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Definitions of instructional control in learning environments

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A fundamental question in the design of learning environments is determining the nature of instructional control which will facilitate optimal learning outcomes. The assumptions that increased control in the hands of learners will produce enhanced learning outcomes is untenable. This short paper reviews a select body of research with varying types and levels of control in learning environments and presents a summary of operational definitions of control applied in those studies. Analysis of these definitions revealed variations in the amount of control allowed which is most meaningful if represented on a continuum ranging from maximum program control on the one hand, to maximum learner control on the other. The impacts of control in learning environments is briefly discussed.

Locus of instructional control in learning environments whether CAI (computer-assisted instruction) or CAVI (computer-assisted video instruction) may range from maximal program control on the one hand to maximal learner control on the other. Program control refers to a learning environment in which the selection and sequence of instructional stimuli are made without strategy inputs from the learner, while learner control refers to one where the learner is responsible for the learning strategy. The condition in which there is maximal or complete learner control of everything (ie., learner control) has been described by Snow (1980) as the 'Adult Scholar Model'; and one where the learner has virtually no control (ie., program control) as 'Child Robot Model'. In the former the learner commands complete independence and self direction while in the latter he/she is subjected to fixed tasks, a fixed pace, and no remediation.

As it is now clear that each learner and learning context is different and that learners will always differ in their preferences for self-control, and also to the extent that they may be able to exercise it effectively for their own benefit, the program/learner control dichotomy in the design and arrangement of learning environments is far from adequate. The assumption that all learners know what is best for themselves at any given moment in an instructional sequence, and that all are capable of acting on this knowledge is untenable, at least for many learners (Snow, 1980). The current feeling is that one can perhaps give control to all of the learners some of the time, and to some of the learners all of the time, but one should probably not give control to all of the learners all of the time. A fundamental instructional design question is to determine what kind of control should be given and when.

Recent research has identified the existence of a whole range of possibilities in the arrangement of learning environments with varying degrees of learner and program control so much so that instructional control in learning environments is now represented more fully and appropriately as a continuum varying or ranging from maximum program control on the one hand to maximum learner control on the other. Between the two there is a range of variations, each recognisable by its placement on the continuum.

The choice of the nature and degree of control in instruction is the net result of a variety of factors pertaining to the learner, the learning environment, and the subject matter being learned. As learners, learning environments, and subject matter become more complex, the design and arrangement of learning environments have become equally complex. The accompanying chart is a summary of recent research on instructional control in learning environments. It is intended to show: a) how various researchers and authors have defined locus of instructional control, and b) the nature of the overlap.

Summary comment

Two issues arising from the above chart are worth further comment. First, clearly there is general concurrence amongst those cited on the existence of *degrees* of instructional control in the arrangement of learning environments ranging from program controlled to learner controlled, and with variations in between. The terminology is not quite the same but the meaning is similar.

Source	Definition			
Holmes, Robson & Steward (1985)	*Program Control* Frame displays and selections made by the computer program.			*Learner Control* Students have pre-instructional advice on self-estimation of comprehension and decision making process on selection of next frame.
Ross & Rakow (1981)	*Program Control* Examples adapted to subjects' pretest scores. Prescriptions varied according to subjects' scores.	*Lecture* Students could attend either one of two lecture presentations.	*Non-Adaptive* Five examples selected per rule considered as optimum.	*Learner Control* Examples selected by subjects who could ask for more.
Gay (1986)	*Program Control* Computer controlled presentation of concepts in hierarchical form with remediation and review. Student controlled pace.			*Learner Control* Student control of pace, sequence, depth, amount of practice, mode of presentation and type of content.
Judd (1972)		*Forced Group:* Forced Group: directed through sequence dictated by task analysis of subject matter.	*Yoked Control* Members paired with learner control group.	*Learner Control* Determined their own sequence through the materials.
Judd (1972)	*Program Control* Learners proceed through fix-ed, optimally ordered sequence.			*Learner Control* Student control over sequence and selection of materials.
Judd (1972)	*Program Control* Order of presentation fixed in an assumed optimal order for all treatments.			*Learner Control* Instructional decisions based on learner's ability to do self-evaluation.

Judd (1972)	*Program Control* No access to memory support. (Control group 1).		*Learner Control with Memory Support* Previous stimuli and their correct classifications displayed on request.	*Learner Control* Memory Support always presented. (Control group 2).
Laurillard (1984)	*Program Control* Designer determined route; a subset of many possible routes.			*Student Control* Interface that allows students free access to materials at any time, in any sequence.
Fisher & Blackwell (1975)	*Yoked* No choice of problem. Same amount of time allowed as in the choice group.		*Choice Control* Selected their own problems from CAI. Time taken (within limits).	
Tennyson, Robert & Rothen (1979)	*Program Control* Selection and sequence made without learner input.		*Adaptive Control* Anon-line algorithm adjusts the learning environment to individual learners or on-task error patterns.	*Learner Control* Learners responsible for learning strategy. Learners made decisions about their own learning.
Tennyson, Tennyson, & Wolfgang (1980)		*Adaptive Control Strategy* Regulated by MAIS: - selects number of instances presented to learners based on pre-task and on-task performance - learners not told how program operated: advised of posttest.		*Learner Control Strategy* Learners decide whether or not to continue receiving instances or go to posttest.
Tennyson (1980)	*Adaptive Control* No student control: examples presented in rational sets.		*Learner-Adaptive Control* Student control of amount and sequence. Advisement on diagnosis and prescription.	*Learner Control* Student control of amount and sequence: presented concepts presented separately.

Tennyson & Buttery (1980)	*Adaptive Control* Number of presentations based on pretask and on-task performance. Sequence determined by response pattern. Program directions given.	*Learner Control with or without advisement* With: Advice on amount of examples necessary. Without: No advice on progress or diagnostic help.	*Learner Control* Students decide whether or not to continue getting examples or go to posttest informed of program directions and had control of amount and sequence.
Hannafin (1984)	*External Locus of Control* Learners follow a predetermined path: no individual judgement as to its appropriateness.		*Internal Locus of Control* Individuals control path, pace and contingencies of instruction by specifying choices from among a range of options presented by designer.
Goetzfried & Hannafin (1985)	*Linear Control* Sequence same as Learner Control with Advisement, but no advisement, no individual control to review of select examples. No externally imposed decisions based on response accuracies. Students controlled pace. Followed predetermined path.	*Adaptive Control* Computer branched students for reteaching or more examples based on response accuracy. Students completed full lesson. No control over pacing or amount. Mastery learning principles used.	*Learner Control with advisement* Internally controlled CAI. Students continuously advised of progress and permitted to determine if reteaching or examples needed. Students free to move from lesson to lesson after each tutorial session.

	Linear Control	*Designer Imposed*	*Learner Selected*
Hannafin & Colomaio (1987, 1988)	Students follow a linear path through the lesson. Feedback given. No option for controlling sequence of lesson. No imposed decision for remediation provided.	Students followed a predetermined path deemed best by experts. Given knowledge of response to question: branched if wrong after second incorrect attempt, correct answer given.	Students controlled path through lesson. Given advice on recommended sequence, but sequence selection was their own. Feedback provided, option to review. Permitted to make decisions on designer imposed design features.

Program control/ External Locus of Control/ Designer Imposed/ Forced Group/ Lecture all referred to learning environments in which learners were permitted to exert only minimal influence on the learning exercise. Conversely, *Learner Control/ Student Control/ Internal Locus of Control/ Learner Control with Advisement* referred to learning environments in which learners were permitted to exercise a much greater influence on their learning experience. *Adaptive Control* refers to arrangements in between in which varying degrees of control were incorporated into the instructional process. Hannafin and associates (1987, 1988) are responsible for introducing yet another category, *linear control* which is different from designer control and refers to environments where the learning path is very fixed. Learners enter at one end and proceed through to the other with no options for controlling either sequence or remediation.

The second point worth further comment has to do with the subtle variations in the definition of each categorisation by different researchers. While there is general consensus on the meaning of these, 'learner control' for example, is not seen in exactly the same vein by all. Tennyson and Buttery (1980) operationalised learner control, quite specifically, as when "students decided whether to continue getting examples, and which ones, or go on to the post test. Students were informed on program directions but had complete control of amount and sequence". On the other hand, for Hannafin and Colomaio (1988), learner control was also very specific: when "students controlled their sequence through the lesson ...students were permitted to make an individual control decision at each point at which a designer-imposed decision had been enforced. Students could choose the order of video segments. They were advised on recommended lesson sequence. They got advice before and after answering embedded questions and feedback on results." For her purposes, Gay (1986) defined learner control as when her "students had control of pace, sequence, depth, or amount of practice, mode of presentation (video, audio, graphics, or

text), and type of content (rules, key ideas, examples, or practice). Similar variations in definitions is true of program control and adaptive control.

In the case of the latter point the variation is somewhat more noticeable. Tennyson and Rothen (1979) offer a nice review of various definitions of adaptive control. Their own definition of adaptive control, similar to the others, refers to "strategies which prescribed the optimal amount of instruction necessary to achieve a given objective" (Tennyson & Rothen, 1977). This variation in the use of terminology is not being pointed out as a criticism but rather as a truism in the literature: a truism necessitated by the need to operationalise definitions for the purpose of measurement of effect.

Existing research on instructional control is limited and critically so in the design of CAVI. We are aware that learners will always differ in the degree of control they would prefer, and on how well they might be able to exercise that control if allowed directly or indirectly. We are also aware that learners always exercise some degree of control over their overt and covert learning activities during instruction regardless of treatment. Snow (1980) has suggested that, bearing the above in mind, instructional treatment variables not ostensibly concerned with learner control *contrasts* often have different implications for learner control of these activities. Moreover, that the question of research on learner control is too simply put if it concerns only whether or not learners are allowed to choose their own amounts, sequences, contents, or methods of instruction. The arrangement of instructional control ought to be seen in relation to a measure of prior individual dispositions (aptitude treatment interaction) than only something worthwhile could be said about learning and achievement, and instruction. There is a basic research need for a measure of differences in prior *individual dispositions* of learners as this is invariably a critical factor in learning achievement (Gary, 1986; Snow, 1980).

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