

Niels B. Dohn is assistant professor in science education at The Danish School of Education, Aarhus University. His research is about learning science in out-of-school settings, such as museums and zoos, with a special focus on students' interest and learning motivation.

NIELS BONDERUP DOHN

The Danish School of Education
Department of Curriculum Research
Aarhus University
nibd@dpu.dk

The formality of learning science in everyday life: A conceptual literature review

Abstract

The terms non-formal and informal are attributed to learning in everyday life by many authors, often linked to their interests in particular learning practices. However, many authors use the terms without any clear definition, or employ conflicting definitions and boundaries. An analysis of relevant literature revealed two fundamentally different interpretations of informal learning. The one describes formality of education at the organizational level, while the second describes formality of learning at the psychological level. This article presents a conceptual reconciling of these two perspectives. Based on a literature review, the educational modes of education are defined as discrete entities (formal, non-formal, and informal education), whereas formality at the psychological level is defined in terms of attributes of formality and informality along a continuum (formal ↔ informal learning). Relations to other well-established frameworks within the field of informal learning are discussed.

INTRODUCTION

Learning taking place outside formal education and training institutions is often referred to as informal or non-formal learning. Informal and non-formal learning has been the subject of educational and policy discussions for several years (Colley, Hodkinson & Malcolm, 2003). The educational discussion focuses on theoretical and empirical issues concerned primarily with learning outside educational institutions: everyday learning. The discussion focuses on the nature of informal learning and its claims to relative effectiveness compared to formal education, often linked with the supposed contrasts between everyday and more objective knowledge. The other discussion is political, in the sense that non-formal education has become a more frequent programmatic alternative for empowering underprivileged learners. In much of the Third World, non-formal education is often assisted in bringing educational services to a rapid growing population that could not be adequately addressed through schools that had to be built, equipped and staffed through a complex economic, managerial and political bureaucracy (Coombs & Ahmed, 1974; La Belle, 1982). There is another, very different, political imperative, as governments seek to promote policies focused on improving economic competitiveness and increasing social cohesion and inclusion (European Commission, 2001; 2007). In what follows, I focus explicitly upon the educational discussion and the ways in which issues of formality or informality is constructed.

Informal learning happens in everyday contexts as part of everyday life, but is also a key element of a discourse which has this everyday process as its 'subject'. Two main approaches can be discerned in the educational literature concerning informal learning. One of these focuses on learning that takes place in everyday life – for example at museum visit (Anderson, Lucas, & Ginns, 2003; Ash, 2003; Dierking, Falk, Rennie, Anderson & Ellenbogen, 2003; Ellebogen, Luke & Dierking, 2004; Falk, 2005; Falk & Dierking, 2000; Falk & Storksdieck, 2005; Griffin, 2004; Hein, 1998; Martin, 2004; Ramey-Gassert et al., 1994; Rennie & Johnson, 2004; Rennie & McClafferty, 1996; Wellington, 1990). The other, which runs parallel to this but sometimes overlaps, focuses on lifelong learning, especially learning at work, management development and the learning organization (Billett, 2002; Eraut, 2004; Garrick, 1998; Gorad, Fevre & Rees, 1999; Greenfield & Lave, 1982; Hager, 2001; Hodgkinson & Hodgkinson, 2004; La Belle, 1982; Livingstone, 2001; Malcolm, Hodgkinson & Colley, 2003; Marsick & Watkins, 1990; McGivney, 1999; Mockler & Spear, 1982; Sawchuk, 2008; Wain, 1987).

If one looks at the literature as a whole, many authors use the terms formal, non-formal and informal to distinguish between various forms of learning, but in ways that are often contradictory, in so far as they use differing definitions and selection criteria. Besides, many researchers and practitioners working in the field of learning science in museums think of learning environments as located along a continuum ranging from highly informal to highly formal. For example, some types of museums like science centres distinguish themselves from others by consciously aiming at being educative without being curriculum based as formal educational settings are. The issue of finding the most suitable location along the continuum to categorize a given real-life learning environment is difficult if not impossible, because a clear-cut definition of what constitutes formality and informality is lacking.

It is not possible to separate out informal/non-formal learning from formal learning in ways that have broad applicability or agreement. Although widely used, the terms informal, non-formal and formal learning have significant limitations because they artificially delimits efforts to describe the type of learning humans engage in daily – learning that occurs across a broad spatial and temporal context, both inside and outside of schooling. Seeing informal and formal learning as fundamentally separate results in stereotyping and a tendency for the advocates of one to see only the weaknesses of the other. Thus it is evident that there is a need for clarification of the formality of learning. I claim that it is more sensible to see attributes of informality and formality as present in all learning situations. These attributes are characteristics of learning to which writers commonly attach labels such as formal and informal. The challenge is to identify such attributes, and understand the implications of the interrelationships between them.

This article intends to clarify the ways in which the terms informal, non-formal and formal learning have been used to describe formality or informality of learning in everyday life. The article does not attempt to review or describe all available literature around informal learning. The purpose was to investigate relevant literature, and to clarify the meanings and uses of the terms formal, non-formal and informal learning. It should be made clear at the outset no attempt is made to do justice to the vast literature on learning in general. The article concentrates on writings that explicitly focus on issues of formality or informality.

METHODOLOGY

The research was conducted as a literature review in order to map the conceptual terrain around informal learning. The literature was found from database search (ERIC and PsychINFO), from which I examined wide range different positions, looking for factors and criteria used to identify differences between informal, non-formal and formal learning/education. The literature search was ceased when subsequent attempts seemed to reveal no new criteria, i.e. conceptual saturation. The analysis revealed that the search for clear agreed boundary criteria between informal, non-formal and formal learning was a chimera.

CRITERIA OF FORMALITY

How do we identify informal learning and distinguish it from formal learning? Which criteria can offer a plausible basis for identification? If we look at the research literature on lifelong learning, informal learning is often described as unstructured, non-intentional, incidental, random, ad hoc or in terms of being “caught, not taught” (Beckett & Hager, 2002; Billett, 2001, 2002; European Commission, 2001; Gorad et al., 1999; Hager, 2001; Hodgkinson & Hodgkinson, 2004; Marsick & Watkins, 1990). The distinction drawn here is between learning that is determined and initiated by the learner (informal) and learning that is designed with a view to meeting certain externally defined academic/subject requirements (formal). The distinction relates to the extent to which learning is the prime and deliberate focus of activity, as in schools; or whether the activity has another prime purpose, and learning is a largely unintended outcome, as in the workplace or local community.

Some authors moreover divide informal learning into two different types, depending on the individual’s intentionality: (a) self-directed or deliberative learning, which is a goal-oriented form of everyday learning – for example when one decides to learn how to make a personal home page; and (b) incidental learning, i.e. everyday learning that is neither intended nor planned (Eraut, 2000; Garrick, 1998; Jarvis, 2004; Marsick & Watkins, 1990). Many everyday learning experiences are self-directed, which refers to experiences where the learner exercises a large degree of choice and control of the learning situation. Broadly, the definition suggests that the learner decides what and how to learn, but that other decisions, such as when and where to learn and how much to learn at any time are implicit. The learner not only selects but may also reject, add, or change resources at will, decide to continue or terminate the project, and finally determines the satisfaction or adequacy of the outcomes (Mocker & Spear, 1982). Incidental learning, by some defined as a subcategory of informal learning, is often seen as a byproduct of some other activity, such as task accomplishment, interpersonal interaction, trial-and-error experimentation, or even formal education (Jarvis, 2004; Marsick & Watkins, 1990). Incidental learning mostly takes place under non-routine conditions in everyday life, that is, when the procedures and responses that we normally use fail. In such cases, we may become aware of many tacit, hidden, taken-for-granted assumptions, realizing that a particular situation can be defined and solved in many different ways. Reber (1993) defines incidental learning as implicit learning; the acquisition of knowledge independently of conscious attempts to learn and in the absence of explicit knowledge about what was learned.

In the literature concerning learning in museums several different criteria tend to be used to distinguish between formal and informal learning. A widely-used mode of procedure is to distinguish between formal, institutionalised learning that takes place in fixed, structured settings, and informal learning that is characteristically unstructured, voluntary and strongly motivated (Dierking et al., 2003; Falk & Dierking, 1992; Ramey-Gassert, Walberg III & Walberg, 1994). This operational distinction between formal and informal learning is based on four criteria: (1) whether the learning is based in an educational institution or not; (2) whether it is structured or not structured; (3) whether it is voluntary or compulsory; and (4) whether the motivation is intrinsic or extrinsic. A review of the literature shows that the list can be expanded to include many other criteria. Authors differ as to how many selection criteria they use, as well as in the ways in which they define the various criteria and the importance they accord them. Certain authors such as Hein (1998) and Maarschalk (1988) use only one criterion to distinguish between formal and informal learning (usually the criterion as to whether the learning is, or is not, part of formal education, or whether it takes place in a museum versus a school), whereas others, such as Falk & Dierking (1992) and Ramey-Gassert et al. (1994), use several criteria. Various criteria encountered are summarised below:

- Education/teaching
- Location

- Learning intentionality and pedagogical goal
- Externally determined or not
- Degree of planning and pedagogical structuring
- Degree and locus of control and autonomy
- Duration of learning
- Whether the learning is collective, collaborative or individual
- How the learning is mediated – by whom (teacher/guide/explainers/peer) and in what way
- Interest and motivation (e.g. intrinsic versus extrinsic motivation)
- The nature and extent of evaluation (assessment and accreditation)

The above list illustrates the range and diversity of the criteria used. The order in which they are listed does not reflect their priority in terms of frequency or relative significance in the literature, nor should the list be regarded as complete. Similar but less comprehensive lists of criteria concerning learning in museums are offered by Eshach (2007), Hofstein & Rosenfeld (1996), Ramey-Gassert et al. (1994), Tamir (1990), and Wellington (1990).

ORGANIZATIONAL MODES OF EDUCATION

Two fundamentally different interpretations of informal learning can be found in the literature on education. The first interpretation is based on a sharp distinction between formal and informal learning. This approach follows a long tradition in pedagogical research. At the beginning of the 20th century it was assumed that the school classroom was the locus of learning. Suitable learning was synonymous with education and was therefore designated as formal. Conversely, the kinds of learning that take place outside the framework of the education system were designated as informal (Dewey, 1916). Since the 1947 UNESCO report on alternative forms of learning found in developing countries which lack (adequate) educational infrastructures, the recognition of various resources for lifelong learning has made it necessary to differentiate between degrees of formality in learning (Colley et al., 2003). Coombs & Ahmed (1974) juxtapose learning with education and on this basis identify three types of learning: formal, non-formal and informal. They define formal education as: “the highly institutionalized, chronologically graded and hierarchically structured ‘education system’; spanning lower primary school and the upper reaches of the university”; non-formal education as: “any organized, systematic, educational activity carried on outside the formal system to provide selected types of learning to particular subgroups in the population, adults as well as children”; and informal education as: “the lifelong process by which every person acquires and accumulates knowledge, skills, attitudes and insights from daily experiences and exposure to the environment at home, at work, at play; from the example and the attitudes of the family and friends; from travel, reading newspapers and books or by listening to the radio or viewing films or television” (p. 8). Like Dewey, the authors draw the formal-informal distinction at the level of the organisation, i.e. according to whether it takes place within the educational system or not. In this approach, informal learning is defined primarily in terms of its (informal) setting and thus by definition cannot take place in formal settings.

PSYCHOLOGICAL MODES OF LEARNING

The other interpretation of informal learning is based on an acceptance that formal learning can take place in informal settings, and vice versa; this view is known as the ‘hybrid approach’ (Hofstein & Rosenfeld, 1996). The process of learning in itself is never either formal or informal, but there are various formal and informal aspects at play in each learning situation – regardless of whether the learning is taking place in a school, in a museum, at the workplace, or at home. In this approach formality is analysed at the modes of the situation, with the learning situation considered from the point of view of the individual learner. It is the individual’s experience of the situation that determines the extent to which the learning can be seen as formal or informal (La

Belle, 1982). The degree of formality is affected by variable like the subcultures of social situations, the politics and culture of the social context, the social position of both learners and teachers (leaders, managers and so on) and even the status given to the knowledge being acquired. What we have here, then, is a psychological approach to the analysis. This approach can also be found in the framework of ‘free-choice learning’: “the operative issue is perceived choice and control by the learner” (Falk, 2005, p.273). For a number of years Falk and Dierking have argued for the introduction of the concept of free-choice learning to replace that of informal learning. Free choice learning should be understood as a relative concept in which the crucial point is whether the individual learner feels that s/he has free choice and autonomy: “Ultimately though, what one person sees as a ‘free-choice’ learning situation may be perceived by another person as ‘compulsory’: free-choice learning is a psychological construct and thus cannot be defined a-contextually” (Falk, 2005, p.273). The free-choice concept thus embarks from the individual learner (and, necessarily, at the level of the situation), on the basis that it is essential to consider learning and motivation from the individual’s perspective (Heimlich, 2005). The concept of free choice can therefore be seen as a response to the traditional formal-informal distinction, based on the existence or not of an institutionalised intention to teach (at the level of the organisation).

CONCEPTUAL OVERVIEW

The two different approaches to informal learning, the organizational modes of education and the psychological modes of learning, can be reconciled in a three-by-two matrix (figure 1). The figure intends to clarify the similarities and differences between the different interpretations of informal learning. It illuminates how a learning situation, given by the specific educational mode, interrelates with both formal and informal aspects of learning.

Along the vertical line are the predominant modes of education. Here, education represents a continuing process, spanning the years from earliest infancy through adulthood and necessarily involving a great variety of methods and resources. According to the thesaurus of ERIC and current literature on lifelong learning (Coombs & Ahmed, 1974; Eraut, 2000; European Commission,

		PSYCHOLOGICAL LEVEL	
		Formal	Informal
ORGANISATIONAL LEVEL	Formal education	A	B
	Nonformal education	C	D
	Informal education	E	F

Figure 1. The figure shows the conceptual framework for understanding science learning in school as well in everyday life in terms of formality and informality. For analytical purposes, the educational modes of education are defined as discrete entities (formal, non-formal, and informal education), whereas formality at the psychological level is defined in terms of attributes of formality and informality along a continuum (formal ↔ informal learning).

2001, 2007; Greenfield & Lave, 1982; Jarvis, 2004; Mocker & Spear, 1982; Scribner & Cole, 1973; Wain, 1987) three modes of education can be summarized as following:

Formal education: Learning typically provided by an education or training institution, structured (in terms of learning objectives, learning time or learning support) and leading to certification.

Non-formal education: Learning that is not provided by an education or training institution and typically does not lead to certification. It is, however, structured (in terms of learning objectives, learning time or learning support).

Informal education: Learning resulting from daily life activities related to work, family or leisure. It is not structured (in terms of learning objectives, learning time or learning support) and does not lead to certification.

The three educational modes of education are viewed as discrete entities, even though in practice there are considerable overlap and interaction between them. Attention is on the structures of education rather than the process of learning.

Across the top of Figure 1 are the psychological modes which concern the formality of learning. In these modes, learning is not formal or informal in itself. Instead, with reference to the above-mentioned 'hybrid approach' (Hoffstein & Rosenfeld, 1996), to the 'free-choice' approach (Falk, 2005, Falk & Dierking, 2000; Heimlich, 2005) and to literature concerning lifelong learning (Ashman, 1997; Billett, 2002; Colley et al., 2003; Eraut, 2000; Malcolm et al., 2003; Sawchuk, 2008), there are both formal and informal aspects in almost any learning situation, whether at school, in the museum or at home. It is obvious that formality of learning itself is multi-dimensional. Formal and informal aspects of learning may exist simultaneously, sometimes in concert with one another and sometimes in conflict. In other words, a single school classroom may reflect both formal and informal aspects of learning simultaneously but the researcher may choose to concentrate on only one mode – say, the formal one represented by the teacher delivering the curriculum – rather than the informal one, represented by the interaction of peers that may be occurring simultaneously in the same classroom. The latter consists of those things students learn through the experience of attending school rather than the stated educational objectives of such institutions, including practices, procedures, rules, relationships, and structure. This is by some authors designated as socialization, tacit learning, or hidden curriculum, referring to the internalization of norms, values, beliefs, attitudes, behaviors, skills, etc. that occur both during everyday life. Not only we have no a priori intention of acquiring them, but we are not aware that we learned something. Many school-specific sources give rise to important elements of informal learning. These sources may include, but are not limited to, the social structures of the classroom, the teacher's exercise of authority, rules governing the relationship between teachers and students, the teacher's use of language, disciplinary measures, timetables, tracking systems, and curricular priorities.

A further important point is that the formality at the psychological level does not rest on a dichotomous, either-or distinction; rather, it should be treated as a continuum (Eraut, 2004; Hodkinson & Hodkinson, 2004; Mocker & Spear, 1982; Sawchuk, 2008; Stern & Sommerlad, 1999), since the psychological mode is associated with features of a situation – discourse, behaviour, diminution of social difference, etc. In this regard it is worthwhile to note the arrow and the greyscale between the psychological modes in the figure, suggesting that formality represent a continuum rather than as discrete entities. It should also be noted that the concept non-formal is absent at the psychological level. Non-formal learning is redundant, at least in the sense that it implies some sort of middle state, between formal on the one hand, and informal on the other.

Where the organizational modes of educational meet the psychological modes of learning in the matrix, the result is a particular form of learning situation. In the case of the formal educational mode, the classroom reflects not only lecturing or other formal learning activities controlled by the teacher (situation A), but also the more subtle informal situations associated with how values, norms, rules and knowledge is negotiated among peers in the classroom (situation B). In the case of situation B, participation in classroom activities fosters informal learning experiences, but it may have little to do with the deliberate and systematic teaching of the teacher.

The non-formal educational mode refers to organized, educational activities carried on outside the formal system to provide selected types of learning to particular subgroups in the population. It does not depend, as formal education, on standardized means or ends for its existence. Youth-serving institutions and programs are significant because they provide a web of community-based learning resources, including the guidance and companionship of adults and peers (Eccles & Templeton, 2002; Schauble et al., 1996). Youth-serving programs differ widely in organization, intended audience, and function, varying from national organizations such as scouting to local grassroots organizations; from interest groups and hobbyist societies organized around specific subject matters to libraries and museums. Although most programs are not specifically aligned to the school curricula, Nicholson, Weiss and Cambell (1994) explained that many programs grew from a deliberate attempt to complement what was perceived as dull, teacher-directed science at school with innovative, hands-on, inquiry activities. Formal implications of non-formal educational modes may for example be docent-directed, lecture-based guided tours at museums in which limited interaction among docent, visitors, and exhibit artefacts are provided (Bamberger & Tal, 2007; Cox-Petersen et al., 2003). Another example of formal learning may be the situation of grading scout badges on completion of set criteria (activity or proficiency awards) (La Belle, 1982). Common to the two examples is that learning intentionality and pedagogical goals are mostly determined externally and the learners have limited control over the learning situation (situation C). When non-formal educational activities are more loosely organized providing more choices and autonomy to the learners, the learners may experience the situation as largely informal (situation D). It is the individual's experience of the situation that determines the extent to which the learning can be seen as predominantly formal or informal, depending on the subcultures of social situations, the culture of the social context, the social position of both learners and educators, how norms, rules and knowledge is negotiated among peers and so on.

Finally, the informal educational mode refers to everyday learning experiences which, according to Jarvis (2004) are probably the most common of all. In these we find ourselves in new situations and we have to learn how to cope – by thinking on our feet about our next action, and so on. In the informal educational mode there may exist formal characteristics associated with for example deliberate parental instruction (situation E) as well as informal characteristics associated with everyday learning experiences like participating in a hobbyist web-based forum (situation F).

The above mentioned examples are chosen as paradigmatic examples to clarify the points, though they may seem stereotyped.

DISCUSSION

The figure enables a clarifying around the formality of learning science in everyday life. Although a number of frameworks have been published in the literature concerning lifelong learning (for example Jarvis, 2004; La Belle, 1982; Marsick & Watkins, 1990; Mocker & Spear, 1982), there have been very few attempts to develop a conceptual framework for learning science in everyday life. Some frameworks, of course, are well established, such as the 'free-choice learning' framework. In what follows, I discuss and contrast the presented figures' definitions and concepts with those of other key writers in this field.

Jarvis (2004) and La Belle (1982) distinguish between three modes of education; formal, non-formal and informal education, but they do not take the psychological modes of learning into explicit account. Jarvis' model includes two types of learning: intended and incidental learning, whereas La Belle juxtaposes educational modes versus educational characteristics. Also Marsick and Watkins (Marsick & Watkins, 1990, 2001; Watkins & Marsick, 1993) frame their model within the organizational modes of education, but they define informal learning as distinct from incidental learning. As such, incidental learning is not planned or intentional as it might be with self-directed

learning. A key distinguishing feature in Marsick and Watkins' definition is therefore that informal learning is intentional, incidental learning is not. Such a distinguishing seems dubious: separating informal and incidental learning seems to represent a false dichotomy.

For Mocker & Spear (1982), the degree of formality is the extent to which a learner has control over both the objectives and the means of learning. Constructed on the idea that an operational definition of lifelong learning should be based on the locus of control for making decisions about the goals and means of learning, the model is a two-by-two matrix of learner and institution that represent four identified situations of learning. According to their model, in formal learning, institutions have control over both objectives and means. In non-formal learning, the learner controls the objectives, but the institution controls the means because institutions organize delivery systems. In informal learning, the institution controls the objectives, but the learner controls the means; while in self-directed learning, the learner controls both objectives and means. Mocker & Spears' model is apparently framed within the psychological approach since the operative issue is control over one's learning, but their model is also implicitly within the organizational modes of education because of the way they see institutional control. Defining self-directed learning as learners' control of objectives and means, this category has much in common with the psychological construct 'free-choice learning', given by Falk & Dierking. It is true that learners do need to exercise choice and autonomy in self-directed activities, but they may not set out intentionally and explicitly to accomplish particular ends through preplanned means as described by Mocker & Spear. Often, learners' choices evolve from their interaction with others in an activity in which they find themselves. Sometimes they become fully conscious of these choices; at other times, they remain somewhat unaware.

The framework of free choice learning was introduced by Falk (2001) in order to replace the concepts informal and non-formal learning. The idea of free choice emphasizes the unique nature of out-of-school environments that allows the learner to identify several learning options, in a variety of spaces, and finally, to choose a specific option, theme, or space for learning. According to Falk (2005), the underlying motivation and interest of the learner is the reason for using the term free-choice learning. Free-choice learning is conceptualized within the broader analytical framework; The Contextual Model of Learning (Falk & Dierking, 2000). The Contextual Model of Learning is an operational model aiming to capture the multi-faceted nature of learning from museums. The model embarks from the assumption that learning in museums takes place within three overlapping contexts: the personal, the socio-cultural and the physical. The personal context refers to the cognitive and psychodynamic processes involved in learning. In this context the focus is on the visitor's background, including their previous experiences, interests, social skills and current understanding of the information on display. The social context in this model refers to the social processes involved in learning. The focus here is both on the visitor's relationship to and interaction with other people, and on the social and cultural features of the artefacts and exhibits themselves. The physical context in the model refers to the physical aspects of the museum environment, including the architectural features, exhibition layout, the exhibits, their labels, and so on. The three contexts together include 12 factors that are regarded as crucial in learning from a museum visit (Falk & Storksdieck, 2005). Free-choice learning is explicitly conceptualized from one of these factors: choice and control (Falk & Dierking, 2000, p. 85).

According to Falk (2005), free-choice emerges as a way to describe and distinguish, from a learner's perspective, the nature of the learning experience that occurs in a variety of settings and contexts. Falk states that free-choice learning typically, but not necessarily, occurs outside school. If we compare this statement with the presented figure (figure 1), free-choice learning may occur at all three educational modes; the formal (in rare instances, cf. Falk), the non-formal, and the informal educational mode. Since free-choice is a psychological construct, like the psychological modes of learning, free-choice fit into the informal part of the model (situation B, D, and F). Hence, the

formal part (situation A, C, and E) represents “something short of free-choice” (cf. Falk, 2005, p. 273). However, the free-choice framework, as described, tends perhaps to overlook important contributions from incidental learning experiences. Various variables in the organizational, social, cultural, economic, and political contexts in which the learning is situated are not necessarily considered by the free-choice framework even though they are important in relation to how the learner experiences a given situation in terms of formality.

In conclusion, I claim that the presented conceptual literature review, which combines formality at the organizational level with formality at the psychological level, may clarify descriptions of learning situations in everyday life in terms of formality and informality. Applying the organizational level with the psychological level suggests that there are significant elements of formal learning in informal situations and elements of informality in formal situations.

With reference to the organizational mode of education, it seems appropriate to describe museums as informal learning environments. The term informal learning environments have served as a unifying concept for learning environments outside the school for a long time, pointing out the independence of the educational system. It is however important to point out that learning in informal learning environments thus not per definition may be called informal learning. With regard to the psychological modes of learning, there are both formal and informal aspects of learning - regardless of characteristics of the learning environment.

REFERENCES

- Anderson, D., Lucas, K.B. & Ginns, I.S. 2003. Theoretical perspectives on learning in an informal setting. *Journal of Research in Science Teaching*, 40(2): 177-199.
- Ash, D. 2003. Dialogic inquiry in life science conversations of family groups in a museum. *Journal of Research in Science Teaching* 40(2): 138-162.
- Ashman, A.F. 1997. A learning experience. *Journal of Cognitive Education* 6: 75-79.
- Bamberger, Y & Tal, T. 2007. Learning in a personal context: levels of choice in a free choice learning environment in science and natural history museums. *Science Education* 91(1): 75-95.
- Beckett, D & Hager, P. 2002. *Life, work, and learning: practice in postmodernity*. London: Routledge.
- Billett, S. 2001. Knowing in practice: re-conceptualising vocational expertise. *Learning and Instruction* 11(6): 431-452.
- Billett, S. 2002. Critiquing workplace learning discourses: Participation and continuity at work. *Studies in the Education of Adults*, 34(1): 56-67.
- Colley, H., Hodkinson, P. & Malcom, J. 2003. *Informality and formality in learning: a report for the Learning and Skills Research Centre*. London: Learning and Skills Research Centre.
- Coombs, P. A. and Ahmed, M. 1974. *Attacking Rural Poverty: How Education Can Help*. Baltimore: John Hopkins University Press.
- Cox-Petersen, A.M., Marsh, D.D., Kisiel, J. & Melber, L.M. 2003. Investigation of guided school tours, student learning, and science reform recommendations at a museum of natural history. *Journal of Research in Science Teaching* 40(2): 200-218.
- Dewey, J. 1916. *Democracy and education*. New York: Macmillan.
- Dierking, L.D., Falk, J.H., Rennie, L., Anderson, D. & Ellenbogen, K. 2003. Policy statement of the “Informal Science Education” Ad Hoc Committee. *Journal of Research in Science Teaching* 40(2): 108-111.
- Eccles, J.S. & Templeton, J. 2002. Extracurricular and other after-school activities for youth. *Review of Research in Education* 26: 113-180.
- Ellebogen, K.M., Luke, J.J. & Dierking, L.D. 2004. Family learning research in museums: an emerging disciplinary matrix? *Science Education* 88(Suppl. 1): S48-S58.

- Eraut, M. 2000. Learning and tacit knowledge in professional work. *British Journal of Educational Psychology* 70: 113-136.
- Eraut, M. 2004. Informal learning in the workplace. *Studies in Continuing Education* 26(2): 247-273.
- Eshach, H. 2007. Bridging in-school and out-of-school learning: formal, non-formal, and informal education. *Journal of Science Education and Technology* 16(2): 171-190.
- European Commission 2001. Making a European area of lifelong learning a reality. Brussels: European Commission.
- European Commission 2007. Validation of non-formal and informal learning in Europe. Brussels: Cedefop.
- Falk, J.H. 2001. Free-choice science education, how we learn science outside of school. New York: Teachers College Press.
- Falk, J.H. & Dierking, L.D. 1992. The museum experience. Washington: Whalesback books.
- Falk, J.H. & Dierking, L.D. 2000. Learning from museums: Visitor experiences and the making of meaning. Walnut Creek, CA: AltaMira Press.
- Falk, J.H. 2005. Free-choice environmental learning: framing the discussion. *Environmental Education Research* 11(3): 265-280.
- Falk, J.S. & Storksdieck, M. 2005. Using the Contextual Model of Learning to understand visitor learning from a science center exhibition. *Science Education* 89: 744-778.
- Garrick, J. 1998. Informal learning in corporate workplaces. *Human Resource Development Quarterly* 9(2): 129-144.
- Gorad, S., Fevre, R. & Rees, G. 1999. The apparent decline of informal learning. *Oxford Review of Education* 25(4): 437-454.
- Greenfield, P. & Lave, J. 1982. Cognitive aspects of informal education. In *Cultural perspectives on child development*, ed. D.A. Wagner & W.D. Stevenson. San Francisco: W.H. Freeman & Co.
- Griffin, J. 2004. Research on students and museums: looking more closely at the students in school groups. *Science Education* 88(Suppl. 1): S59-S70.
- Hager, P. 2001. Lifelong learning and the contribution of informal learning. In *International Handbook of Lifelong Learning*, ed. D. Aspin, J. Chapman, M. Hatton & Y. Sawano, Y., Dordrecht: Kluwer Academic Publishers.
- Heimlich, J. 2005. Editorial. *Environmental Education Research* 11(3): 261-263.
- Hein, G.E. 1998. Learning in the museum. New York: Routledge.
- Hodkinson, P. & Hodkinson, H. 2004. The complexities of workplace learning: problems and dangers in trying to measure attainment. In *Workplace learning in context*. ed. H. Rainbird, A. Fuller & A. Munroe, A. London: Routledge.
- Hofstein, A. & Rosenfeld, S. 1996. Bridging the gap between formal and informal science learning. *Studies in science education* 28: 87-112.
- Jarvis, P. 2004. Adult education and lifelong learning: Theory and practice. London: Routledge.
- La Belle, T. 1982. Formal, non-formal, and informal education: a holistic perspective on lifelong learning. *International Review of Education*, 159-175.
- Livingstone, D.W. 2001. Adults' informal learning: definitions, findings, gaps, and future research. NALL Working Paper no. 21. Toronto: New Approaches to Lifelong Learning, Ontario Institute for Studies in Education, University of Toronto.
- Maarschalk, J. 1988. Scientific Literacy and Informal Science Teaching. *Journal of Research in Science Teaching* 25(2): 135-146.
- Malcolm, J., Hodkinson, P. & Colley, H. 2003. The interrelationships between informal and formal learning. *Journal of Workplace Learning* 15(7/8): 313-318.
- Marsick, V.J. & Watkins, K.E. 1990. Informal and incidental learning in the workplace. London: Routledge.
- Marsick, V.J. & Watkins, K.E. 2001. Informal and incidental learning. In *New directions for adults and continuing education*, no. 89, ed. S.B. Merriam. San Francisco: Jossey-Bass.

- Martin, L.W. 2004. An emerging research framework for studying informal learning and schools. *Science Education* 88(Suppl. 1): 71-82.
- McGivney, V. 1999. *Informal learning in the community*. Leicester: National Institute of Adult Continuing Education.
- Mocker, D.W. & Spear, G.E. 1982. *Lifelong learning: formal, non-formal, informal, and self-directed*. Columbus: ERIC Clearinghouse on Adult, Career, and Vocational Education.
- Nicholson, H.J., Weiss, F. & Cambell, P.B. 1994. Evaluation in informal science education: community-based programs. In *Informal science learning: What the research says about television, science museums, and community-based projects*, eds. V. Crane, H. Nicholson, M. Chen & S. Bitgood, S. Dedham, MA: Research Communications Ltd.
- Ramey-Gassert, L, Walberg III, H.J. & Walberg, H.J. 1994. Reexamining connections: museums as science learning environments. *Science Education* 78(4): 345-363.
- Reber, A.S. 1993. *Implicit learning and tacit knowledge: An essay on the cognitive unconscious*. Oxford: Oxford University Press.
- Rennie, L.J., Feher, E, Dierking, L.D. & Falk, J.H. 2003. Toward an agenda for advancing research on science learning in out-of-school settings. *Journal of Research in Science Teaching* 40(2): 112-120.
- Rennie, L.J. & Johnston, D.J. 2004. The nature of learning and its implications for research on learning from museums. *Science Education* 88(S1): S4-S16.
- Rennie, L.J. & McClafferty, P. 1996. Science centres and science learning. *Studies in Science Education* 27: 53-98.
- Resnick, L.B. 1987. The 1987 presidential address: learning in school and out. *Educational Researcher* 12: 13-20.
- Sawchuk, P.H. 2008. Theories and methods for research on informal learning and work: towards cross-fertilization. *Studies in Continuing Education* 30(1): 1-16.
- Schauble, L., Beane, D.B., Coates, G.D., Martin, L.M.W. & Sterling, P.V. 1996. Outside the classroom walls: learning in informal environments. In *Innovations in learning: new environments for education*, eds. L. Schauble & R. Glaser, R. Mahwah: Lawrence Erlbaum Associates, Publishers.
- Schauble, L., Leinhardt, G. & Martin, L. 1997. A framework for organizing a cumulative research agenda in informal learning contexts. *Journal of Museum Education* 22 (2&3): 3-8.
- Scribner, S. & Cole, M. 1973. Cognitive consequences of formal and informal education. *Science* 182(4112): 553-559.
- Stern, E. & Sommerlad, E 1999. *Workplace learning, culture and performance*. London: Institute of Personnel and Development.
- Tamir, P. 1990. Factors associated with the relationship between formal, informal, and non-formal science learning. *Journal of Environmental Learning* 22(2): 34-40.
- Wain, K. 1987. *Philosophy of lifelong learning*. London: Croon Helm.
- Watkins, K.E. & Marsick, V.J. 1993. *Sculpting the learning organization*. San Francisco: Jossey-Bass Publishers.
- Wellington, J. 1990. Formal and informal learning in science: the role of the interactive science centres. *Physics Education* 25: 247-252.