Motivational factors in female senior secondary students: Staying and thriving on the technology education pipeline

Author

Knopke, Vicki, Leon de la Barra, Bernardo

Published

2013

Conference Title

PATT27: Technology Education for the Future: A Play on Sustainability

Version

Version of Record (VoR)

Motivational Factors in Female Senior Secondary Students: Staying and Thriving on the Technology Education Pipeline

Vicki Knopke and Bernardo León de la Barra
Griffith University
Australia
vicki.knopke@griffithuni.edu.au

ABSTRACT
Learning is an active process that functions optimally when student's motivation is autonomous. This paper will critique elements of motivation that impact on students' engagement in technology education subjects with an emphasis on female students in senior secondary years of schooling.

After defining technology education and motivational factors, the critique will examine elements identified by various authors as those which motivate modern day youth to engage in non-compulsory education. In fact, the origins of personal and group motivation need to be explored in terms of how youth utilise self-values to engage in practices that schools program for them. Of particular interest are the steps taken by schools to engage females in technology centred programs. Australian data show that young female learners are not articulating through to maths, science, or technology classes and in turn not enrolling in tertiary courses such as Engineering.

The critique takes a feminist constructionist view and will draw on research undertaken in senior secondary schools in 2013. Earlier studies have claimed that the artefacts to be made and freedom of choice in the learning process had the most effect on the motivation of students as participants in technology education. For some students these elements have affected their intrinsic motivation by expanding their reflectivity and feelings of autonomy. By providing an apparent freedom of choice in materials, techniques, and products to be made, student motivation appears to rise.

In examining the research studies on what motivates youth - values are seen to be inextricably linked to the interests and motivation of both individuals and groups. Thus, values will be explored in the context of educational settings of students in the secondary years, with a focus on Technology education.

The implications of the findings in the paper will provide practitioners with strategies to alter the ecology of classrooms for female participants in technology education programs in the long term. Those strategies are not about plugging the leaks in the pipeline, but rather about building a gendered pipeline where girls feel at home doing technology regardless of whether their school or class is co-educational or single-sex.

Keywords: Technology education, motivation, females, youth.

INTRODUCTION

This paper explores elements of motivation that impact on students' engagement in technology education subjects. It is posited that learning functions optimally when students' motivation is an active and autonomous process. The focus stems from a current research study on factors that influence the participation of female students in the senior secondary years of schooling (Knopke, 2012).

In examining elements which motivate modern day youth to engage in non-compulsory technology education the origins of personal and group motivation have been explored in terms of how youth utilise self-values to engage in technology education practices that schools program for them. Of particular interest are the steps taken by schools to engage females in technology centred programs. Australian data, in line with European data, show that young female learners are not articulating through to maths, science, or technology classes into STEM (Science, Technology, Engineering and Maths) related tertiary fields (Boe, Henriksen, Lyons, & Schreiner, 2011; Engineers Australia, 2012). Despite long term goals of educators, females are still not enrolling in senior secondary technology courses that will lead to tertiary courses such as Engineering, Mathematics or Technology Studies. The figurative pipeline mentioned earlier refers to the point where students commence in technology education and then continue to engage along a continuum of studies related to technology education with a view to a post school pathway. Given that all students in lower secondary high school (Years 8 and 9 in Queensland), participate in some studies in technology female students need to be encouraged to remain in this learning pipeline and to thrive to reach senior secondary levels and beyond.

Technology has been defined as the innovation, change or modification of the natural environment to satisfy preconceived human needs and wants (International Technology Educators Association (ITEA), 1996, 2006). Technology education encompasses all subjects that have design processes as the key learning activity. In the Australian context subjects such as agriculture, business studies, industrial arts and design, graphics, home economics, hospitality, information and communication studies, technology studies, engineering studies, fall into this definition. Whilst there is currently much debate surrounding the term it links to past and present syllabus practice in the Australian education system.

ACARA (Australian Curriculum Assessment and Reporting Authority) currently developing the Technologies syllabus for Australia requires that students engage in technological capabilities and with technological and computational thinking (Australian Curriculum Assessment and Reporting Authority, 2012). Less of a definition, but rather a concept which is not centred on objects but focussed on capabilities those students will achieve.The social constructionist view used in this paper is defined by Shotter and Gergen (1994) in Potter (1997).

[Social constructionism] has given voice to a range of new topics, such as the social construction of personal identities; the role of power in the social making of meanings; rhetoric and narrative in establishing sciences; the centrality of everyday activities; remembering and forgetting as socially constituted activities; reflexivity in method and theorising. The common thread underlying all these topics is a concern with the processes by which human abilities, experiences, common sense and scientific knowledge are both produced in, and reproduce, human communities.

A feminist constructionist stance which sees gender as a construct that is not created by nature as a result of biology but rather created by and contingent on social and historical processes (Oldenziel, 2003; Stanley, 1993). To prepare students for the future, technology educators must seek alternative ways to conceptualize their subject matter to reach the diverse population of citizens in society (Wright, 1992). Technology educators must rethink the way in which they legitimize the knowledge of technology education for students in order to meet their needs and

wants. Wright, stated, the social commitment must legitimize the principle of difference, to encourage and multiply different kinds of people and positions and values for their own sake, within the bounds of social order. It is through the legitimacy of difference that new and necessary forms of rationality will emerge and a motivation to engage will occur.

In examining the literature on what motivates youth - values will be explored in the context of educational settings of secondary school students, with a focus on Technology education.

MOTIVATION THROUGH VALUES

Motivation is defined in the broadest sense as 'the process whereby goal–directed activity is instigated and sustained' (Pintrich & Schunk, 2002). Values, argues Rokeach have a motivational function: to guide human activity in daily situations, their more long-range function is to give expression to basic human needs. Values' components include motivational, cognitive, affective and behavioural elements. Instrumental values are motivating because the idealised modes of behaviour they are concerned with are perceived to be instrumental to the attainment of desired end goals. Terminal values are motivating because they represent goals beyond the immediate, biologically urgent goals. They are the conceptual tools that we employ to maintain and enhance self-esteem (Rokeach, 1973). Terminal and instrumental values are relevant when considering types of behaviour students engage in in classrooms.

Values that are internalised as a result of cultural, societal, and personal experience are psychological structures that, in turn, have consequences of their own (Rokeach, 1973). Values are determinants of all kinds of social behaviour – of social action, attitudes and ideology, evaluations, moral judgements and justification, comparisons and presentations of self and others, and attempts to influence others. Klapwijk and Rommes (2009) note values in their use of the phrase 'career anchors'.

A person's actions may then vary depending on the priorities they place on social and personal values. Their actions will vary depending on whether their social or personal values have priority. An increase in one value may see a decrease in the opposite, e.g., social or personal. Personal values arise from participants in relation to their learning within technology classrooms and about artefacts that students interact with on a daily basis. Terms such as personal and social ambition, self-control, capability, imagination and independence can be identified by participants in terms of which aspect motivates them to succeed. Pavlova & Turner (2007) examined the critical issue of values in technology education and discussed the design process as a starting point for internal and external values. Custer (2007) argues that values and technology are intimately connected.

In the modern world, it has become virtually impossible to disentangle technology, in its variety of forms from ethical implications. Ethics and values shape and drive demand of new technologies. New technologies in turn mirror and reflect what we value. The two have become inextricably woven together (Custer, 2007).

A value system is thus defined as an enduring organisation of beliefs concerning preferable modes of conduct or end states of existence along a continuum of relative importance. Values, like all beliefs have cognitive, affective and behavioural components.

FEMINIST CONSTRUCTIONIST VIEW

This paper takes a positivist perspective in unearthing the voices of females in technology education. Modern socio-cultural liberal feminism and awareness of gender issues enables young women to move past their historic roles in society to achieve some degree of equality in learning. It is awareness and a willingness to achieve that is sustaining a change in the state of the technology education pipeline.

Socio-cultural approaches to learning provide instruction which recognizes and empowers linguistically and culturally diverse students. Socio-cultural theory describes learning as distributed, interactive, and contextual and the result of a learner's participation in a community of practice. The collaboration of thinking that results from these processes opens up access to research data on thought processes and provides avenues to uncover distinguishing characteristics that can lead to change and transformation.

Learning within a techno-social sphere may be the best environment for females. Bijker (1995) claims that there is a process of closure, reflecting on aspects of technical change and stability over time which shows that everything can fit into a technological frame comprising of knowledge, goals, and values as well as artefacts (Bernstein, 2003 ed.).

Postmodernist theories such as Wright's feminist theories encourage diversity in their view (Wright, 1992). Feminist theories, like other forms of postmodernism, encourage us to tolerate and interpret ambivalence, ambiguity, and multiplicity as well as to expose the roots of our needs for imposing order and structure….If we do our work well, reality will appear even more unstable, complex, and disorderly than it does now (Flax, 1990). Both postmodern and feminist theories point to diversity as a direction for the future and can provide some of the ideology for technology educators' avoiding a restricted cultural view and creating change in the profession (Zuga, 2007).

The research of Zuga (2007) and Wajcman (2004) has examined the stigma of artefacts and highlighted the sociotechnical constructivist approaches born of but modified from social studies of technology. It was the characterisation of Wacjman's 'techno-feminist' which represented a major development in theorising the gendered character of technology. Haraway's cyborg-feminists and socialist feminist inquiry was pivotal in exposing the gender blindness of main stream techno-science studies in order to show the possibilities this area offers women and how they could strategically engage with techno science (Wajcman, 2004).

Recent studies have claimed that the artefacts to be made and freedom of choice in the learning process had the most effect on the motivation of students as participants in technology education (Boe et al., 2011; Thaler & Zorn, 2010). Authors such as Campbell and Jane have demonstrated that for some students, elements of individual choice have affected their intrinsic motivation (2012). By expanding the amount of internal feedback, their feeling of high levels of autonomy, choice and self-direction, providing an apparent freedom of choice in materials (autonomy), techniques, and products to be made, student motivation appears to rise through more active engagement and a willingness to persist. Similarly, Autio (2013) claims self-confidence and expectations for success give value to the options available to females in technology education today.

In order to bring about change the approach must be to raise the consciousness of gender and the feminist uses of the construction of ideas and the delivery of programs in the broad area of technology education. Biological differences between sexes do not determine gender, gender attributes, or gender relations. Gender, is a constitutive social construction, a social category whose definition makes reference to a broad network of social relations, not anatomical differences (Durack, 1997; Haslanger, 2005). Motivation can be championed through pedagogy that suits not just girls but many boys who are themselves not a single homogenous group (Klapwijk & Rommes, 2009).

In exploring the perceptions held by students, Technology education continues to be perceived as masculine in nature, procedural in delivery and lacking conceptual dimension. Such an enduring perception serves to restrict female interest in the subject (Dakers, Dow, & McNamee, 2009). Similarly, Klapwij & Rommes (2009, 406) note the problem with stereotypes - *that women prefer working with people and men with things – that if we repeat it often enough it becomes the norm….. Repetition makes it impossible to loosen the unilateral connections….*

Research studies suggest that motivation can be raised through addressing technology education as a positive concept which they (females) come into contact with often and hence develop skills and knowledge. Frequency of exposure and role models can be the link between Technology and femineity (Dakers et al., 2009; Kolmos, Mejlgaard, Haase, & Holgaard, 2013). Wacjman (2004) would say this links back to a masculine definition of technology.

MOTIVATIONAL STRATEGIES AND GENDER

The following provides strategies for increasing participation of female students through early observations of research undertaken in high schools in 2013.

SOCIAL VALUES

Women are attracted to careers that help and work with people and enact communal goals. If females are provided with more knowledge of how careers in the STEM fields could be a vehicle to enact altruistic goals and values, they could be prepared to go along the STEM pathway (Colvin, Lyden, & León de la Barra, 2013). Social values are ranked highly by female students. Research in secondary schools in Queensland has shown that values can and do motivate students in technology education classes. Internal and external values as noted by Pavlova and Turner come into play at different points of learning for students (2007). Instrumental values meant more for students starting in Technology education classes. Learning for fun or for life skills was important to begin with. As students matured over time the terminal values of life and career goals came into play and the purpose for participating in technology education changed. Driven by internal values students were self-motivated to achieve in order to reach their end goal.

SELF-EFFICACY

Self-efficacy is a second strategy in motivating female students in technology education. A belief that one has the capabilities of exercising courses of action to manage certain situations has been seen as a positive predictor of achievement in task specific goals and success for women in non-traditional career areas. Cognitive and metacognitive skills focussing on self-efficacy provide motivation to learn. Marra, Rodgers, Shein & Bogue (2009) examined positive outcomes that were achieved with women to understand student satisfaction, achievement and ultimately, retention in engineering programs. Influencing environments, in turn sustained persistence and enabled mastery experiences in complex design projects via strategies of instructional demonstrations and encouragement. Positive success leads to long term participation.

LEVEL OF CHALLENGES

Self-regulation and the level of challenge females set themselves, the amount they mobilise and persist in the face of difficulties comes back to level of self-efficacy, confidence and support provided by both peers and teachers. Ultimately their achievement in the design task was the motivational factor.

PROCESS OR PRODUCT

The process of transmission of technology, the use of aids and the pedagogic interest which an artefact or object creates can be questioned in terms of a balance point of view with regards to gender (Chatoney & Andreucci, 2009). Process or product can make a difference to the motivation of girls. Not all teaching devices are viewed as neutral and females are more sensitive than males to study aids; they will use more creativity and inventiveness and take more risks than boys on items they are familiar with. Perhaps there could be a reuniting of girls with Technology through changing approaches. Feminising the pedagogy with habitat, clothes, inventive and creative skills, and informal learning interactions may in the long term attract more females.

ONE FOR ALL- ALL FOR ONE

One school in the 2013 research study motivated students to a higher degree than others (Knopke, 2012). Competition to gain entry into the technology education classes began in Years 8 and 9. Students were taught to excel via an encompassing school culture. The essence of achieving was to not only gain great personal results but to uphold those averages of all the fellow students in a year cohort and keep the school as an academic entity. A discussion with one boy was about his potentially letting the cohort down and how hard he needed to work not for himself, but for his peers. His determination demonstrated how important this was as a motivational factor for students to produce high quality work. The self-efficacy notions of Marra, Rodgers, Shein & Bogue (2009) have proved through the early research study to stand true in what remains a non-traditional area of learning.

In elaborating on the early findings from the current study, terminal values and career aspirations were a key factor that motivated students in the classes. The second factor that heightened participation and, in turn, motivation was choice of design tasks. Freedom to select what an artefact would look like was important to the students. Once the female students made a design choice they were rarely swayed from that decision. Once they understood the task they are able to project manage, plan and then execute the task. This does not imply they personally completed all the steps but they are able to plan to have them done to reach an outcome.

The pedagogical approach of the teacher in the context of the classroom ecology was the third factor that motivated the female students. A relaxed working atmosphere where students shared ideas, learned from one another, and collectively solved design problems added to the independent drive of students in the classes that were observed.

CONCLUDING REMARKS

The implications of the early findings send a message to practitioners. There are strategies to alter the ecology of classrooms to accommodate female participants in technology education programs. This paper has shown through current empirical and theoretical research that strategies to promote female participation involve long term planning, short term immediate support and constructionist considerations.

The short term strategies are important but it is the long term planning and human resource component that appears to be making key impacts on female participation and motivation in secondary schools. Role modelling, peer supportive environments, elements of choice and sustainability and the processes to achieve artefacts are the factors which will bring about further changes. The longer term strategies are about changing the phenomenon that is socio-culturally and psychologically rooted and constructed - 'Women need to be given the explicit message that technology, in all its aspects, is suitable for women' (Klapwijk & Rommes, 2009).

These strategies are not about plugging the leaks in the pipeline, but rather about building a 'gendered pipeline' where girls "feel at home doing technology".

REFERENCES

Australian Curriculum Assessment and Reporting Authority. (2012). Draft Shape of the Australian Curriculum: Technologies. Sydney: ACARA.

Autio, O. (2013). When Talent is not enough: Why Technologically Talented Women are not studying Technology. *Journal of Technology Education, 24*(2), 14- 30.

Bernstein, B. (2003 ed.). *Class Codes and Control, Volume IV Structuring of Pedagogic Discourse,* (Griffith on line. ed.). London: Routledge,.

Bijker, W. E. (1995). *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change*. Cambridge, Massachusetts: The MIT Press.

Boe, M. V., Henriksen, E., 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. doi: 10.1080/03057267.2011.549621

Campbell, C., & Jane, B. (2012). Motivating children to learn: the role of technology education. *International Journal of Technology & Design Education, 22*, 1 - 11. doi: 10.1007/s10798-010-9134-4

Chatoney, & Andreucci, C. (2009). How study aids influence learning and motivation for girls in technology education. *International Journal of Technology and Design Education, 19*, 393-402. doi: 10.1007/s10798-009-9094-8

Colvin, W., Lyden, S., & León de la Barra, B. (2013). Attracting Girls to Civil Engineering through Hands-On Activities That Reveal the Communal Goals and values of the Profession. *Leadership and Management in Engineering, 13*(35), 35-41.

Custer, R. L. (2007). Ethics in Technology *Analysing Best Practices in Technology Education* (pp. 139-151). Rotterdam/ Taipei: Sense.

Dakers, J. R., Dow, W., & McNamee, L. (2009). De-constructing technology's masculinity: Discovering a missing pedagogy in technolgy education. *International Journal of Technology Design Education, Netherlands, 19*, 381-391. doi: 10.1007/s10798-009-9099-3

Durack, K. T. (1997). Gender, technology, and the history of technical communication. *Technical Communication Quarterly, 6*(3), 249-260. doi: 10.1207/s15427625tcq0603_2

Engineers Australia. (2012). Inquiry into the Shortage of Engineering and Related Employment Skills,. In Senate Education Employment and Workplace Relations References Committee (Ed.), (pp. 16). Barton ACT: Engineers Australia.

Flax, J. (1990). Postmodernism and gender relations in feminist theory. In L. J. Nicholson (Ed.), *Feminism/postmodernism* (pp. 39-62). New York: Routledge.

Haslanger, S. (2005). What Are We Talking About? The Semantics and Politics of Social Kinds. *Hypatia, 20*(4), 10-26. doi: 10.1111/j.1527-2001.2005.tb00533.x

International Technology Educators Association (ITEA). (1996). *Technology for All Americans Project*. VA: Reston, .

International Technology Educators Association (ITEA). (2006). *Technological Literacy for All: A rationale and structure for the study of Technology* (2 ed.). Virginia: International Technology Education Association.

Klapwijk, R., & Rommes, E. (2009). Career orientation of secondary school students (m/f) in the Netherlands. *International Journal of Technology and Design Education, 19*, 403-418. doi: 10.1007/s10798-009-9095-7

Knopke, V. M. (2012). Gender and Technology Education: Some theoretical implications. In H. Middleton (Ed.), *Explorations of best practice in Technology in Design & Engineering Education* (Vol. 2, pp. 1 - 8). Australia: Griffith Institute for Educational Research.

Kolmos, A., Mejlgaard, N., Haase, S., & Holgaard, J. E. (2013). Motivational factors, gender and engineering education. *European Journal of Engineering Education, Netherlands, 38*(3), 340-358. doi: 10.1080/03043797.2013.794198

Oldenziel, R. (2003). Why Masculine Technologies Matter. In N E Lerman, R Oldenziel & A. Mohun (Eds.), *Gender and Technology* (pp. 37-71). Maryland: Johns Hopkins University Press.

Pintrich, P., & Schunk, D. (2002). *Motivation in Education, theory, research, and applications* (2 ed.). New Jersey: Merrill, Prentice-Hall International.

Potter, J. (1997). Discourse analusis and constructionist approaches: theoretical background. In J. T. E. Richardson (Ed.), *Handbook of Qualitative Research Methods for Psychology and the Social Sciences* (2 ed., pp. 125- 140). Leicester: BPS Books.

Restivo, S., & Croissant, J. (2008). Social Constructionism in Science and Technology Studies. In J A Holstein & J. F. Gubrium (Eds.), *Handbook of constructionist research* (pp. 213-229). USA: Guilford Press.

Rokeach, M. (1973). *The Nature of Human Values*. New York: Free Press.

Stanley, A. (1993). Mothers and Daughters of Invention: Notes for a revised History of Technology,. In Hopkins (Ed.), *Sex/Machine*. Bloomington: Indiana University Press.

Thaler, A., & Zorn, I. (2010). Issues of doing gender and doing technology - Music as an innovative theme for technology education. *European Journal of Engineering Education, 35*(4), 445-454. doi: 10.1080/03043797.2010.490578

Wajcman, J. (2004). *TechnoFeminism*. Cambridge, UK: Polity Press.
Wright, W. (1992). *Wild knowledge: Science, language, and social life in a fragile environment*. Minneapolis: University of Minnesota.
Zuga, K. (2007). STEM and Technology Education. *White Paper written for ITEA*, 6. Retrieved from https:/iteea.org/mbraonly/library/whitepaper/STEM(Zuga)pdf website: