, young people's surroundings, such as their cultural *milieu* and the beliefs and behaviours of socialisers, young people's perceptions of the beliefs, expectations and stereotypes in their surroundings, and young people's personal goals and identity, and their affective reactions and memories. These factors influence their expectation of success and the subjective values that affect educational choices. The model includes constructs that overlap with concepts from other motivational theories. These include Bandura's (1997) *self-efficacy*, Ryan and Deci's (2000) *intrinsic* and *extrinsic motivation*, and the concept of *interest* (Hidi and Renninger 2006; Krapp 2002, 2005). The link between these concepts and the Eccles et al. model are described by (Eccles and Wigfield 2002). The model has been developed and tested over many years and in many studies (see Eccles et al. 1999, 1983; Nagy et al. 2008; Meece et al. 1990).

The strengths mentioned above made the Eccles et al. model well-suited to guide the development of the IRIS questionnaire (see Appendix), and to strengthen analyses and interpretation of results for some of the IRIS data and research questions. The focus on both expectation of success (or self-efficacy) and subjective task value is particularly pertinent, as both are reported to be very influential in young people's decisions about whether or not to study STEM (see e.g. Simpkins et al. 2006; Bandura et al. 2001). Another favourable trait of the model is its acknowledgement of the many other social and psychological aspects that affect the formation of students' expectations and subjective values. How family and friends talk about science, for example, impact on students' own relationship with science. Moreover, cultural stereotypes of STEM subjects and occupations affect how students relate to these subjects and occupations. It is important to note that the choice process is dynamic, that expectations and subjective values develop and change over time. At specific decision points, for example when applying for higher education, these expectations and values are brought to the fore and influence what courses students choose to apply for. However, the choice process continues beyond the decision point. That is, choices are negotiated and renegotiated as students gain experience with the study they have selected. This on-going nature of the choice process is clearly illustrated in Chap. 3, and is also relevant for understanding why some students choose to leave their STEM study before graduating (Part III).

A few issues require consideration when the Eccles et al. model is used (Bøe et al. 2011). First, expectation of success and subjective values are affected by constantly changing society and cultural *milieu*. As a result, measures of expectation of success and subjective values are sensitive to cultural changes. Second, social background variables such as ethnicity and class may not be sufficiently clearly stated in the model. Third, researchers should note that the expectancy-value structure of the model does not imply that choices are made through a fully informed calculation of all the available options. For example, interest-enjoyment value has major affective components and might be based on a "gut-feeling". Moreover, the utility value that a youngster ascribes to, for instance, an engineering course, may not be based on actual facts about the employability and career prospects of engineers; it may be based on stereotypes or hearsay. Yet it is this subjective perception of the utility value of the study in question which guides the choice.

Sociological Theories on Late-Modernity

We draw on some perspectives from sociology about late-modernity and identity development to understand better how cultural traits of highly developed societies may be recognised in young people's STEM-related choices. These theories provide additional insight into the importance of identity development for educational choices, and into young people's pronounced search for education and careers that appear interesting, self-realising and personally meaningful.

Sociologists such as Giddens (1991), Beck (Beck and Beck-Gernsheim 2002) and Inglehart (1997) described late-modernity in the 1990s, and the period's characteristic traits have also been recognised in more recent work (Bauman 2008; Furlong and Cartmel 2007). Characteristics of late-modern societies include less emphasis on material values and more emphasis on personal ones, such as self-realisation and quality of life (Inglehart 1997). Each individual is more culturally liberated and can to a larger extent than in more traditional societies make choices in relation to, for example, education and job. This liberation is a result of a less tradition-bound society, where identity is no longer inherited or given but must be constructed by the individual (Côté 1996; Giddens 1991). Young people see their interests, their favourite school subjects, their job plans, their activities and their views (on science and technology and everything else) as part of their identity, of who they are (Beck 1999; Goffman 1959). Note that identity is not a fixed entity that has implications for young people's choices. Rather, identity is in constant development and is negotiated against young people's choices and everyday behaviour, as is also described in Chap. 3. Schreiner and Sjøberg (2007) drew on late-modernity theories and claimed that late-modern young people tend to evaluate STEM education in terms of its contribution to their identity and self-development.

It is important to note that late-modernity provides an *idea* of free choice. Class, gender and other constraints of social life continue to limit young people's life chances, but have been obscured (Furlong and Cartmel 2007; Atkinson 2008). Although young people of different sexes or from different family backgrounds may have equal formal access to, for example, higher education, informal constraints in terms of cultural expectations and stereotypes still restrict access for certain groups. These restrictions may very well not be perceived as such by young people themselves, and are thus obscured.

STEM-Related Expectation of Success and Subjective Task Values

We will now briefly present the most central agency-related constructs of the Eccles et al. model: expectation of success and subjective value (the two rightmost boxes in Fig. 2.1). We use the term "agency-related" to express the idea that expectations of success and subjective values are constructs that students consider – more or less consciously – when they make an educational choice. In contrast, cultural *milieu* is a more structural construct that is very likely to influence students' choices, but potentially in ways that are less direct and less recognised by the students themselves. Subjective values and expectation of success are therefore readily recognised in students' self-reports concerning how they came to make an educational choice (see Chaps. 12 and 18).

In the model, subjective task value is split into four components: interest-enjoyment value, attainment value, utility value, and relative cost. Each of these components and expectation of success will be presented separately below and linked to insights from the STEM education research literature to inform our understanding of the values underlying educational choice. Late-modernity perspectives are included to add insight into how these components are formed and negotiated among young people in highly developed societies.

Expectation of Success

Expectation of success concerns how well students believe they will perform in, for example, a school subject they may choose to take. It includes both the students' self-concept of ability and their impression of the difficulty of the subject. As an example, consider the choice between two subjects in upper secondary school: advanced mathematics and English. What students see as success in advanced mathematics and English, depends on their self-concepts of ability in the two areas. Achieving a mark just above average in mathematics may be seen as a success if they see themselves as average mathematics students, but a failure if they consider themselves to be very good mathematics students. Expectation of success also includes the students' estimations of how difficult the subjects are. If they regard advanced mathematics as more difficult than English, they may characterise a slightly above average mark in advanced mathematics as a big success, while an equal level of success in English would require a top mark.

Physical science and mathematics subjects are often regarded as particularly difficult and demanding (Angell et al. 2004; Tytler et al. 2008; Carlone 2003; Osborne and Collins 2001). Due to this reputation, students might have to be particularly confident in their own abilities to expect to succeed. Females are more likely than males to have a low expectation of success in science and mathematics (Cavallo et al. 2004; Lloyd et al. 2005; Lyons 2006; Barnes et al. 2005; Preckel et al. 2008; Simpkins et al. 2006), especially compared to other school subjects (Häussler and Hoffmann 2000). The impact of expectation of success on choices of STEM education and occupations is widely documented (Bandura et al. 2001; Bennett and Hogarth 2009; Eccles et al. 2004; Kjærnsli and Lie 2011; Nagy et al. 2008).

Late-modern students feel responsible for the outcome of their choices (Furlong and Cartmel 1997), and it may, therefore, be difficult to develop an expectation of success that is strong enough to outweigh the potential costs related to a failure and lost opportunities. Late-modern individualisation means that each person has a unique character with special potentials that may or may not be fulfilled (Frønes and Brusdal 2001). Young people's perception of their talents and abilities are reflected in what they see as their potential, and in how well they expect to succeed in various activities. Expectation of success in STEM subjects is challenged by their reputation as particularly difficult and demanding, which causes some students to shy away from them.

Interest-Enjoyment Value

Interest-enjoyment value concerns how interested students are in the subject in question and the enjoyment they expect to experience when engaging with it. Students who are interested in literature, for example, may attach a higher interest-enjoyment value to an English course than to advanced mathematics.

Some claim that interest in school science among young people in developed countries is low (OECD 2008; Osborne 2008; Tytler 2007), and that it tends to decrease as students progress through school (Osborne et al. 2003). Liking of mathematics has also been found to decline throughout school (Fredricks and Eccles 2002; Wigfield et al. 1991). It is worth noting that interest in science topics *per se* tends to be higher than interest in school science and mathematics as experienced in the classroom (Hazari et al. 2008; Lyons and Quinn 2010; Häussler and Hoffmann 2000; OECD 2007; Schreiner 2006). A number of studies show that females and males, on average, express different interests in science topics (Cerini et al. 2003; Osborne and Collins 2001; Scantlebury and Baker 2007). On a general level, females are more likely to report interest in issues to do with human health and well-being, whereas males are more likely to be interested in things to do with, for example, technology and physics. Females also appear to be generally less engaged by science (Tytler et al. 2008). Several studies have found interest to be among the most important factors for choices of education and occupations in STEM subjects (Archer et al. 2010; Bøe 2012; Purcell et al. 2008; Hipkins and Bolstad 2006; Kjærnsli and Lie 2011; Lindahl 2003; Maltese and Tai 2011).

Late-modern societies emphasise individual self-realisation, personal meaning and subjective well-being (Beck and Beck-Gernsheim 2002; Inglehart 1997). Educational institutions are seen as arenas for self-realisation, where talents are developed and interests fostered. As described in Chap. 3, students expect to be passionate about their chosen education; tediousness is perceived as betraying their identity. It is not surprising, therefore, that many young people who choose science often highlight their interests as the main driving force, and, correspondingly, that students who opt out of science refer to a lack of interest.

Attainment Value

Attainment value concerns how well a subject or career choice fits into a person's identity development and the importance the individual attaches to attaining the goals (in this case a STEM education) they have set for themselves. People will attribute higher value to options that are easily negotiated into their identity development (Eccles 2009). For instance, for someone who wants 'very intelligent' to be part of their identity, an advanced mathematics course may have higher attainment value than an English course, because mathematics is generally considered to be more difficult than most other subjects. Similarly, it may be important not to choose subjects that appear to be in conflict with the direction students want their identity development to take. If physics is perceived to be for brainy and unpopular geeks, physics will have low attainment value for someone who rejects such an identity trait.

School science and STEM career identities appear to be less attractive to many young people (Archer et al. 2010; Hazari et al. 2010; Schreiner 2006; Taconis and Kessels 2009), in particular to females (Buck et al. 2008; Lyons and Quinn 2010; Eccles 2009). Identity development lies at the heart of late-modern youth culture (Illeris et al. 2002), and an educational or occupational choice is an identity choice. In recent years, increased attention has been paid to identity in research considering young people's relationship to STEM (Taconis and Kessels 2009; Schreiner and Sjøberg 2007; Hazari et al. 2010; DeWitt et al. 2011).

Utility Value

Utility value concerns how helpful a certain educational option is in reaching external goals, such as admission to higher education or entry to a future career. Physics in upper secondary school may have high utility value for students who hope to gain entry to medical school, even if they have no personal interest in the subject.

Utility for future careers often emerges as an important reason for choosing these subjects in upper secondary school (Angell et al. 2004; Bøe 2012; Miller et al. 2006; Lie et al. 2010; Hutchinson et al. 2009; Lyons 2006; Osborne and Collins 2001). As upper secondary STEM subjects often have a 'gate keeping' function for entry into prestigious higher education programmes such as medicine and engineering science, some students choose them to gain entry whereas others just want to keep their options open. The utility value of higher education in STEM may concern the prospect of a secure and well-paid job, if such an expectation is reasonable within the economic climate. Due to their perceived high costs, however (see below), STEM education programmes are unlikely to be considered as easy ways to economic security or other job benefits in most developed societies.

Late-modern identity development happens reflexively, in constant negotiation with a rapidly changing society, filled to the brim with information, choices and trends (Giddens 1991). To ensure that educational choices are easily included into this on-going identity development, young people are likely to want a lot of helpful information and as many open options as possible. The school sciences tend to open doors towards many different university studies, giving them high utility value. Concerning STEM higher education the potential utility value for future careers may be obscured for many students, since studies indicate that young people's knowledge about what STEM careers may involve is often limited (Cleaves 2005; Bøe and Henriksen 2013).

Relative Cost

Relative cost refers to negative aspects related to one educational choice compared to other options. It could, for example, be the time and effort that is required to do well in advanced mathematics compared to in English. It could be fear of failing advanced mathematics, or fear of disappointing parents.

Physical science and mathematics subjects on all levels are generally perceived to have higher costs in terms of difficulty and workload than most other subjects (Angell et al. 2004; Tytler et al. 2008; Carlone 2003; Osborne and Collins 2001). Females are more likely than males to perceive the costs of pursuing STEM careers to be high (OECD 2008; Carlone 2003; Warrington and Younger 2000; Angell et al. 2004; Frome et al. 2006).

Late-modern young people who choose an education feel that they themselves are responsible for the outcome. Should something go wrong, they have only themselves to blame and must themselves handle the consequences (Furlong and Cartmel 1997). A study may turn out to be too demanding, it may fail to live up to students' expectations, or for other reasons lead to non-completion. Young people tend not to explain this unhappy situation in terms of destiny, limitations of social class or lack of options, but by their personal failure, even if their problems are actually rooted in social constraints (Furlong and Cartmel 2007). Students are, therefore, likely to balance their STEM-related choices against the risks and costs they entail.

Conclusion

This chapter has presented the Eccles et al. expectancy-value model of achievement-related choices, and argued for its relevance when investigating young people's STEM-related choices. The relevance of the model is demonstrated by linking core constructs of the model to science education research literature, increasing our understanding of current participation problems in STEM. Due to this relevance, the Eccles et al. model has provided guidance in the development of the IRIS questionnaire. It has also been used as a tool for analysing data and interpreting results in parts of the IRIS work where the research questions and type of data material fit such perspectives. In addition, this chapter has introduced perspectives from sociology on late-modernity to provide more insight into how cultural traits of rich, developed societies can be recognised in students' expectations of success and subjective values related to STEM, and thus help us understand their participation in STEM in a cultural context. The Eccles et al. model and/or late-modernity perspectives are used in several of the chapters in the present volume, notably Chaps. 9, 12, 16, and 18.

References

Angell, C., Guttersrud, Ø., Henriksen, E. K., & Isnes, A. (2004). Physics: Frightful but fun. Pupils' and teachers' views of physics and physics teaching. *Science Education, 88*(5), 683–706.

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2010). "Doing" science versus "Being" a scientist: Examining 10/11-year-old schoolchildren's constructions of science through the lens of identity. *Science Education, 94*(4), 617–639.

Atkinson, W. (2008). Not all that was solid has melted into air (or liquid): A critique of Bauman on individualization and class in liquid modernity. *The Sociological Review, 56*(1).

Ball, S. J., Davies, J., David, M., & Reay, D. (2002). 'Classification' and 'Judgement': Social class and the 'cognitive structures' of choice of higher education. *British Journal of Sociology of Education, 23*(1), 51–72.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

Bandura, A., Barbaranelli, C., Caprara, G. V., & Pastorelli, C. (2001). Self-efficacy beliefs as shapers of children's aspirations and career trajectories. *Child Development, 72*(1), 187–206.

Barnes, G., McInerney, D., & Marsh, H. (2005). Exploring sex differences in science enrolment intentions: An application of the general model of academic choice. *Australian Educational Researcher, 32*(2), 1–24.

Bauman, Z. (2008). *The art of life*. Cambridge: Polity Press.

Beck, U. (1999). *World risk society*. Cambridge: Polity Press.

Beck, U., & Beck-Gernsheim, E. (2002). *Individualization*. London: SAGE Publications Ltd.

Bennett, J., & Hogarth, S. (2009). Would you want to talk to a scientist at a party? High school students' attitudes to school science and to science. *International Journal of Science Education, 31*(14), 1975–1998.

Bøe, M. V. (2012). Science choices in Norwegian upper secondary school: What matters? *Science Education, 96*, 1–20.

Bøe, M. V., & Henriksen, E. K. (2013). Love it or leave it: Norwegian students' motivations and expectations for postcompulsory physics. *Science Education, 97*(4), 550–573.

Bøe, M. V., Henriksen, E. K., Lyons, T., & Schreiner, C. (2011). Participation in science and technology: Young people's achievement-related choices in late modern societies. *Studies in Science Education, 47*(1), 37–72.

Bourdieu, P., & Passeron, J.-C. (1990). *Reproduction in education, society and culture* (R. Nice, Trans., 2nd ed.). London: Sage Publications.

Buck, G., Clark, V. L. P., Leslie-Pelecky, D., Lu, Y., & Cerda-Lizarraga, P. (2008). Examining the cognitive processes used by adolescent girls and women scientists in identifying science role models: A feminist approach. *Science Education, 92*(4), 688–707.

Carlone, H. B. (2003). Innovative science within and against a culture of "achievement". *Science Education, 87*, 307–328.

Cavallo, A. M. L., Rozman, M., & Potter, W. H. (2004). Gender differences in learning constructs, shifts in learning constructs and their relationship to course achievement in structured enquiry, yearlong college physics course for life science majors. *School Science and Mathematics, 104*(6), 288–300.

Cerini, B., Murray, I., & Reiss, M. J. (2003). *Student review of the science curriculum. Major findings*. London: Planet Science, Institute of Education, University of London, Science Museum.

Cleaves, A. (2005). The formation of science choices in secondary school. *International Journal of Science Education, 27*(4), 471–486.

Costa, P. T., McCrae, R. R., & Holland, J. L. (1984). Personality and vocational interests in an adult sample. *Journal of Applied Psychology, 69*(3), 390–400.

Côté, J. E. (1996). Sociological perspectives on identity formation: The culture-identity link and identity capital. *Journal of Adolescence, 19*, 417–428.

Denissen, J. J. A., Zarrett, N. R., & Eccles, J. (2007). I like to do it, I'm able, and I know I am: Longitudinal couplings between domain-specific achievement, self-concept, and interest. *Child Development, 78*(2), 430–447.

DeWitt, J., Osborne, J., Archer, L., Dillon, J., Willis, B., & Wong, B. (2011). Young children's aspirations in science: The unequivocal, the uncertain and the unthinkable. *International Journal of Science Education*. doi:10.1080/09500693.09502011.09608197.

Eccles, J. (1994). Understanding women's educational and occupational choices. *Psychology of Women Quarterly, 18*, 585–609.

Eccles, J. (2009). Who am I and what am I going to do with my life? Personal and collective identities as motivators of action. *Educational Psychologist, 44*(2), 78–89.

Eccles, J., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Reviews Psychology, 53*, 109–132.

Eccles, J., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., et al. (1983). Expectancies, values, and academic behaviours. In J. T. Spence (Ed.), *Achievement and achievement motives. Psychological and sociological approaches*. San Francisco: W. H. Friedman & Co.

Eccles, J., Barber, B., & Jozefowicz, D. (1999). Linking gender to educational, occupational, and recreational choices: Applying the Eccles et al. model of achievement-related choices. In W. B. Swann Jr., J. H. Langlois, & L. A. Gilbert (Eds.), *Sexism and stereotypes in modern society: The gender science of Janet Taylor Spence* (pp. 153–192). Washington, DC: American Psychological Association.

Eccles, J., Vida, M. N., & Barber, B. (2004). The relation of early adolescents' college plans and both academic ability and task-value beliefs to subsequent college enrollment. *Journal of Early Adolescence, 24*(1), 63–77.

Fredricks, J. A., & Eccles, J. S. (2002). Children's competence and value beliefs from childhood through adolescence: Growth trajectories in two male-sex-typed domains. *Developmental Psychology, 38*(4), 519–533.

Frome, P. M., Alfeld, C. J., Eccles, J. S., & Barber, B. L. (2006). Why don't they want a male-dominated job? An investigation of young women who changed their occupational aspirations. *Educational Research and Evaluation, 12*(4), 359–372.

Frønes, I., & Brusdal, R. (2001). *På sporet av den nye tid. Kulturelle varsler for en nær fremtid* [On the track of the new era. Cultural signs of a near future]. Bergen: Fagbokforlaget Vigmostad & Bjørke AS.

Furlong, A., & Cartmel, F. (1997). *Young people and social change: Individualization and risk in late modernity*. Buckingham: Open University Press.

Furlong, A., & Cartmel, F. (2007). *Young people and social change – New perspectives* (2nd ed.). Berkshire: Open University Press.

Giddens, A. (1991). *Modernity and self-identity. Self and society in the late modern age*. Cambridge: Polity Press.

Goffman, E. (1959). *The presentation of self in everyday life*. New York: Anchor Book.

Häussler, P., & Hoffmann, L. (2000). A curricular frame for physics education: Development, comparison with students' interests, and impact on students' achievement and self-concept. *Science Education, 84*(6), 689–705.

Hazari, Z., Sadler, P. M., & Tai, R. H. (2008). Gender differences in the high school and affective experiences of introductory college physics students. *The Physics Teacher, 46*(7), 423–427.

Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, M.-C. (2010). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. *Journal of Research in Science Teaching, 47*(8), 978–1003.

Head, J., & Ramsden, J. (1990). Gender, psychological type and science. *International Journal of Science Education, 12*(1), 115–121.

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist, 41*(2), 111–127.

Hipkins, R., & Bolstad, R. (2006). *Staying in Science. An investigation of factors that encourage students to choose science as a study and career focus*. Wellington: New Zealand Council for Educational Research.

Hutchinson, J., Stagg, P., & Bentley, K. (2009). *STEM careers awareness timelines: Attitudes and ambitions towards science, technology, engineering and maths*. Derby: International Centre for Guidance Studies, University of Derby.

Illeris, K., Katznelson, N., Simonsen, B., & Ulriksen, L. (2002). *Ungdom, identitet og uddannelse* [Youth, identity and education]. Frederiksberg: Roskilde universitetsforlag.

Inglehart, R. (1997). *Modernization and postmodernization. Cultural, economic, and political change in 43 societies*. Princeton: Princeton University Press.

Kjærnsli, M., & Lie, S. (2011). Students' preference for science careers: International comparisons based on PISA 2006. *International Journal of Science Education, 33*(1), 121–144.

Krapp, A. (2002). Structural and dynamic aspects of interest development: Theoretical considerations from an ontogenetic perspective. *Learning and Instruction, 12*, 383–409.

Krapp, A. (2005). Basic needs and the development of interest and intrinsic motivational orientations. *Learning and Instruction, 15*, 381–395.

Lie, S., Angell, C., & Rohatgi, A. (2010). *Fysikk i fritt fall? TIMSS Advanced 2008 i videregående skole* [Physics in free fall? TIMSS Advanced 2008 in upper secondary school]. Oslo: Unipub.

Lindahl, B. (2003). *Pupils' responses to school science and technology? A longitudinal study of pathways to upper secondary school*. Göteborg: Acta Universitatis Gothoburgensis.

Lloyd, J. E. V., Walsh, J., & Yailagh, M. S. (2005). Sex differences in performance attribution, self-efficacy, and achievement in mathematics: If I'm so smart, why don't I know it? *Canadian Journal of Education, 28*(3), 384–408.

Lyons, T. (2006). Different countries, same science classes: Students' experiences of school science in their own words. *International Journal of Science Education, 28*(6), 591–613.

Lyons, T., & Quinn, F. (2010). *Choosing science. Understanding the declines in senior high school science enrolments*. Armidale: University of New England.

Maltese, A. V., & Tai, R. H. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among U.S. students. *Science Education, 95*(5), 877–907. doi:10.1002/sce.20441.

Meece, J. L., Wigfield, A., & Eccles, J. S. (1990). Predictors of math anxiety and its influence on young adolescents' course enrollment intentions and performance in mathematics. *Journal of Educational Psychology, 82*(1), 60–70.

Miller, P. H., Blessing, J. S., & Schwartz, S. (2006). Gender differences in high-school students' views about science. *International Journal of Science Education, 28*(4), 363–381.

Nagy, G., Garrett, J., Trautwein, U., Cortina, K. S., Baumert, J., & Eccles, J. (2008). Gendered high school course selection as a precursor of gendered careers: The mediating role of self-concept and intrinsic value. In H. M. G. Watt & J. Eccles (Eds.), *Gender and occupational outcomes* (pp. 115–143). Washington, DC: American Psychology Association.

OECD. (2007). *PISA 2006. Science competencies for tomorrow's world* (Vol. 1). Paris: OECD.

OECD. (2008). *Encouraging student interest in science and technology studies*. Paris: Global Science Forum.

Osborne, J. (2008). Engaging young people with science: Does science education need a new vision? *School Science Review, 89*(328), 67–74.

Osborne, J., & Collins, S. (2001). Pupils' views of the role and value of the science curriculum: A focus-group study. *International Journal of Science Education, 23*(5), 441–467.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049–1079.

Preckel, F., Goetz, T., Pekrun, R., & Kleine, M. (2008). Gender differences in gifted and average-ability students: Comparing girls' and boys' achievement, self-concept, interest, and motivation in mathematics. *Gifted Child Quarterly, 52*(2), 146–159.

Purcell, K., Elias, P., Ellison, R., Atfield, G., Adam, D., & Livanos, I. (2008). *Applying for Higher Education – The diversity of career choices, plans and expectations. Findings from the first futuretrack survey of the 'class of 2006' applicants for higher education*. Coventry: IER, University of Warwick.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*(1), 68–78.

Scantlebury, K., & Baker, D. (2007). Gender issues in science education research: Remembering where the difference lies. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 257–285). Mahwah: Lawrence Erlbaum Associates.

Schreiner, C. (2006). *Exploring a ROSE-garden. Norwegian youth's orientation towards science – Seen as signs of late modern identities*. Doctoral Thesis, University of Oslo, Oslo.

Schreiner, C., & Sjøberg, S. (2007). Science education and youth's identity construction – Two incompatible projects? In D. Corrigan, J. Dillon, & R. Gunstone (Eds.), *The re-emergence of values in science education* (pp. 231–247). Rotterdam: Sense Publishers.

Simpkins, S., Davis-Kean, P., & Eccles, J. (2006). Math and science motivation: A longitudinal examination of the links between choices and beliefs. *Developmental Psychology, 42*(1), 70–83.

Taconis, R., & Kessels, U. (2009). How choosing science depends on students' individual fit to "science culture". *International Journal of Science Education, 31*(8), 1115–1132.

Tytler, R. (2007). *"Re-imagining science education": Engaging students in science for Australia's future*. Camberwell: Australian Council for Educational Research.

Tytler, R., Osborne, J., Williams, G., Tytler, K., & Clark, J. C. (2008). *Opening up pathways: Engagement in STEM across the primary-secondary school transition*. Canberra: Australian Department of Education, Employment and Workplace Relations.

Warrington, M., & Younger, M. (2000). The other side of the gender gap. *Gender and Education, 12*(4), 493–508.

Weiner, B. (1985). An attributional theory of achievement motivation and emotion. *Psychological Review, 92*(4), 548–573.

Wigfield, A., & Eccles, J. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology, 25*, 68–81.

Wigfield, A., Eccles, J. S., Iver, D. M., Reuman, D. A., & Midgley, C. (1991). Transition during early adolescence: Changes in children's domain-specific self-perceptions and general self-esteem across the transition to junior high school. *Developmental Psychology, 27*(4), 552–565.

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