Lifelong mathematics learning – a threat or an opportunity? Some remarks on affective conditions in mathematics courses.

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Abstract

In the last decades of the 20th century lifelong learning became a key concept for solving social and economic problems in highly industrialized countries. Lifelong learning was the societal response to conditions in a rapidly changing economic world. Humans have always learned in the normal course of their lives, but this learning was informal. Modern conditions require formal education in formal courses with a controlled output. In many reports by international organizations lifelong learning is seen as a necessity and also as an opportunity for adult learners. But does this picture reflect the affective situation of all adults in mathematics courses? Many adult learners in mathematics courses are unemployed, and instead of being willing participants, they were forced into courses which include mathematics as a compulsory component. They have not chosen to participate in a learning program. This paper discusses the motives of adult learners for pursuing mathematics courses, as well as their emotional state in these courses, by using the results of a previous empirical study of the state of mathematics education within the Austrian adult education system.

Key words: Lifelong learning, participation, cognitive, affective, basic skills, motivation, Austria.

Lifelong learning – a consequence of technological development and globalisation?

For a long time, only philosophers and pedagogues discussed lifelong learning (Aspin, Chapman, Hatton, & Sawano, 2001). In the final decades of the 20th century, lifelong learning became a key concept in solving social and economic problems in highly industrialized countries. International bodies such as UNESCO, the OECD and bodies within the EU declared that education has to be a lifelong undertaking (Aspin et al., 2001; FitzSimons, Coben, & O'Donoghue, 2003). That means that education could no longer be considered as a process that finishes at the beginning of adulthood, and adults could no longer be considered experts in their job based only on the competencies acquired in their youth. To understand this development we must understand the power of change and its driving force.
Highly industrialized countries are characterized by the use of technologies because technology determines the structure of society (the philosopher Heinz Hülsmann uses the term

"technological formation" (Hülsmann, 1985)). While Hülsmann emphasizes the significance of the natural sciences for the development of technologies, it is important to note that the technological formation of our society is also a consequence of other sciences, particularly the social sciences and economics (Schlöglmann, 1992). That means that research leads to technological development and consequently to a change in competencies required to fulfil the demands of the technological change.
Lifelong learning was the societal solution to conditions arising from rapid economic and technological change. Lifelong learning, according to this view, has various functions:

> [We] suggest that lifelong learning policies currently introduced across the globe could be classified into four categories: (1) a compensatory education model, which aims at compensating for inequality in access to initial school education, and improving basic literacy and vocational skills; (2) a continuing vocational training model, which aims at coping with changes occurring in the workplace and solving problems arising from unemployment; (3) a social innovation model, or civil society model, which aims at overcoming social estrangement and promoting socio–economic transition and democratization; (4) a leisure orientated model, which aims at enriching the leisure time of individuals and personal fulfilment. (Aspin et al., 2001, p.XXII)

The concepts embodied in these four categories address the problem of lifelong learning and its role within a society in a very general way. Within specific nations and societies, these four categories are realized in a variety of ways. It should also be kept in mind that even in highly industrialized countries – which are the focus of the present paper – the context for lifelong learning can be very heterogeneous. Although in industrialized countries, too, a need exists to eliminate inequalities in education and improve basic literacy and vocational skills, there are nevertheless distinctions that ought to be made: for instance, between people who have passed through the education system with a low level of achievement and people who have emigrated to these highly industrialized nations from countries with a weak education system (Note: At least in Austria many refugees from war or political persecution come from countries with a strong education system). Moreover, in economically advanced countries, more people want a higher level of education.
When authorities speak of lifelong learning, they usually have in mind the continuing vocational training model:

> This economic justification for lifelong learning is highly dependent upon two prior assumptions: one, that 'lifelong education' is instrumental for and anterior to some more ultimate goal; and secondly, that the purpose of lifelong learning is highly job related and economic–policy–dependent. This approach, as we have seen from discussion at the OECD (1996), UNESCO (1996), the European Parliament (1995) and the Nordic Council of Ministers (1995), has now been rejected as presenting too narrow and limited an understanding of the nature, aims and purpose of 'lifelong education. (Aspin, et al., 2001, p.XX).

From the point of view that lifelong learning is a means of coping with the consequences of technological development and globalisation - bearing in mind that governments and supra-national bodies often resort to rhetorical set phrases when referring to lifelong learning (FitzSimons et al., 2003) - we must extend the concept of lifelong learning to encompass the needs of people in a democratic society. The concept of lifelong learning ought to be seen as a social innovation model or civil society model that stresses structural and political aims. This concept is often called “critical citizenship” and means “engagement with discussions and debates about individual, family and public well-being, and about describing, appreciating, evaluating, deciding on future directions of public policy” (Evans & Thornstad, 1994, p.65).
While the third category introduced by Aspin, et. al. (2001) in the quotation above emphasizes people as social beings (the social innovation model), the fourth category (the leisure model) emphasizes the individual side of people.

In order to account for all of these aspects of lifelong learning, Aspin and Chapman (2001) in another paper mention three elements that are necessary in lifelong learning:

> The central elements in what we have described as the 'triadic' nature of lifelong learning – for economic progress and development; for personal development and fulfilment; for social inclusiveness and democratic understanding and activity – are now seen as fundamental to bringing about a more democratic policy and set of social institutions, in which the principles and ideals of social inclusiveness, justice and equity are present; and a richer range of provision of those activities on which individual members of society are able to choose to spend their time and energy, for the personal rewards and satisfactions that they confer. (Aspin & Chapman, 2001,p.29)

This quotation expresses an important point. Lifelong learning is often seen as institutional organized learning, repressing the fact that life and work is always combined with learning. But this kind of learning – learning in context, "situated learning", workplace learning – is not the focal point when one speaks of lifelong learning. Consequently democratic societies ought to broaden the scope of institutional learning, and thereby create more opportunities for adults to pursue further education.

Why lifelong learning of mathematics?

Present discussion of lifelong learning does not generally address the role of content. Rather, the focus is usually on catch-phrases such as globalisation and technological development, particularly in information technology. One may therefore ask, why should the lifelong learning of mathematics be a viable option? To answer this question, we have to look at the role of mathematics in society and technology.

> 1. Mathematics in our society is a tool used to organize our everyday life. Mathematics is also used as a tool in many occupations. The use of mathematical black boxes in the form of computer programs gives them a new quality.
>
> 2. Mathematics is a part of our culture. Democratic principles such as equality, justice and so on need an operational concretization. On the one hand, democracy demands a means for communicating and discussing principles in a rational way. Mathematics, with its close relationship to rationality, is our concept to do this. On the other hand, democracy demands operational procedures for its concrete implementation. Mathematics is again the tool that facilitates this. (Schlöglmann, 2002, pp. 143-144).

This quotation stresses the significance of mathematics in the democratic organization of our society as well as in everyday life. But this was also the significance of mathematics in earlier times. If mathematics is to become an important part of lifelong learning today, the teaching of the subject must reflect the new demands of our time. Analyzing this situation, mathematics also has a central role in the development of new technologies and this role gives mathematics a central position in processes occurring in highly industrialized countries (Schlöglmann, 1992, 2002). Briefly, we can say:

> Mathematics is the basis of all new technologies, since algorithms are the basis of software, and materialized mathematical logic is the basis of computer hardware (microprocessors).
> Mathematical theories and models are becoming increasingly important as the basis of a variety of forward-looking alternatives, in simulating planning in economic and technical fields, for example, in control, automation and construction; or in political and social life.
> Mathematics has long been established as the scientific core of the natural sciences and, to an increasing extent, also of social science. (Maasz & Schöglmann, 1988)

This characterization opens the way to understanding the meaning of mathematics in the lifelong learning concept. In the light of the categories of lifelong learning given in the "triad" of Aspin and Chapman (2001), the role of mathematics in lifelong learning may be taken to be the following:

- As the basis of new technologies, mathematics is central to economic progress and development.
- Mathematics is used to structure our everyday life and democratic processes, and is therefore a necessary precondition for social inclusiveness and democratic understanding and activity.
- As part of our cultural development, mathematics can also be valuable for personal development and fulfilment.

An empirical study

In the above two sections, I have argued on theoretical grounds that lifelong learning in general, and lifelong mathematics learning in particular, is important for the functioning of highly industrialized societies. But it is the "reality" of lifelong learning that is important for research and practice. Hence, between 1993 and 1997, Jungwirth, Maasz and the present author explored the state of mathematics education within the adult education system in Austria (Jungwirth, Maasz, & Schlöglmann, 1995). Adult education in Austria is characterized by the diversity of agencies offering programs: state-run institutions of adult education; community services; services for vocational education run by the trade union or by the federation of industry; universities; industrial enterprises; and the education departments of public or private service enterprises. This diversity is also reflected in the numerous courses and programs on offer, in mathematics as in other subjects. In our empirical study, we distinguished between the courses according to whether mathematics teaching explicitly took place or whether mathematical concepts and methods were used in an implicit way (for instance, in courses in CAD (computer-aided design), Excel or other computer software). Furthermore, courses could also be distinguished by the level of mathematics (basic, upper secondary or university) as well as whether they were part of general education or vocational education. To explore the state of adult education in mathematics (this part of the research was done by Jungwirth) we selected 419 participants (80.5% men and 19.5% women) from 19 courses at 7 institutions within the Austrian adult education system. In all of the courses, mathematics was either explicitly or implicitly included, and the courses ranged from basic (10.3% of the participants) to upper secondary level (36.3%) and vocational education (53.4%). The extensive questionnaire elicited each participant's personal data including sex, age, vocation and education, and contained questions characterizing the course of study, the institution, as well as the participant's attitude toward mathematics and school; their use of computers and mathematics at work; their motivation for participation; their appraisal of the value of further education; the goals and priorities of the course they were studying; the participant's learning problems; and suggestions for improvements in mathematics education. In the second part of the questionnaire, we asked for the participant's beliefs and attitudes toward mathematics. Besides the questionnaire for the participants, we also asked the teachers of the courses to answer another questionnaire with partly analogous questions. This quantitative part of the study was complemented by interviews with participants and teachers. Even though the data were collected between 1993 and 1997, they are still relevant today because the situation in adult education in Austria has not changed; moreover, the state of adult education in mathematics is more stable than in other subjects. Mathematics teaching in adult education courses and in schools for adults has a high level of

stability. Although the responses to some of the items are correlated with economic factors (we elaborate on this below), the categories are still relevant.
In the present paper, we only refer to a small portion of the results of the study, namely those pertaining to the motivation for participation in an adult education course and to the individual's attitudes toward mathematics and mathematics learning.

Results

After investigating the data from the survey, we found that the frequencies were correlated with the year the questionnaire was administered, as well as with the type of adult education the participants were engaging in. For example, the low response for the motive, "job threatened", can be accounted for by the rosy state of the labour market at the time. (In 1993, the Austrian labour market was strong with low unemployment.) Also, participants in basic programs cited "improvement of personal education" (74.4%), "increased vocational demands" (62.8%), "joy of learning new subjects" (60.5%) and "to cope with life problems" (48.8%) as their main motives for taking adult education courses (Table 1). It should be noted that in interviews, some of these participants cited their own physical condition and the necessity to prepare for a new job as their main reasons (many were undertaking vocational training because they had to change jobs for health reasons); however, this category did not appear in the questionnaire. In contrast, the motives profile of the vocational education group consisted of "acquisition of latest professional knowledge" (62.9%), "increased vocational demands" (57.9%), "improvement of personal education" (57.9%) and "security in economically unstable times" (48%).

To get a better insight into the structure of participants' motives, principle component analysis was used to extract the factors of motivation (explained variance 63%). The results showed four significant factors at work in motivating the participants to take part in adult education courses. The first factor was "professional and economic advancement" and includes preparation for a better position as well as protection of the position already attained. The second factor was "personal motives" such as the desire for more knowledge, as part of the individual's general thirst for knowledge. The third factor was "general professional performance orientation", which means that the participants considered their job to be significant to a greater degree than usual. The fourth factor was a "change in job", the change being either an aspiration or a forced move.

Table 1. *Percentage of students who agreed with nominated motivation for participation in adult education* (n = 419)

Motivation for participation in adult education	Completely agree	Partially agree
Job threatened	6.5%	8.2%
financial gain	42.1%	30.3%
increased vocational demands	51.9%	21.4%
security in economically unstable times	43.0%	26.9%
dissatisfaction with job conditions	20.9%	21.2 %
higher position in the company	41.1%	23.1%
acquisition of latest professional knowledge	57.0%	22.8%
changing scope of duties	30.0%	26.7%
improvement of personal education	65.1%	21.2%
to cope with life problems	24.3%	19.5%
Joy of learning new subjects	54.6%	32.2%

In order to obtain a better understanding of participants' motives, it was fruitful to consider their opinion of the value of Higher Education (Table 2). As a word of explanation about this issue, we should say that the concept of “Bildung” has a long history in the German educational tradition. “Bildung” means more than "education" in a narrow sense. An individual that is “gebildet” not only has knowledge and the ability to acquire new knowledge, but he or she is also able on the basis of this knowledge to develop their inner abilities to the full extent (see Klafki, 1975). The significance of Higher Education (höhere Bildung) in German tradition can give a better insight into the participants' motives.

Table 2. *Percentages of students who agreed with nominated value of Higher Education* (n = 419)

The value of Higher Education lies in	Completely agree	Partially agree
increasing one's reputation	29.3%	32.0%
understanding society better	48.1%	26.7%
increasing one's job opportunities	78.1%	15.4%
earning more money	57.0%	27.6%
understanding political affairs better	23.6%	33.4%
living more consciously	27.9%	27.2%
organizing leisure time better	14.7%	20.2%

Principle component analysis was also used here to extract the independent factors (explained variance 70%). The results suggested a model with three factors: the value of Higher Education lies in (1) its effect on vocational advancement, financial security and personal prestige; (2) its potential for personal development; and, (3) its contribution to a better understanding of society. We can see that these factors – explaining the value attached to Higher Education by the participants – are similar to the factors of the participants' personal motives. A closer look at the data showed that more men value Higher Education for its

improvement of financial security than women (59.1% versus 48.1%). People with a lower level of education prefer Higher Education's potential for personal development, while younger people prefer its contribution to a better understanding of social and political conditions.

Regarding the mathematics content in the participants' courses, we found that in many cases adults did not have any choice in studying the mathematics component. For instance, if a participant desired to acquire a certificate for completing a lower secondary or a upper secondary school, they had to study mathematics as part of the program. Therefore, in order to understand the learning conditions experienced by adults in their further studies in mathematics, it was of interest to know their attitude toward their past experience in mathematics education at school, as pupils. A heterogeneous picture emerges:

- Interested in mathematics in school (57.7% yes, 37.7% no)
- Had ability in mathematics in school (50.2% yes, 42.5% no)
- Good rapport with mathematics teachers at school (60.3% yes, 30.3% no).

The correlation between interest and claimed ability is high ($r = 0.63$). Those who were interested in mathematics had no problems with mathematics (75%) and had good rapport with teachers (72.9%).

Regarding the adult education system in Austria, two groups with very different motives and personal situations could be discerned. Members of the larger group chose to participate in adult education, and viewed learning as an opportunity to increase their chances in the labour market, to raise their prestige and so on. They were highly motivated to learn. They usually had a positive recollection of their school experience. Members of the other group, in contrast, had been compelled to participate in adult education (in many cases they had lost their job or they had to change their job on health grounds). The existence of this group did not emerge from the data of the questionnaires (we had not asked the right questions to identify this group), but from the interviews with the participants as well as the teachers: from these we received hints as to the problems these adult learners faced. The number of persons for whom these conditions were relevant depends strongly on the state of the labour market. However, the existence of this group is not a specifically Austrian problem – see the paper by Wedege & Evans (2006), who consider the problem of adult learners who had a resistance to learning in childhood schooling.
Mathematics learning is not just a cognitive process. Mathematics education research in the last few decades has addressed the influence of affect on mathematics learning. While most of the research has been carried out in the areas of student and teacher education, beliefs and attitudes in relation to mathematics are very important factors which influence mathematics learning, particularly in adult learning (see also Evans (2000)). From narratives given by adult learners in particular, we know that many adults had negative experiences with mathematics learning in school (see Ingleton & O'Regan, 2002; Stroop, 1998; Adults Learning Mathematics Conference Proceedings). Hence below we consider influences on the emotional states of members of the second of the above two groups.

Must learn mathematics – some remarks on emotional influences

We ought to bear in mind that individuals who are forced into further education in order to prepare for a new job had originally lost their job, for instance, through an accident that incapacitated them, or because of company restructuring. Learning for a new job is not their decision, it is forced on them by circumstances. To understand the circumstances of such a person, we may use the concept of "situated learning" developed by Lave and Wenger (1991). This concept is applicable to many participants in Austrian adult education because most participants, after their compulsory schooling, are educated in companies as apprentices, while simultaneously – amounting to a much smaller proportion of their time – undertaking part-time studies at a vocational school. They acquire their qualification by working in companies, and therefore in most cases, at their previous workplace, they had been members of a "community of practice" (Lave and Wenger, 1991). In order to be accepted into such a community, a newcomer or apprentice must go through a long process of practice within the framework of legitimate peripheral participation:

> Viewing learning as legitimate peripheral participation means that learning is not merely a condition for membership, but is itself an evolving form of membership. We conceive of identities as long-term, living relations between persons and their place and participation in communities of practice. Thus identity, knowing, and social membership entail one another (Lave & Wenger, 1991, p. 53).

The goal of all learning processes amounts to becoming an experienced member of the community. Such a position requires numerous skills, experience of responsibility for various tasks, knowing codes within the community and so on. The result is a place within the community. A person is part of the community, part of the routine of a company (Schlöglmann, 2003). All of these together bestow a sense of prestige and of identity.

> Knowing is inherent in the growth and transformation of identities and it is located in relations among practitioners, their practice, the artefacts of that practice, and the social organization and political economy of communities in practice (Lave & Wenger, 1991, p. 122).

It is important to bear in mind that this kind of knowledge, together with the experience a person needs to gain a place within such a community, is often not explicitly and fully communicated. Therefore, acknowledgement of such knowledge is only possible within the community of practice, and is often without value outside the community because in many cases important parts of this knowledge are not transferable to other communities of practice.

For older people, in particular, the process of situated learning entails a confrontation. Although learning gives an inexperienced person the opportunity to gain experience – which is the process of reproduction of the community of practice - it has the further consequence of replacing older people by younger people:

> There is a fundamental contradiction in the meaning of newcomers and old-timers of increasing participation by the former, for the centripetal development of full participants, and with it the successful production of a community of practice, also implies the replacement of old-timers (Lave & Wenger, 1991, p.57).

Old-timers are replaced particularly keenly when experience is not valued by a company, and when they are perceived as inflexible and therefore unable to fit in with company restructuring. The upshot is a loss of self-confidence.

> I will argue that non-participation can take many forms – being an outsider, being a peripheral participant, or being marginalized – each with a different implication for the resulting identities. (Wenger, 1998, p.148)

Furthermore, many of these people have bad recollections of their time at school. Narratives give us an insight into these recollections (Ingleton & O'Regan, 2002; Stroop, 1998) and into their implications for mathematics learning. Taken together - loss of prestige and identity; marginalization of experience; low self-confidence; and low confidence in one's ability to learn mathematics as a consequence of the school learning experience - these influences make for emotional difficulties during new learning processes.

Is mathematics learning possible?

As argued above, learning in adult further education can be difficult. Successful learning often also requires motivation of learners by teachers, particularly learners who want to learn mathematics. Teachers in adult further education report anxiety and learning blockages in mathematics learning processes (see also Lindenskov, 1996 and Wedege, 1998). To understand learning better, we may use a model introduced by Hannula (1998). Hannula sees the "landscape of mind" continuously changing. The process of change is stimulated by information arriving from the senses, as well as by mechanisms and structures within the brain. One central principle of Hannula's model is the distinction between dynamic and static systems of representation. Dynamic representation includes all systems that are activated at a given moment. Static representation encompasses all the information stored in the memory systems of the various representational systems. The structure of each static representation – cognitive and affective schemata – is crucial for all processes. The schemata representing the static representations are changeable via learning processes. In all situations of interest to us, many brain systems are activated; in particular, so is a certain system that generates so-called “background emotions” (Damasio, 1999). We can observe these background emotions – if a person is discouraged or enthusiastic, down or cheerful – by interpreting physiological reactions called body language. Background emotions influence cognitive processes in a positive or negative way. Let me describe this through an example. In class, a teacher explains the solution method for solving equations in one variable; then he or she writes an equation on the blackboard. However, from the student's viewpoint, the information constituting the situation might be different. A successful student sees the different signs on the blackboard and grasps the principles – the structure of the terms – necessary to solve the equation. Another student who is not in a position to handle variables correctly might see the same equation as a set of signs with no structure. The student's fear, present as a background emotion during mathematics lessons, might be intensified, thus preventing the learning process from succeeding.

Teachers in adult education can help adult students manage their learning situation. Above, we have discussed reasons for negative background emotions. The student has lost his or her position as an experienced professional and this position is likely to have been a crucial part of their identity – now, like children, they have to learn new things. In many courses, adult participants have had no formal education since their school years. They often feel unable to learn, because their learning processes have occurred over a long time, whereas they recognize that mathematics learning requires intense processes of abstraction and generalization. A frequent consequence of this is a student's fear that his or her memory is unable to hold all the abstract concepts required. Formal learning often brings back memories of mathematics learning

in school and it is generally accepted that for many adults these memories are bad. It is important to impart onto the adult student the importance of their knowledge, in situated learning processes; to give them the feeling of having valuable knowledge at their disposal. Using situated knowledge as a starting point for mathematics learning processes is possible (Schlieman, 1999). Processes of abstraction and generalization must be done very carefully with resort to situated knowledge. Creating a successful learning process ought to include steps to help students better manage their fear (Goldin (2002) uses the term "meta–affect" to denote the process of monitoring and regulation of emotions) and to change their emotional background. However, it is important that students actually understand mathematics by doing real mathematics, and are not learning a diluted form of mathematics via what the present author calls “replacement strategies” (Schlöglmann, 1999). In the latter, the learner does not try to understand mathematical concepts because the learner thinks that he or she cannot understand mathematics. The learner looks for other strategies to solve a mathematical task; for instance, he or she might try to find a keyword in the text – such as "more", which might indicate that addition is required, or "fewer", which might mean that subtraction is required. Another strategy is to enter all the numbers contained in the text into the most recently learned algorithm. A characteristic of this replacement strategy is that the understanding of the mathematical concept and the analysis of a task with a mathematical flavour are replaced by strategies that have as an input non-mathematical features of the text.

Conclusion

Lifelong learning is one of the catchphrases that comes with globalization. International bodies in particular view lifelong learning as an appropriate answer to the demands of a rapidly changing labour market. The study presented here demonstrates that many adults view learning as an opportunity – an opportunity to improve their professional and economic positions and to secure their personal status within the companies and communities. These employees also see learning as an opportunity to make their lives richer, as well as a necessary prerequisite for participating in democratic life. Knowledge and possessing qualifications are important parts of these adults' lives.

However, current socio-economic conditions also lead to some adults feeling like losers amidst the present-day developments because they are unable to fulfil the demands made of them by the economy. The number of people belonging to this group is strongly correlated to economic trends. They are forced to participate in adult education courses and have not chosen to do so. They do it because they must. Many have had bad experiences learning at school and see adult education as a continuation of school learning. Mathematics in particular is often associated with negative memories, and so people try to avoid using mathematics in their everyday or vocational lives. This leads to a problematic affective situation in adult-educational mathematics courses.

In our study we were able to identify both these groups: the winners, with their positive attitude towards learning – including mathematics learning; and the losers, who view learning, especially mathematics learning, as a threat.

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