
Panel Discussions

Motivation vs. Cognition : What is more important?

edited by

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Abstract: This chapter is a transcript of the panel discussion held as the final session of the ICCE 93 conference. The panel reflected a theme of the conference that technology per se is not the answer to educational problems but that full account has to be taken of social, situational and motivational factors.

Panelists :

Claude Frasson (chairman), University of Montreal, Montreal, Canada

Jie-Yung Juang, National Central University, Taiwan, R.O.C.

Jean-François Nicaud, University of Paris 11, France

William Clancey, Institute for Research on Learning, Palo-Alto, USA

Tak-Wai Chan, National Central University, Taiwan, R.O.C.

Introduction (Claude Frasson)

As you can see in this picture, the following question : MOTIVATION VS COGNITION: WHAT IS MORE IMPORTANT? will be addressed to all the participants indicated, the panelists and the dragon. Let me first introduce the different panelists to you : myself, Claude Frasson from the University of Montreal (Canada), then from left to right, Jie-Yung Juang from the National Central University (R.O.C.), William Clancey from the Institute for Research on Learning(USA), Jean-François Nicaud, from the University of Paris 11 (France), and our host Tak-Wai Chan, also from the National Central University (R.O.C.). But who is the dragon? In fact the dragon is you. The dragon will have to ask questions in order to provoke an animated debate. The red light that you can see in my hand represents the eyes of the dragon which will watch to limit the time given to each speaker. Each panelist will speak for about eight minutes and after that we will start the discussion and you will act the role of the dragon.

What are motivation and cognition? In fact motivation in learning can be considered as a means to strengthen knowledge acquisition. For instance, in "the conditions of learning" edited by Robert Gagné, we find a list of conditions that supports acquisition in which the first step is to motivate the student by clearly indicating the objectives he has to reach, then by giving some exercises with increasing complexity, then by asking questions on the subject in various contexts. This method is also found in the theory of instructional design, by David Merrill.

However, I think that a majority of present research which is oriented towards cognition in terms of abstraction, forward or backward reasoning, is more or less oriented to the conditions of knowledge acquisition. For instance :

- Situated learning explains that knowledge is not independent but fundamentally included in a context and it results from an activity in which context and culture are involved.
- Research in tutoring systems is more oriented towards architectures, how the different expertise in term of student models, subject matters, pedagogy, are involved and can be included in a system.
- The interactive learning environment and social technical approaches are also new orientations in which many researchers are involved.
- Memory architectures : how do we memorize facts, events,...? How does the brain function? For instance, maybe you will not be able to recall all the names of the panelists and even their precise affiliation, but I am sure that you will remember the dragon and you will associate it with the speakers in future conferences like ICCE, AIED or ITS conferences.

At the base of all these questions and research topics we find a fundamental interrogation on motivation : **How is the learner motivated?** In fact, this process of providing motivation has already started in industry where we can see the development of video games, interactive games, interactive CD and hypermedia software. However, learning by playing can be problematic as it concerns superficial knowledge acquisition and not in-depth knowledge acquisition. Also, this learning is not independent of situations. For example: playing games cannot be transferred to different situations. Finally, topics addressed in social learning can be considered as the first step to motivation.

The fundamental questions to which I hope the panelists will be able to give answers are:
 What are the tools to develop to enhance motivation? What are the motivational rules? What are the relationships between motivation and cognition? Which is more necessary? How can we appreciate and evaluate the benefits of the motivation (and I insist on this aspect of evaluation)? How can we evaluate the effects of the motivation on the tutoring system's effectiveness? What tools can we implement in tutoring systems (ITS or interactive learning environments)?

All these questions are important and fundamental. They can orient future research and I hope that the panelists will be able to bring some clarification.

Jie-Yung Juang

My view of motivation may be different than yours. The most difficult part for me is the meaning of the terms used in this domain. What is the meaning of cognition? What is the meaning of motivation? This morning, I thought it over and came up with several thoughts and I will share these with you to give us a place to start.

First, I think, men are created equal. This is not my thought but a well-known thought. I think cognition is built in to all people but it may be turned off. Many people do not use their mind's power to its fullest extent. The goal of education is to turn it on, not to rebuild it. So we are not trying to redo a cognition system for a learner or a student.

Second, human beings are able to think because they have strong cognitive capabilities. Robots are able to act but do not have cognitive capabilities. Motivation is to ask those who can think to act and cognition is to teach those who can act to think. So, are you teaching to a robot or a human being?

We can distinguish two kinds of learning:

- Easy learning helps knowledge accumulation.

- Stressed learning is needed to develop intellectual capability.

This I know because I have Ph.D. students graduating. I have to stress them in order to develop their intellectual reasoning. The goals are to motivate students as efficiently as possible and we have to find what kind of mechanism motivates students and for that find volunteers (patients) for stressed learning. Nobody likes to be stressed but everybody needs to be motivated. Those are my thoughts, my vision concerning motivation.

Jean-François Nicaud

Motivation and cognition, which is more important? I selected some subquestions and I will try to point out some ideas about them. Because I am a computer scientist, I think that it is mainly questions for researchers in psychology and education. However I will still try to answer the question: Which is more important, cognition or motivation? Remember that we are in the framework of computers in education and that I consider mainly the development of systems.

My answer is cognition and that the real motivating elements that we can put inside computers are in fact cognitive elements. I will try to develop this a little more.

What is motivating? Is it motivating to use this mathematical expression instead of that one? Is it motivating to apply this rule to this expression without having before rewritten it in that form? Yes. Probably. But this is the domain of education.

Is it motivating to use colors, windows, cut and paste functions? Yes of course, but this is general ergonomics.

What is motivating? Is it to use new things that we can create with the computer? For example, new representation as interfaces, for example, a modification of the solving process? Modifications of the solving process can look like that used in AlgebraLand or in AplusX. It seems that we have many things like this, in many systems, and it is an important and interesting capacity of computers. We have things like this also in development to teach programming languages demonstrated by McCalla, by Reiser and so on...

Is it motivating to define new interaction modes, for example shared resolution in the AplusX system? The student solves the exercises but doesn't do the calculation. He selects an operator, a sub-expression, he makes the matching and then the system applies the rule that is correct. So we have a new sort of interaction mode.

Is it motivating to have things like artificial colors, to have immediate feedback of error? I will say probably, probably often but I think we have to study these new things, they are in fact epistemic values.

What is motivating? Is it social learning, cooperation, competition and so on? I would say sometimes, as in school. But don't forget that many students in school make progress if they are given individualized teaching. So, we should not throw away individualized teaching.

So what is interesting? Is it motivating to have funny text, music and so on. I don't know. It can be dangerous. For example, a student can have a behavior directly oriented towards trying to get music or a funny text and not trying to solve the problem. So, I think it has to be studied in depth.

Is it motivating to introduce the right concept, or to give the right problem at the right time?

I would say certainly, and I will say it is motivating to have a good representation of the domain and also a good representation of the student and now we are in the heart of the intelligent learning environment or intelligent tutoring systems.

To summarize these things, I would say that the basic motivating things are no longer elements of computers in education, they are important and all but a few of them are cognitive elements. Motivation is, for the student, the will of learning knowledge, the will of learning to learn and I think it is the role of the humans to provide this motivation, not of artificial systems.

First, don't forget the rule: There are many things in the fields, many agents and go for them.

So what is the goal of the designer? He can build the system to test an idea, to get a Ph.D., to write a paper, to built a usable system. He may start with the first two goals and after perhaps a few years only the last will remain.

Second, what are the goals for the system: what do you want the system to be? To be OK with some learning, to provide some elements of the domain, or to teach a domain in depth? We have to define these things.

We have to take care of the goals for the students. He can have no goals. He has to sit in front of the computer for one or two hours, he can want to see another view of the domain, to pass an examination, to acquire knowledge in a domain.

I end with recommendations for developing usable systems: Choose the main context, situation, with or without a human teacher, group or one-to-one, choose the system, and the type of student. Indicate this context when you speak of the system at conferences.

Tak-Wai Chan

- Why motivation?

Of course, learning is a burden in life. One of my students wrote "Students always feel that they derive pleasure from playing games but burden from studying."

- What is motivation?

Something that the students really want, yet it decides whether the student 'will' learn, not whether he/she 'can' learn. A learning task is motivational if a student is paying effort to learn without knowing that he/she is paying effort to learn.

- Where are we now?

Since we are studying computer systems for education, if we regard ourselves as designers, developers, or programmers, then we need theory and techniques from psychology, artificial intelligence, multimedia, networks, telecommunication and so on. At the same time, we have our clients, subject matter teachers, students, parents, and educators. A subject-matter teacher will ask: Will the student learn using the software? A student will ask: Why do I 'want' to use the software? A parent will ask: Will using the software help my kid behave at home and survive financially in the future? An educator will ask: Will the student learn and be a better citizen after using the software?

- Why social learning?

I think social learning has something to do with motivation. As I mentioned in my tutorial earlier, aspects such as learning better (through shared cognition and resolving cognitive conflict), triggering motivation (through sharing success and perhaps with competition), developing better

social skills, and nurturing better learning attitude, are all coming together. We cannot isolate any of these aspects. Actually, when I first had the idea of the 'learning companion' (Chan & Baskin, 1988), I thought its role was to promote the students to learn.

- Why Collaboration?

In general, collaboration generates motivation, at least, I'd say, for two reasons. First, it is an 'obligation', "... one 'ought' to pull one's weight, to contribute, to satisfy peer norms and sanctions" (Ames 1984). Second, it is a 'relationship with peers': "Because when I work with someone I get on well with, I can concentrate and learn a lot more." "We got on well and helped each other out" (Issroff, 1993).

- Why Competition?

For the competition, there is some evidence that students enjoy competition. For example students enjoy competitive computer games. Also, evaluation of Distributed West shows that more students prefer human competition (group to group) to human collaboration (Chan et al. 1992). Competition is a means of comparing students' knowledge. On one hand there could be undesirable effects on students, for example, the 'lower half problem', that is, there may exist half the population of students who are always less competent than another half; on the other hand, learning quality under competition, perhaps, in accordance with Darwinian evolution theory, elevates.

In real life, I would say, collaboration is socialism while competition is capitalism. Collaboration in capitalism is mainly for the sake of winning competition. For designing learning systems, competition could be a 'powerful idea'.

- What are powerful ideas?

They are ideas that are 'simple enough to be understood and implemented' and can 'help designers to develop' effective learning systems.

Here are examples: Hypertext is a powerful idea and there are authoring systems to implement the idea easily. Scaffolding is a powerful idea because it is easily to be understood and not too difficult to implement, furthermore, it is very effective. Student modeling is not a powerful idea because it is generally difficult to implement. Situated learning is not yet a powerful idea because its concept is still not clear enough to know how it can be implemented or modeled in a computer.

A scaffolding system is also motivational (e.g. Petal, see Bhuiyan et al., 1992). It reduces cognitive load, thus shortens time for a user to 'control' the system. Also, it blends cognitive skill and physical skill, allowing some sort of freedom for students to manipulate the environment and thus provides some flavor of games.

- What is the relationship between cognition and motivation?

First, we have to understand that 'learning is energy consuming.' Learning needs effort, so consumes energy. But willingness to consume energy without motivation is not part of human nature. So, from this perspective, we can re-interpret Chi and her colleagues' findings on self-explanation (Chi et al., 1989). In distinguishing 'good' and 'poor' students based on their performance in studying physics examples and solving problems, they found that (1) Good students used self-explanation and poor students merely read and paraphrased examples; (2) Good students understand an example's line and poor students tended to say that they did understand the line. I'd say these findings are unfair to the 'poor' students. Only when all the students consume the same amount of energy is judgment of their performance fair. Self-explanation is more energy consuming while reading and paraphrasing is more energy saving. Similarly, to say 'understand' means the student can proceed to the next task immediately while to say 'don't understand' means

he or she will have to spend more time on the current task. It is not clear how many of the 'poor' students did not use the more energy consuming strategies, such as self-explanation because they were unwilling to, not because they were not aware or unable to. It is also not clear how many 'poor' students become 'good' students if they are eager to use the energy consuming strategies. The cognitive nature of self-explanation is of course interesting and important, but it is more beneficial to focus on how and when to motivate students using these energy consuming strategies. Self-explanation research is only an example of cognitive studies that ignores the fact that learning is an energy consuming process.

Second, we have to analyze what constitutes motivation. Keller's ARCS model suggested four stages of motivation, namely, attention, relevance, confidence, and satisfaction (Keller, 1983).

Now, we can attach these four items with interpretations of learning as an energy consuming process: attention: "I'm ready and have been consuming my energy;" relevance: "I have reasons to invest my energy;" confidence: "I have an abundance of energy to face challenge;" satisfaction: "My consumed energy is worthwhile and I'm willing to consume if there is another opportunity."

Another approach is to start with the cognition process, decompose it into sub-processes and relate them to motivation. Since regarding learning as an energy consuming process matches well with the theory of constructivism which assumes the knowledge acquisition process is a constructive process, as Keller did for motivation, we can decompose the knowledge construction process into four sub-processes(cf. Chan et al., 1993): connection (students relate their prior knowledge of the domain to learn); accretion (students acquire new knowledge under the guidance of a teacher or by discovery); tuning (students modify, restructure, and generalize their learned knowledge via peer interaction and the teacher plays a less active role); and solidification (students consolidate their knowledge by keeping on practicing, perhaps under some forms of peer pressure). Furthermore, tuning can be further sub-divided into three sub-sub-processes: modification, integration, and generalization.

Now given these sub-processes or sub-sub-processes, we may attach them with motivational aspects as follows:

connection:	attention and relevance.
accretion:	attention, relevance, and confidence.
modification:	attention.
integration:	relevance, confidence, and satisfaction.
generalization:	confidence and satisfaction.
solidification:	confidence and satisfaction.

- Which is the means? Which is the end?

Apparently, 'motivation is a means and learning is the end'. However, there is a notion of a kind of motivation called 'continuing motivation' which says that a student is continuing motivated if the student returns from a previous learning environment without external constraints to do so. Note that continuing motivation is such a crucial and ultimate long term educational goal that we can say 'learning is only a means and continuing motivation is the end'. Indeed, education is a big success if students develop continuing motivation on learning.

- Conclusion

Computing and education research is not subordinated to AI or a testing place of AI ideas; not a technology (e.g. multimedia) chasing slave; not just psychology without means to be realized in a computer; not just educational theory without mastering of computing technology. It is inherently multi-disciplinary research with its own fundamental problems. Motivation is a fundamental problem. Yes, it is difficult. But when people started cognition research, who said

that studying cognition was easy. However, given the current imbalance of the amount of the research on cognition and motivation, motivational research is more necessary.

William Clancey

My ideas about motivation today are very different than they might have been six or seven years ago when I was an A.I. researcher. What I have learned about motivation comes from the work of John Dewey - for example, his study of remembering emphasizes that an attitude is always an inherent aspect of a remembering experience: to have an attitude is to remember it - the work of John Dewey and his study of inquiry, which I will say a bit about development in a few moments, and of course, my colleagues at IRL who study learning in the perspective of social identity and participation.

I think the first question we might ask is why do we oppose motivation from cognition? Why does it even occur to us to set up contrasts between the two of them?

Partly, I believe it is because we think of motivation as an aspect of emotion and we come from a tradition in which reasoning and emotion are opposite. To be a reasoning creature is one that is not ruled by emotion, but it is somehow dispassionate, somehow objective and separated from emotion. So now, when we come back to the students we have a problem because we have separated reasoning from emotion and we want to know how to put them back together again. I will tell you that in my study of situated learning and situated cognition this comes up over and over again. You always have X and the opposite of X and we are always wondering how do we put them back together again. And it is because we started with an assumption that separated them. That was the incorrect move at the very beginning.

Now of course we viewed motivation and emotion as very important in Artificial Intelligence and there have been books written on the topic, but we again always treat it from the reasoning perspective, from the symbolic perspective. So we have tried to represent emotion and motivation in terms of beliefs, desires and goals, but this makes motivation appear like an opinion, it is a thought I have about cognition. What is my opinion about this subject matter? When John Dewey tells us, it is the other way around: motivation is the source of subject matter, it is the source of wanting to know, it is the source of representing the world. There would not be attempts to model the world and to solve problem if you weren't already motivated, if there were not something else you were already doing that made you want to understand.

So this notion that comes up in the work Dewey, Bartlett, social scientists and a lot of psychologists is that there is no cognition, no human cognition without value, without interest that is already part of the cognition. So there would be no attention, you would not be paying attention, you would not be categorizing, you would not be in goal related activity at all, if you didn't already have motivation. And so to put it broadly, it seems there would be no movement, you would be like a creature standing in a corner if you didn't have motivation. So motivation is always part of your changing and your doing anything. Motivation is already there. When we talk about motivation as a means, it is as if someone is outside the student saying how can I change this person, so if I give them the motivation then they will learn. But for the person inside there is always motivation one way or the another. I am motivated not to be in this class or to be paying attention or to be trying to understand and so on. I always experience motivation.

Now, as I said, many people have studied this and one of the ways of putting it that I find very intriguing is the notion of self-regulation. Some of this comes from the cyberneticists who viewed reasoning as the total system, and they viewed learning as a natural part of growing of life of the system. They used many terms like organic views of learning. One thing that influenced me

very much when I was in high school was the work of Maslow who talked about self-actualization and he said that in becoming something, your learning is part of being a human being and there is a natural drive that makes you want to learn and as my colleagues at IRL say we are learning all the time. The question is, what are we learning? What I think my colleagues at IRL missed is this inherent aspect of the psychology of people, which we know as curiosity. The pleasure of making things, these are things that we don't talk about very much in these conferences, that there is something that is already there in people and I don't think that the social scientists talk about it very well either and maybe it is up to those of us with a psychological bent to try to bring curiosity and pleasure back into learning. We see that certainly in the emphasis on games.

Another way that I have seen this, and there is a little phrase that I like "What keeps cognitive development moving?" So we view learning that it is something that is always occurring, what for the person is keeping it moving? The social scientist says, what keeps it moving is that you want to participate in some way. You want to become somebody, there is a certain aspect of identity which is part of your learning. And the definition that my colleagues give, which I like, is that "learning is becoming a member of some community". And that is the essence of the drive that the human experiences.

We should ask ourselves, and Jean-François was starting to get into this a bit, why do you learn as a researcher? What makes you pick-up one of these papers, one of my papers, and try to understand it? That is work, yes, it is consuming energy. Then why do we do that? And as has been pointed out there are many reasons: you want to contribute in some way, you would like to add something yourself, you do have curiosity, you have been stimulated or provoked in some way, you are now a little bit off balance and you need some help to bring back your previous understanding together with what you have just heard. So there is an inherent aspect of some kind of contradiction or questions that now need to be understood and this is what Dewey meant by inquiry. You are part, you are an actor, you are engaged in the activity of being a researcher and within that activity you naturally are provoked and want to learn and you form questions for yourself.

Other aspects: your self-esteem, wanting to be important, to be recognized, that is certainly important. Also there is just basic survival. It is not just getting a Ph.D. Most of us are here because we get paid for it in some way or another and so that we can live where we want to live and have the kind of life we want to have and that is just another way of viewing participation and belonging. That is part of it as well.

To summarize and to answer some of the questions that are not quite clear. Should we care about the motivational problem? Definitely, it would enrich the field for motivation to be viewed as an inherent thing that we always talk about.

What is the relationship of human cognition and motivation? They are inseparable. It is not sensible to ask if one is more necessary than the other. You can't have human cognition without motivation. You can have a robot doing symbolic calculation without motivation. Fortunately, that is why they do all those calculations, we don't have to motivate them. It's a big mistake to give them motivation.

So it is a difficult problem and what is a possible approach? I would say, the two sides pursuing the psychological part about curiosity and self-regulation that is well worthwhile. But also, study motivation within a social context. Motivation is not something to put in the design of an ITS but is somehow surrounding how ITS are developed and used.

There is nothing wrong about talking about motivation as a means. I will just conclude by saying let's look how the social scientist will put it. What do we wish to motivate our students to

become? If we think about education, what kind of people do we want them to be? We are already doing that implicitly. If we think about it, when we talk about meta-cognition we already have ideas of what kind of capability we think that we value. We also want to think of how do we wish for them to participate in the future. And here the notion of education for being a citizen of a certain kind, being able to understand the front page of a newspaper, there is an important part of motivation.

QUESTIONS FROM THE AUDIENCE

Claude Frasson

Now it is the turn of the audience. So I would like to receive a flow of questions from the dragon. Please use a microphone and give your name and affiliation before asking, as the session is recorded and will be edited later. So don't hesitate to be motivated to ask questions.

Audience: Damian Conway, Monash University

In a sense, it occurs to me that the question is itself deceiving. It is like comparing apples and something else. It is like asking which is more important hunger or the ability to digest food. If you don't have hunger the ability to digest food does not do you much good. If you are not able to digest the food, your hunger may be satisfied but it is not going to get you very far. In a sense I think that the fact that we can describe both these abstract things as nouns, motivation and cognition, hides the fact that they are really not things you can compare.

The other thing I would like to say is when you look at another domain entirely, suppose that of elite athletes and if you make an analogy between cognition and athletic ability or conditioning, it seems to me that at these elite levels the only difference between top athletes is their level of motivation. There is not really a big difference between how fast the top sprinters can run. It is often a matter of how much they want to win. But the point I would like to make is that it might be fantasy for us to believe that we can actually do anything about that. If you yell at someone, it is not going to make them run faster. You are not going to increase either their motivation or their conditioning.

William Clancey

I am still at an early enough phase in my thinking about these things that I can still be somewhat idealistic and hopeful, and my idealism is to pass some of the responsibility for some of these questions on to colleagues in other disciplines. And so by working with a social anthropologist, or even an educator and not just computer scientists. I'm hoping that with that combination of views that these considerations will be brought more into account. And I think that might be a part of the secret for us not to assume that as computer scientists, or just psychologists, that it is up to us to figure out all about motivation.

Audience

I think the point that I would like to make here is that motivation is an element that we build into a system that makes this system help people learn more effectively and the thing we need to focus on is how do we build a system that is motivational to help people learn.

I would like to use John Anderson's model as the example. If students do not pay attention to the information how are they going to learn it. He also talks about relevance. If the information is irrelevant to the student's current goals, how can he learn this piece of information? He also talks about competence. If this piece of information is too difficult for him to learn or too simple for him to learn then why should he learn this piece of information. Another element he talks about is self-reflection. If this person does not think, he can not enjoy learning from this piece of information. He misses out on the sense of achievement inherent in the learning process. If he does not feel this achievement, he will not feel motivated.

So I think that instructional design ought to look at those aspects and decide to incorporate motivation into the design in order to present the instruction to the learner more effectively.

Claude Frasson

This can also be found in the conditions of learning by Gagné and also in the self-explanation effect. Good students can acquire knowledge using the self explanation effect. It is a question of provoking their own inference mechanism, asking questions to themselves and trying to explain using their own knowledge base and reasoning on the problem. So it is a question of motivation.

Audience: Wing-Kwong Wong, National Yunlin Institute of Technology

I think this panel has been asked a very important question. I think motivation is very important and I think we can add this part, the motivation part, into learning systems. As a teacher, I found that many students are frustrated sometimes, they may have hostility towards the teacher. As a teacher I have to use different strategies to convince them to work hard: I really don't want to fail you but if you work harder, I may be able to improve your final grade. Strategies like this are not being considered in today's learning systems and I think we can add this kind of strategy to computing systems.

As a teacher I understand the motivation level of the students. In this conference we talked about student modeling a lot but we didn't talk about the emotional part of the feelings of the students. If the students have hostility towards the teacher, we can find it difficult to motivate the students, so we have to say something kind to the students. And this is something the computer can do, and to have a model of the student feelings and motivations, emotions, their thoughts.

Jie-Yung Juang

The debate happened in China more than a thousand years ago about how to teach a student, whether we should motivate them or teach them step by step. There is still no definite answer for that, but I think the most important thing is to look at the target of the teaching: What kind of student are we teaching? If you are teaching a student whose built-in cognition has not been turned on, they have to be guided step-by-step.

Audience: Michael Jacobson, University of Illinois

I would say if you are listening to the conversation now it seems like things are certainly tilting over to the motivation side as being the thing we should all root for.

I suggest though that there is some research that our group has been involved with which might suggest that motivation is certainly necessary but not a sufficient condition particularly for

learning at a more advanced level and learning very difficult and potentially demanding material. Just briefly, some of this research involves medical school students as well as practicing physicians and in some research which I have been directly involved with, with my colleagues we found that students at this level have frequently very serious misunderstandings about biomedical phenomena, things they may have learned in the first year medical school curriculum. They memorized many things and did well on their tests but then later when they are asked to solve particular problems, or apply that knowledge in a critical setting, they had great difficulty in doing that. So what is disturbing about that is that these are students who are bright, highly motivated, they are going to make a lot of money when they get out, they are receiving the most expensive education that we provide in the United States. Yet we are seeing some serious learning failures occurring even in a situation like this. I suggest it is research like that we really need to focus on, because that is where we can get at the cusp of this issue of cognition and motivation. We need to account for why those types of problems are occurring.

So again the charge is: Is motivation important? Certainly it is, but maybe the panel would like to consider whether this is a necessary and sufficient condition or if it is as an earlier person suggested the difference between elite athletes. It's not their ability, it is just their motivation.

William Clancey

I think this is a very good example and even given what we said, that there are two factors and that things are inseparable, that doesn't mean there can't be a spectrum of importance for individuals at different times. And I'm reminded, in putting those remarks together, of my colleagues when they talk about motivation. They are interested in how do we keep the student from dropping out of school, how do we get the student to stay in the classroom? And it is not to move on to the next lesson or to read the next line of text but to even sit down. Now that is clearly the other extreme where cognition is probably playing a role, because they have a conception of what school is about, what the interaction is going to be. But I like your example because it brings us to the far end, where as you say, it is not a matter that they don't want to or they are not trying, or they are not paying attention, but it has more to do with the conceptual change and what understanding is, which is closer to how we now think of cognition.

Claude Frasson

Thank you. Other comments?

So, if you have no more comments, I will say that effectively motivation should constitute a future orientation of our research in the next years. It is complex, requires different levels of interactions and is definitely a problem of high interest.

Now before closing this session, I would like to give you a good example of motivation. I would like to thank the organization committee of this conference which was very motivated to organize a good conference. I would like to express our many thanks to them.

References

- Ames, C. (1984). Competitive, Cooperative and Individualistic Goal Structure: A Cognitive-Motivational Analysis, in Ames, R.E. & Ames, C. (Eds), *Research on Motivation in Education. Vol 1: Student Motivation*. Academic Press Inc. Orlando, Florida.

Bhuiyan, S., Greer, J.E., & McCalla, G.I. (1992). Learning Recursion Through the Use of a Mental Model-Based Programming Environment, *The 2nd International Conference of Intelligent Tutoring Systems*, Lecture Notes in Computer Science, 608, Springer-Verlag, 50-57.

Chan T. W. & Baskin A. B. (1988). Studying with the prince: the computer as a learning companion. *International Conference of Intelligent Tutoring Systems*, 1988, June, Montreal, Canada, pp. 194-200.

Chan, T.W., Lin, C.C., Lin, S.J. & Kuo, H.C. (1993). OCTR: A Model of Learning Stages. *The Proceedings of the World Conference on Artificial Intelligence in Education*, Edinburgh, Scotland, 257-264.

Chi, M.T.H., Bassok, M., Lewis, M.W., Reimann, P. & Glaser, R. (1989). Self-Explanations: How students study and use examples in learning to solve problems. *Cognitive Science*, 5, 121-152.

Keller, J.M. (1983). Motivational Design of Instruction, in C.M. Reigeluth (Ed.), *Instructional Design Theories and Models: A overview of the current Status*. Lawrence Erlbaum Associates, Hillsdale, New Jersey.

Issroff, K. (1993). Motivation and CAL in Different Learning Situations, *The Proceedings of the World Conference on Artificial Intelligence in Education*, Edinburgh, Scotland, 233-240.