Game-Based Learning for Supporting Self-Confidence and Motivation of Female STEM Students

Bernhard Ertl
Universität der Bundeswehr München, Germany

Many areas of STEM are influenced by gender related stereotypes. Studies report a lower self-concept of female students in most of the STEM subjects and lower interest, motivation, and class contributions in physics and the information and communication technologies (ICT). Subjects like physics and ICT are often perceived as "male" which puts them out of the focus of female students. This paper describes the concept and implementation of the Mit-Mut project, which applies aspects of game-based learning and gamification to STEM domains to promote positive self-concept and motivation in female students. The Mit-Mut game was designed to accompany class measures in school, particularly for female students in lower secondary school. Although the project mainly focuses on entrepreneurial skills and ICT, it has several connections to physics teaching. Results of the evaluation show that the game was able to improve the self-concept of students while the motivation for pursuing a STEM career did not increase significantly.

1 Introduction and Theory

Studies show that STEM (science, technology, engineering, & mathematics)-classrooms, particularly in the subjects of physics and information and communication technologies (ICT), are subject to stereotype related gender phenomena (Ertl, Helling, & Kikis-Papadakis, 2011; Jurik, Gröschner, & Seidel, 2013; Kessels & Hannover, 2008): they report gender differences with respect to students' academic self-concept in these subjects (Dickhäuser & Meyer, 2006; OECD, 2015), their motivation and interests (Jurik et al., 2013; Kessels & Hannover, 2008), as well as their classroom participation (Ertl & Helling, 2010; Jurik et al., 2013). These factors are known to have an impact on students' achievements (see OECD, 2015) and are therefore essential to consider when aiming at gender appropriate classroom teaching.

First of all, the *academic self-concept* is crucial for a student to realise one's own academic potential in a subject (see Jahnke-Klein, 2006; Marsh & Scalas, 2011). Results of the latest PISA study (OECD, 2015) indicate that differences in the outcomes of science scores between boys and girls can be explained by differences in their self-concept. Self-concept has implications for success and failure (Beermann, Heller, & Menacher, 1992). Even if girls and boys have the same grades, girls are less likely than boys to attribute success to their talent, and yet more likely to attribute failure to their lack of ability (Dickhäuser & Meyer, 2006). Such attribution patterns are detrimental to academic achievement (Heller & Ziegler, 1996; Steinmayr & Spinath, 2009) as they reduce the motivation for putting further efforts into a subject.

For this reason, several studies have emphasized the role of *motivation* (e.g. Dresel, Schober, & Ziegler, 2007) in earning appropriate achievements in a subject. According to expectancy-value theories (Eccles et al., 1983; Schlag, 2006), a reduced expectation for

Ertl, B. (2016). Game-Based Learning for Supporting Self-Confidence and Motivation of Female STEM Students. In L.-J. Thoms & R. Girwidz (Eds.), *Proceedings of the 20th International Conference on Multimedia in Physics Teaching and Learning* (pp. 89–98). European Physical Society.

success in an area usually inhibits the motivation for further learning in this area and therefore leads to poorer outcomes. This is particularly important in the context of gender and STEM, because several studies report lower motivation in females in STEM areas (e.g. Ertl et al., 2011; Ihsen, 2009; Jurik et al., 2013).

Both, self-concept and motivation are often affected by stereotypes (Owens & Massey, 2010). Research on the *stereotype threat* describes how much mere presentation of a stereotype can influence students' achievements (see e.g. Owens & Massey, 2011). Stereotypes, particularly those of parents and teachers, can have a big impact on students' dispositions, especially stereotypes regarding females in science (Martignon, 2010). Evidence for that was provided by Nosek et al. (2009): In a cross-national study, these researchers were able to describe the aspirations of females in STEM in different countries in terms of their perception of STEM as a "male" domain in their respective countries. Girls consider subjects stereotyped as "male" as less relevant for their personal development (Schwarze, 2010) and female students with preferences for such subjects often experience negative consequences from their peer group (Kessels & Hannover, 2008). Kessels and Hannover (2008) argue that girls who like physics are seen as out of favor, less attractive and less feminine, and are therefore likely to lose interest in these subjects as their sense of identity develops. Consequently, support for females in STEM has to focus on the support of their self-concept, the enhancement of their motivation, and the overcoming of stereotypes.

As these discussions show, there is a special need for facilitating females' self-concept and motivation with respect to STEM subjects. It is necessary to allow students to develop their self-concept in a positive way (see Lazarides & Ittel, 2012). For this process of discovery, students should find themselves in a safe space that allows them to work on issues that are associated with challenges rather than with stereotypes (see Ertl, Luttenberger, & Paechter, 2014). Such activities may include hands-on activities that are focused on students (see Paechter, Jones, Tretter, Bokinsky, Kubasco, Negishi, & Andre, 2006), extracurricular learning activities to allow students to form professional experiences (Prenzel, Reiss, & Hasselhorn, 2009), and the involvement of role models that counteract stereotypes (e.g. Marx & Roman, 2002).

2 Concept and Implementation

This paper will present the concept and the implementation of game based learning to promote motivation and positive self-concept of female students in lower secondary school. It will elaborate on situated learning scenarios as an approach for supporting girls' development of skills and discuss how these can counteract the development of stereotypes and enhance appropriate self-evaluations. It will present the implementation of the game-based learning didactics of the project Mit-Mut. Mit-Mut is an Austrian project dedicated to supporting girls' key qualifications and entrepreneurial skills in the ICT sector and has several relations to physics teaching.

2.1 Situated learning scenario

Situated learning scenarios can facilitate hands-on activities and support development of self-confidence. Such environments often apply aspects of the *anchored instruction* approach that was developed by the Cognition and Technology Group at Vanderbilt University (CGTV, 1990) to support students in mathematics. Using learning technologies, the anchored instruction approach provides students the setting of a role play game with particular tasks to solve. It uses narratives to transfer learning contents from the classroom with stereotypical attribution of abilities in mathematics and physics to a (fictional) scenario with realistic problems. It departs from structured classroom lectures to evoke and facilitate self-directed and problem-oriented learning to allow students to discover their own abilities. Starting from the problems presented in the narrations, students should be able to develop their problem solving skills and to transfer them to further situations and problems.

The original anchored instruction approach was implemented by the Jasper Woodbury series and consisted of several video episodes that included mathematical and physical issues for grades five to eight. These dealt with a ranger called Jasper Woodbury who had to master several challenges, e.g. saving a bald eagle or coming home with a broken boat. At the end of each episode, students are challenged to help Jasper solving his problem. Research emphasizes seven design principles as important for anchored instruction (see CGTV 1992); for the context of Mit-Mut we will focus on these five:

- The *Video-based format* aims at presenting the issues comprehensibly and emotionally and thereby promotes students' identification with the protagonist and their engagement in the problem solving process.
- A *narrative format of presentation* allows displaying authentic real-life problems and the applicability of the skills developed for new situations.
- The *generative format* provides connections to students' experiences and prior knowledge and encourages them to find an ending for each episode.
- The learning materials consists of *complex problems* that include several sub-problems to be solved.
- Furthermore, the episodes establish *links across the curriculum*, e.g. by including the concepts of velocity and distances from physics or business cases from economics.

Several of these principles can be found in game based learning approaches (see Günther, Mandl, Klevers, & Sailer, 2015) while other aspects of gamification go beyond the situated learning scenario.

2.2 Gamification approach

While situated learning scenarios emphasize the learning design, gamification approaches focus on learners' needs. Many gamification approaches relate to Decy and Ryan's (1992) self-determination theory on motivation and try to establish flow by fulfilling these needs, according to Csikszentmihaliy (1985). Deci and Ryan (1992) identify three basic needs for motivated and self-directed learning: *autonomy*, *competence*, and *relatedness*. Gamification approaches derive several game mechanisms from these basic needs, e.g. feedback, personal profiles, transparency of results, goals, competition, and collaboration. Günther et al. (2015) discuss how well these mechanisms could satisfy basic needs and which particular game elements, e.g. high scores, badges, achievements, avatars, and of course the game story, are appropriate to implement the game mechanisms (see Günther et al., 2015). This implies the application of several of these mechanisms in combination with the situated learning scenario.

2.3 Concept for the Mit-Mut game

The concept for the Mit-Mut game is to apply an anchored instructional learning scenario enriched with gamification elements. To offset common gender-specific norms in the classroom, the game was dedicated only to girls. A particular focus of the game was the aspect of social inclusion, which was implemented by a community (according to Lave and Wenger, 1991) of students, role models, teachers, and the Mit-Mut team in the style of a social enterprise education entertainment network (Se^3N).

In accordance with many established theories about females in STEM, the *didactic design* focused particularly on facilitating students' discovery of personal skills and key qualifications to overcome stereotype skill attributions. Consequently, the design aimed at learning situations that allowed students to experience self-efficacy to support the development of a positive self-concept with anchored instruction as a didactic approach. This includes an authentic context by video messages as well as the interaction with role models. As the development of a positive self-concept in the subject area is a key aspect of the game, it was designed to offer experiences of success as well as to give differential and supportive feedback by the Mit-Mut team and the role models in the Se^3N. In particular, the interaction with role models can allow students to overcome missing experiences in socialization. It helps students find appropriate attribution patterns of their own skills

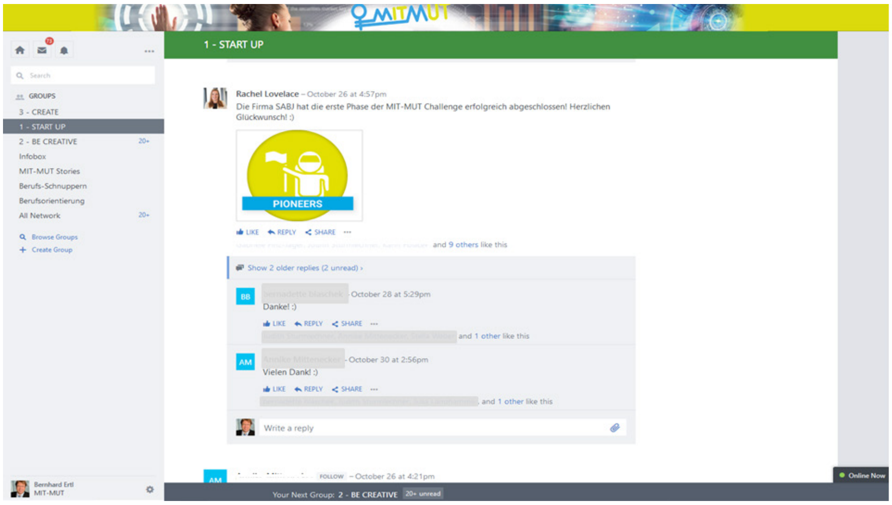

Fig. 1. Screenshot of the Se³N.

and abilities beyond stereotypes—an issue that is particularly important in the context of STEM subjects.

Mit-Mut included particular aspects of gamification to evoke students' perception of playing, unlike performing school project work. These aspects are introduced by the provision of badges and achievements as well as by the inclusion of gaming apps as incentives.

2.4 Implementation of the Mit-Mut game

The Mit-Mut game had an anchor story about a CEO from Silicon Valley, called Rachel Lovelace, who came to Austria to open a local branch. She was looking for a team of motivated females that would help her company find an entry to the Austrian market. For this reason, she was asking groups of students to develop an idea for a mobile phone app. Rachel was communicating to the groups by video messages or via the comment/chat function of the Se³N. The game consisted of five phases of project work and four mini games between these phases. In total, the game was designed to be a 6 week class project with an estimated two lessons per week. A teacher handbook completed the game materials.

2.4.1 Social enterprise education entertainment network (Se³N)

The Se³N was the core element and interface of the game. It was implemented in the platform Microsoft YAMMER (see figure 1) and supported interaction between the students. Thus, it served as an interaction and communication platform within the game, collected students' project work, and provided access to the mini games and information about professional development.

2.4.2 Project work

The project work of the game comprised five project phases that could be accomplished in the classroom or at home: A *start-up* phase in which the students formed groups and developed a logo for their company, a phase for inventing an idea and a concept for their app, called *being creative,* a phase for developing a paper prototype of the app called *create,* a phase for preparing a video presentation of the idea and the app, called *present,* and a phase for voting for the best app and earning the achievements called *achieve.* Each project work phase was introduced by a video message by Rachel posted in the Se³N and

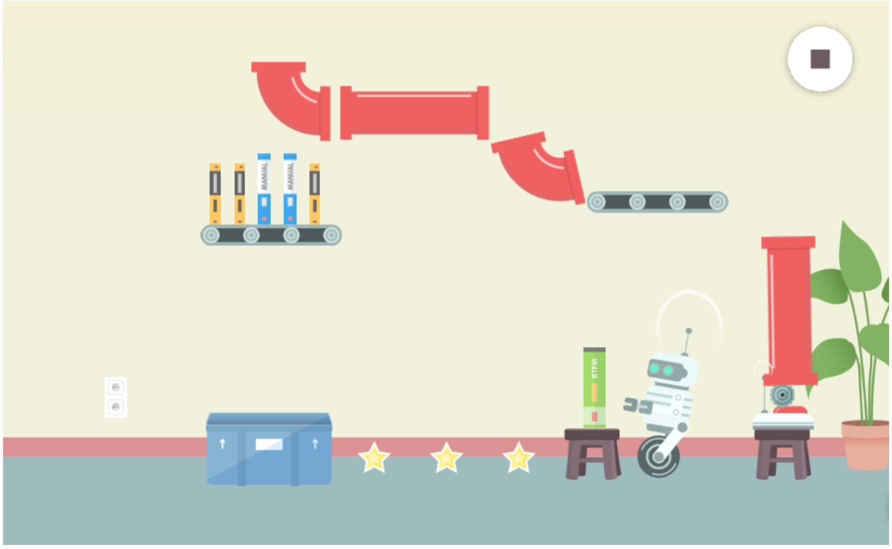

Fig. 2. Screenshot of the physics mini game.

by links to support items for each phase. The teacher handbook also provided materials for facilitating project work in the classroom.

2.4.3 Mini-games and further gamification elements

Between these phases, the game included four mini-games in the style of gaming apps. These mini-games consisted of different levels and were designed to motivate students by providing incentives. All of the games dealt with issues important for female entrepreneurs, e.g. taking up issues of work-life balance, computer security, analytic thinking, or problem-solving issues. Figure 2 gives an example of the mini game that dealt with problem solving in the domain of physics. The particular problem was to use a wheel that dropped from the top to solve a challenge. The wheel was either a car wheel with a rubber tire or a gear wheel out of iron. Each kind of wheel followed the respective laws of physics concerning gravity, acceleration and bouncing behavior. Students had some utilities like tubes, springs, and slides which they could arrange and rotate freely to build a course for the wheel. During this course, students were able to collect stars for earning an extra bonus. In the level shown below, students had to bring the green book into the blue box. They had a small gear wheel (lower right) that had to be used to hold down the remote control of the robot to push the book on the stool until it fell into the box (in order to collect the stars). The particular challenge of this course was to keep the wheel on the remote control for the robot and prevent it from rolling down. This could be accomplished either by positioning the tube as shown in the figure to fix the wheel in place, or by finding ways to reduce its spin. Core concepts of the game, e.g. problem solving strategies in the physics game were intended to be reflected with the teacher in the classroom. High scores of the mini games were posted in the Se^{3}N. Furthermore, students were able to earn badges and achievements, e.g. for postings or results of the project phases.

2.4.4 Teacher materials and classroom reflection

The aspects of the mini-game, the project progress, and career opportunities were intended to be reflected in the classroom. Therefore, the project provided an elaborate teacher manual than contained information and methods for supporting the groups during their project and for reflecting the mini games. Furthermore, the manual provided teachers with aspects essential for gender appropriate teaching in STEM, e.g. gender phenomena, attribution patterns etc.

		before		after		t-Test		
		M	*SD*	*M*	*SD*	*n*	*t*	*p*
Skills	planning	1.94	0.802	2.11	0.936	35	-1.063	n. s.
	communication	2.14	1.141	1.80	0.797	35	1.555	n. s.
	presentation	2.29	0.938	1.97	0.870	35	2.149	.039
Motivation		2.98	0.835	2.97	1.027	35	0.062	n. s.
Self-concept	scale	2.33	0.725	2.22	0.742	35	0.790	n. s.
	ability	2.91	0.951	2.49	0.951	35	2.266	.030

Tab. 2. Means, standard deviations, *t*- and significance values with respect to skills, motivation, and self-concept. Lower means indicate better results.

3 Objectives and Assessment

The game ran from September to November 2015 in the lower secondary classes (ages 13-14) of 9 Austrian schools. Originally, 15 schools agreed to participate in the game.However, after the summer break, several schools struggled with the integration of refugees, leaving them with reduced resources for the game or even resulting in them dropping out entirely. Ultimately, 9 schools remained and in total 79 students built 20 teams. Students participated in the Se^{3}N and provided between 0 and 144 postings (M = 13). They created 17 logos for their company (phase 1), invented 16 concepts for their apps (phase 2) and provided 15 paper prototypes (phase 3). However, they found the video presentations quite challenging and so only 10 groups provided them (phase 4). 16 votings in phase 5 indicate that 80 per cent of the groups finished the game. To analyse of the effects of the game, students were asked to fill in a questionnaire before and after the game. 50 students filled in the first questionnaire, 44 students filled in the second, and 35 students filled in both questionnaires. In the following, the instruments will be described and the results will be presented and discussed. The Mit-Mut game ended recently and therefore we can only present parts of the analysis.

3.1 Instruments

The questionnaires each consisted of a self-evaluation of skills, an estimation of motivation, and a measurement of students' self-concept and took place before and after the game. Students estimated the level of their own skills with respect to planning, communication, and presentation on a scale from 1 to 6 with 1 as strongest value. To evaluate students' motivation, a scale of intrinsic and extrinsic motivation for STEM professions, with 7 items was applied (Ertl et al., 2014). The reliability of the scale was good (Cronbach's α = .852 before and α = .912 after). With respect to students' self-concept, a scale of Dickhäuser, Schöne, Spinath, and Stiensmeier-Pelster (2002) was adapted for computer and media. The reliability of this scale was also good (Cronbach's α = .887 before and α = .898 after).

3.2 Results

The results of the study highlight different points. Regarding the self-evaluation of skills, students showed a statistically significantly improved self-estimation of their presentation skills, an statistically insignificant higher self-evaluation of their communication skills, and an statistically insignificant decrease in the estimation of their planning skills. Regarding their motivation for STEM professions, the analysis couldn't reveal differences on a statistical level and regarding the self-concept, there was a slight (but not significant) increase with respect to their academic self-concept. Nevertheless, students had a significantly higher estimation of their ability (which related to one item of the self-concept scale).

3.3 Limitations

Mit-Mut was designed as a long-term field study and depends on implementation across different schools. Unfortunately, there was a dropout of schools that resulted in a low number of participants. A higher number would have been desirable in order to obtain deeper knowledge about the impact of the game. Another obstacle was that Mit-Mut was specifically dedicated to females to prevent dysfunctional gender specific interactions and norms in classroom during the game (see Ertl & Helling, 2010; Kessels & Hannover, 2008; Jurik et al., 2013). This had the consequence that teachers had to care for an alternative program for male students which may have resulted in some specific teacher behavior, e.g., cutting time for game. Greater insight into how both aspects may have hindered game implementation are expected by the qualitative study that is currently being conducted.

3.4 Discussion and consequences

Bearing in mind the obstacles described above, the Mit-Mut game could demonstrate effectiveness in aiding students' self-estimation of presentation skills and could help improve their self-concept in the field—which is much more important in the context of the theory described above. Given the results from OECD (2015) and Nosek et al. (2009), this is a first important step toward increasing females' motivation for STEM subjects. Contrary to our expectation, the game did not yet have an impact on student's motivation for working in a STEM area (even if answers to open questions indicated they found the game itself motivating). The academic self-concept is an essential aspect for the development of interests (Eccles et al., 1983; Lazarides & Ittel, 2012) and it may be that the paths toward motivation postulated in the respective models (e.g. Eccles et al., 1983) need some time to develop. Furthermore, one has to consider that females in the age of 13-14 are not yet in the age to make professional decisions and thus may not have realized the relevance of the game to their own future career. Nevertheless, the game showed a significant effect on the self-concept of the female students in a stereotypically male domain and therefore it can serve as a prototype to gauge success in counteracting gender stereotype ability attributions.

Acknowledgements

Mit-Mut (http://www.mit-mut.at) is funded by the Austrian ministry for transport, innovation and technology by the program Talents-FEMTECH (funding no. 844855). The project is coordinated by MAKAM Research GmbH with die Berater® Unternehmensberatungs GmbH, Webducation Software Planungs- und EntwicklungsgmbH, Pädagogische Hochschule Niederösterreich, and Donau-Universität Krems as partners.

References

Beermann, L., Heller, K. A., & Menacher, P. (1992). *Mathe: nichts für Mädchen? Begabung und Geschlecht am Beispiel von Mathematik, Naturwissenschaft und Technik*. Bern: Verlag Hans Huber.

Bunchball. (2010). Gamification 101: An Introduction to the Use of Game Dynamics to Influence Behavior. Retrieved from http://www.bunchball.com/sites/default/files/downloads/gamification101.pdf

CGTV - Cognition and Technology Group at Vanderbilt. (1990). Anchored instruction and its relationship to situated cognition. *Educational Researcher, 19*, 2-10.

CGTV - Cognition and Technology Group at Vanderbilt. (1992). The Jasper Experiment: An exploration of issues learning and institutional design. *Educational Technology Research and Development, 40*, 63-80.

Csikszentmihalyi, M. (1985). *Das Flow-Erlebnis*. Stuttgart: Ernst-Klett Verlag.

Deci, E. L., & Ryan, R. M. (1992). The initiation and regulation of intrinsically motivated learning and achievement. In A. K. Boggiano & T. S. Pittman (Eds.), *Achievement and motivation: A social-developmental perspective* (pp. 9-36). Cambridge: Cambridge University Press.

Dickhäuser, O., & Meyer, W.-U. (2006). Gender differences in young children's math ability attributions. *Psychology Science, 48*(1), 3-16.

Dickhäuser, O., Schöne, C., Spinath, B., & Stiensmeier-Pelster, J. (2002). Die Skalen zum akademischen Selbstkonzept. *Zeitschrift für Differentielle und Diagnostische Psychologie, 23*(4), 393-405.

Dresel, M., Schober, B., & Ziegler, A. (2007). Golem und Pygmalion. Scheitert die Chancengleichheit von Mädchen im mathematisch-naturwissenschaftlich-technischen Bereich am geschlechtsstereotypen Denken der Eltern? In P. H. Ludwig & H. Ludwig (Eds.), *Erwartungen in himmelblau und rosarot. Effekte, Determinanten und Konsequenzen von Geschlechterdifferenzen in der Schule* (pp. 61-81). Weinheim: Juventa.

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & al., e. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motives* (pp. 75-146). San Francisco: Freeman.

Ertl, B., & Helling, K. (2010). Genderunterstützung beim Lernen mit neuen Medien. In T. Hug & R. Maier (Eds.), *Medien – Wissen – Bildung. Explorationen visualisierter und kollaborativer Wissensräume* (pp. 144-161). Innsbruck: innsbruck university press.

Ertl, B., Helling, K., & Kikis-Papadakis, K. (2011). The impact of gender in IT careers. In C. Romm Livermore (Ed.), *Gender and social computing: interactions, differences and relationships* (pp. 98-119). Hershey, PA: Information Science Reference.

Ertl, B., Luttenberger, S., & Paechter, M. (2014). Stereotype als Einflussfaktoren auf die Motivation und die Einschätzung der eigenen Fähigkeiten bei Studentinnen in MINT-Fächern. *Gruppendynamik und Organisationsberatung, 45*(4). doi:10.1007/s11612-014-0261-3

Günthner, W. A., Klevers, M., Mandl, H., & Sailer, M. (2015). *GameLog - Gamification in der Intralogistik*. Garching b. München: Lehrstuhl für Fördertechnik Materialfluß Logistik (fml) TU München.

Hannover, B., & Kessels, U. (2004). Self-to-prototype matching as a strategy for making academic choices. Why High School students do not like math and science. *Learning and Instruction, 14*, 51-67. doi:10.1016/j.learninstruc.2003.10.002

Heller, K. A., & Ziegler, A. (1996). Gender differences in mathematics and the sciences: Can attributional retraining improve the performance of gifted females? *Gifted Child Quarterly, 40*(4), 200-210.

Ihsen, S. (2009). Spurensuche. Entscheidungskriterien für Natur- bzw. Ingenieurwissenschaften und mögliche Ursachen für frühe Studienabbrüche von Frauen und Männern an den TU9-Universitäten. *Bundesministerium für Bildung und Forschung, EU, Europäischer Sozialfonds für Deutschland*: TUM.

Jahnke-Klein, S. (2006). Mathematik, Informatik, Naturwissenschaften und Technik - (immer noch) nichts für Mädchen? In S. Jösting & M. Seemann (Eds.), *Gender und Schule. Geschlechterverhältnisse in Theorie und schulischer Praxis* (pp. 97-120). Oldenburg: Bis-Verlag.

Jurik, V., Gröschner, A., & Seidel, T. (2013). How student characteristics affect girls' and boys' verbal engagement in physics instruction. *Learning and Instruction, 23*(1), 33-42. doi:10.1016/j.learninstruc.2012.09.002

Kessels, U., & Hannover, B. (2008). When being a girl matters less: Accessibility of gender-related self-knowledge in single-sex and coeducational classes and its impact on students' physics-related self-concept of ability. *British Journal of Educational Psychology, 78*(2), 273-289.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. New York, NY: Cambridge University Press.

Lazarides, R., & Ittel, A. (2012). Unterrichtsmerkmale, mathematisches Fähigkeitsselbstkonzept und individuelles Unterrichtsinteresse. In R. Lazarides & A. Ittel (Eds.), *Differenzierung im mathematisch-naturwissenschaftlichen Unterricht* (pp. 167-186). Bad Heilbrunn: Klinkhardt.

Marsh, H. W., & Scalas, L. F. (2011). Self-concept in learning: reciprocal effects model between academic self-concept and academic achievement. In S. Järvela (Ed.), *Social and Emotional Aspects of Learning* (pp. 191-197). Amsterdam: Elsevier.

Martignon, L. (2010). Mädchen und Mathematik. In M. Matzner & I. Wyrobnik (Eds.), *Handbuch Mädchen-Pädagogik* (pp. 220-232). Weinheim Beltz.

Marx, D. M., & Roman, J. S. (2002). Female Role Models: Protecting Women´s Math Test Performance. *Personalitiy and Socal Psychology Bulletin*, 1183-1193.

Nosek, B. A., Smyth, F. L., Sriram, N., Lindner, N. M., Devos, T., Ayala, A., . . . Greenwald, A. G. (2009). National differences in gender-science stereotypes predict national sex differences in science and math achievement. *Proceedings of the National Academy of Sciences of the United States of America, 106*(26), 10593-10597. doi:10.1073/pnas.0809921106

OECD. (2015). *The ABC of gender equality in education: aptitude, behaviour, confidence*: OECD Publishing.

Owens, J., & Massey, D. S. (2011). Stereotype threat and college academic performance: A latent variables approach. *Social Science Research, 40*(1), 150-166. doi:10.1016/j.ssresearch.2010.09.010

Paechter, M., Jones, G., Tretter, T., Bokinsky, A., Kubasko, D., Negishi, A., & Andre, T. (2006). Hands-on in science education: Multimedia instruction that is appealing to female and male students. In D. Grabe & H. Zimmermann (Eds.), *Multimedia Applications in Education* (pp. 78-85). Graz: FH Joanneum.

Prenzel, M., Reiss, K., & Hasselhorn, M. (2009). Förderung der Kompetenzen von Kindern und Jugendlichen. In J. Milberg (Ed.), *Förderung des Nachwuchses in Technik und Naturwissenschaft.Beiträge zu den zentralen Handlungsfeldern.* Heidelberg: Springer.

Schlag, B. (2006). *Lern- und Leistungsmotivation* Wiesbaden: VS Verlag für Sozialwissenschaften.

Schwarze, B. (2010). Einflussfaktoren auf das Technikinteresse von Mädchen und jungen Frauen. In M. Matzner & I. Wyrobnik (Eds.), *Handbuch Mädchen-Pädagogik* (pp. 256-268). Weinheim Beltz.

Steinmayr, R., & Spinath, B. (2009). The importance of motivation as a predictor of school achievement. *Learning and Individual Differences, 19*(1), 80-90. doi:10.1016/j.lindif.2008.05.004