AIED 2011 Workshop Proceedings

First Workshop on Artificial Intelligence in Education to Support the Social Inclusion of Communities (AIEDSIC)

Edited by

Fabio Akhras and Paul Brna

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Preface

About 20 years ago, in a paper entitled "Computational Mathetics: the Missing Link of Artificial Intelligence in Education", John Self argued that AI in Education has missed its connection with formal AI, its theoretical side. Some people argued that this was necessary so that AI in Education (AIED) could be able to deliver real world applications. However, in the real world, half of the population lives with less then 3 dollars a day with many socially excluded from education, health and other basic services. Social inclusion seeks to address the needs of this population, mostly living in underdeveloped countries, and also combat factors that are socially problematic in developed countries such as poor educational attainment, unemployment, poor health/special needs, low income, crime and poor housing/local environment.

The Artificial Intelligence in Education community has spent more than 30 years researching the design of adaptive technologies to support learning. However, the issue of supporting social inclusion has never been directly addressed. Has AI in Education also missed an important connection with the real world?

We argue that AI in Education systems have a challenging role to play in helping to transform communities but we also accept that much has to be done to establish the ways in which work on AI in Education supports such activities indirectly, and to determine what future work needs to be done.

The European Union made 2010 the European Year For Combating Poverty and Social Exclusion. The key objectives were to improve public awareness and commitment at the political level to fight poverty and social exclusion while some key challenges are: to eradicate child poverty by breaking the vicious circle of intergenerational inheritance, to promote the active inclusion in the society and the labour market of the most vulnerable groups, to overcome discrimination and increase the integration of people with disabilities, ethnic minorities and immigrants and other vulnerable groups.

We can start by focusing on AIED's capacity to support these aims. Therefore, the main purpose of this workshop is to identify and discuss the challenges that arise in addressing issues of supporting the social inclusion of communities in the context of AI in Education research and lay the groundwork for future workshops in this area.

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AIED for Civic Engagement

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Abstract: This paper argues that AIED (Artificial Intelligence in Education) can promote social inclusion by focusing on civic engagement. By teaching the skills of policy reasoning, journalism, and activism, AIED techniques can be used to train an alert and knowledgeable citizenry that can in turn demand policies that promote social inclusion. Unlike the *AIED export* approach in which we adapt AIED technologies to work in the technological infrastructures of poor countries, AIED for civic engagement could be deployed in rich countries to promote social inclusion in both rich and poor countries. This is because rich country policy often impacts poor country development, and an alert and knowledgeable citizenry can demand more socially inclusive international policies.

Keywords: social inclusion, policy, civic engagement, intelligent tutoring

1 Introduction: Policy Problems and Education

The AIED community has largely ignored the fact that half the world lives on less than $3 a day and that even in rich countries there are serious disparities in income, health, and education. This is not surprising. Poverty and social exclusion are political problems that defy the sorts of technological fixes in which we specialize. Furthermore, AIED technology has been designed specifically for the technological infrastructure of rich countries. On the other hand, policy solutions in a democracy invariably require the education of an alert and active citizenry. So AIED should have some role to play.

To illustrate how education might affect policy, consider a rural Mongolian town like the one in which I served as a Peace Corps volunteer. This town might face high rates of sexually transmitted infection, poor nutrition, and low income. At a grass-roots level, one educational project might be teaching residents to start microbusinesses such as dairy cooperatives, increasing income for herders and nutrition for school children. One might train health workers in basic sex education. One might start after-school life-skills clubs to teach teenage school students the skills of communication and decision-making that allow them to take advantage of existing health resources to avoid risky sexual behavior.

At a policy level, one might teach Mongolian activists, newly exposed to democracy after the collapse of the Soviet Union, how to form interest groups to demand that their government prevent the sale of state enterprises to foreign companies. These activists might also demand that the government promote infant

industries that could provide value-added processing of minerals, cashmere, and beef, rather than the less profitable policy of exporting unprocessed raw materials.

At the international policy level, one might educate rich-country citizens to demand that their foreign aid programs (e.g., USAID) do not sell agricultural products at below-market prices, thus undermining poor country agriculture[1].

The educational interventions at the grass-roots and domestic policy level could just as easily be applied to promote social inclusion in rich countries, for example, on issues of health care, obesity, incarceration, education, and global warming in the U.S.

The policy education projects described above take place at different policy levels and in different technological contexts including: (a) at the level of poor country education, (b) at the domestic policy level in poor countries, (c) at the international policy level in rich countries, and (d) at the domestic policy level in rich countries. All of these policy problems require an alert and knowledgeable citizenry to solve. [1] In fact, there seems to be no shortage of educational projects for promoting social inclusion.

AIED might affect these policy education projects via two different approaches (Figure 1). The *AIED export* approach proposes using AIED technology to improve poor country education but must adapt current technology to the technological infrastructure of poor countries (while satisfying norms for what constitutes AIED technology). The *AIED for civic engagement* approach proposes using AIED technology in rich countries to effect changes in rich country policy that would lead to social inclusion in both rich and poor countries, but requires AIED to address domains it has traditionally ignored, especially civic engagement. The remainder of this paper will discuss the advantages and challenges of the two approaches to using AIED to promote social inclusion.

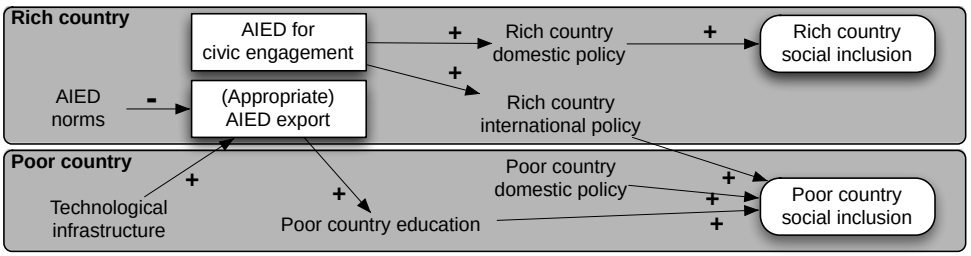

Figure 1. Causal pathways by which AIED for civic engagement and AIED export affect social inclusion in rich and poor countries.

2 Appropriate Technology and AIED Export

Let us again consider the rural Mongolian town. When I first moved to this town, School #12, one of the better-funded province capital schools, had a working computer lab and a computer science teacher. Unfortunately, the town itself only had an intermittent supply of electricity. Further complicating the situation, the dust from the steppe had rendered all the low-cost PCs inoperable within months. The town itself had no computer repair shops, nor was there additional grant money for repair or replacement. In the context of this technological infrastructure, any application of current AIED technology would be infeasible. Thus we have what will continue to be

a central dilemma of AIED for social inclusion: how can rich-country technology promote poor country development?

We might call the use of current AIED technology in poor countries the *AIED export* approach. The AIED export approach suggests that rich country AIED researchers adapt AIED applications to promote education in poor countries. Presumably these AIED applications would be in areas in which we currently focus, such as math, language learning, and science. Analogous information and communication technology projects for development in the export vein include the LINCOS project and the One Laptop per Child project (OLPC). The original initial iteration of LINCOS involved dropping an Internet center in-a-box (literally in a shipping container) into rural, poor country villages [1]. The OLPC project takes a similar approach seeks widespread distribution of low-cost (approximately $200) laptops for education to children in poor countries. A more AIED-like project in this domain might look like the cell-phone based TEFL games for rural learners in India of the MILEE project [2].

The main challenge for the AIED export approach is that current AIED technology may not be appropriate technology for environments in which the average income is under $3 a day. Current AIED applications may be too expensive, depend on a non-existent technology infrastructure, not directly address social exclusion, and have excessively high opportunity costs. Tongia [3] provides a good description of these problems with the OLPC project and most apply equally to AIED. Even if one could make computers cheaper, more sustainable, and that run AIED software, one still has to consider whether it would not be better to hire a local teacher at a lower cost, which would have the added benefit of increasing employment.

A second difficulty for the AIED export approach may be the AIED community itself. AIED researchers may reject appropriate technologies that do not include cutting edge AI. If we follow a learner-centered design process [1]to address social exclusion in poor countries, we may find that the best solutions require little AI. For example, the rural Mongolian school described earlier also lacked textbooks. To make durable, reusable educational materials, teachers would spend their own money to photocopy a few pages using the town Xerox machine. They would then "scotch" the photocopies by covering it with clear tape—a sort of poor-man's lamination. This was cheaper than creating more copies when the students inevitably ripped the un-scotched copies. Scotched-paper is certainly an appropriate instructional technology, but not AIED. I suspect that the educational technological innovations appropriate for those living on under $3 a day will not include the level of AI required to be of interest to this community. For the AIED community to truly address social exclusion in poor countries, we may have to broaden our focus to include educational technology in general, at least when we are focusing on the problem of social inclusion in poor countries.

AIED technology has been developed within the context a rich-country technological infrastructure. In some sense, the challenges of the AIED export approach, both in terms of adapting our technology and changing our focus, arise because we now want to use a very specific kind of hammer to hit a very different kind of nail.

3 New Domains: AIED for Civic Engagement

Another AEID approach for addressing social inclusion in both rich and poor countries is to focus on civic engagement. In this approach, rich-country AIED applications would be used to train an alert and knowledgeable citizenry, a citizenry that would in turn demand socially inclusive policies both at home and abroad. Since this approach may not be as intuitive as the AIED export approach, a few points may need to be argued: (a) rich country policy affects social inclusion in poor countries (and of course the rich country as well), (b) rich country policy will not promote social inclusion in the absence of an alert and knowledgeable citizenry, and (c) civic training will require education in policy reasoning, journalism, and activism. Let's consider each point in turn.

3.1 Effect of Rich Country Policy on Social Inclusion in Poor Countries

One must first acknowledge that rich-country foreign and domestic policy affects social inclusion. While obvious to many, let's consider a few examples from US policy.

US military policy has often included the overthrow of governments, as in Iran, Guatemala, Vietnam, Chile, Grenada, Panama, Afghanistan, and Iraq [4, 5]. The US also provides military support to chosen allies such as the Salvadoran government during its civil war, the Contras in Nicaragua, and the Suharto government during the invasion of East Timor. For better or worse, US military policy often affects who governs and to what ends in poor countries. These policies require a large military and over 700 military bases circling the globe, which comes at a significant cost to the US public [6]. US military spending almost equals that of all other countries combined and accounts for more than half the discretionary budget [1][7]. These policies represent a striking choice between "guns and butter."

For a second example of the effect of rich-country policy on foreign and domestic social inclusion, consider rich country economic policy. Rich countries dominate economic output, international trade, and foreign direct investment, so they can make poor countries change their policies in order to receive foreign aid or preferential trade status. The rich countries also control 60% of the voting shares of the IMF and World Bank which require poor countries to adopt free-trade policies affecting everything from industrial regulation, agricultural pricing, labor market regulation, privatization of state owned enterprises, government decentralization, central bank independence, and corporate governance [8]. For example in 1992, Jamaica took a $50m loan from the Inter-American Development Bank that required Jamaica to remove tariffs on imports of powered milk (subsidized by the US at 137%), which in turn decimated the Jamaican dairy industry [9]. As another example, the IMF (in the 1997 Japanese and US funded bailout) required South Korea to accelerate the reduction of trade barriers to Japanese products [8]. More recently, failures in US financial regulation have led to a world wide economic recession that has impacted rich and poor countries alike [10].

The point here is not to debate the merits of rich country policy, only to point out that it impacts poor country development, affecting social inclusion both at home and abroad.

3.2 An Alert and Knowledgeable Citizenry

A second point to acknowledge when considering AEID for civic engagement [5] is that rich country policy will not promote social inclusion in the absence of an alert and knowledge citizenry. In the case of the military policy described earlier, US President Dwight D. Eisenhower warned that only an "alert and knowledgeable citizenry [could] guard against the acquisition of unwarranted influence … of the military-industrial complex" described previously [11]. Yet the US citizenry seems neither alert nor knowledgeable. For example, even 3 years after the US invasion of Iraq, 60% of Americans held at least or more of the following misconceptions about the war: that links between an Iraq and al Qaeda had been found, that weapons of mass destruction had been found, or that the world public opinion favored the US going to war. The more misconceptions Americans held, the more likely they were to support the war. Americans with 0 misconceptions: 23% in favor, those with all 3 misconceptions: 86% in favor [12]. Low voter turnout rates paint a similar picture of inattentiveness. If changing public policy in a democracy requires an alert and knowledgeable citizenry and the public is generally ignorant, then we seem to have an educational project of the highest order.

3.3 New Domains: Policy Reasoning, Journalism, and Activism

How might AIED train an engaged citizenry? By focusing on 3 areas overlooked by current AIED research: policy reasoning, citizen journalism, and organizing.

Policy reasoning includes the knowledge, skills, and dispositions needed to understand policy issues. Policy reasoning includes causal reasoning about how policy interventions affect desired outcomes [13], for example how rich country agricultural policy affects poor country food security. Policy reasoning also includes argument, especially arguments based on evidence. Causal reasoning and argumentation provide the basis for deliberation, as in deliberative polls where citizens meet to discuss policy issues [14]. Citizens need the skills of policy reasoning not only to understand policy but as inoculation against the political advertising used to confuse and misinform.

Of course, it is not enough to just to understand policy issues. Citizens must also be able to communicate these issues to build the movements required to change policy. As such, citizens need to learn journalistic and communication skills needed to inform other citizens about the issues needed to make informed political choices. For example, a community journalism class might teach students to write profiles of community members suffering from diabetes as a way of raising awareness about the obesity epidemic.

Understanding public policy and raising awareness is not sufficient if citizens cannot act effectively to change policy. A curriculum for civic engagement would also have to teach citizens how to organize. This would include the kinds of project planning skills taught in business schools as well as the kinds of goals, tactics, and tools specific to the political realm, such as voter registration, creating press releases, pressuring decision makers, and so on. For example, one might teach high school students how to campaign for more nutritious school lunches, or to create direct-service programs that teach their classmates how to lead healthy lifestyles.

Policy reasoning, journalism, and organizing form the core of a curriculum for civic engagement—one that teaches students how to understand policy issues, connect with like-minded citizens, and act together to make change. An AIED for civic engagement could thus provide a vehicle for promoting social inclusion. If social exclusion is a political problem, then we must teach citizens how to become political actors.

4 Challenges to an AIED for Civic Engagement

The previous account of an AIED for civic engagement argues that AIED can teach students to become alert and knowledgeable citizens, concerned about social inclusion both at home and abroad, and who can affect policy. Each of the propositions can be challenged. A critic might argue that: (a) people cannot learn to become alert and knowledgeable citizens, (b) that alert and knowledgeable citizens would not care about social inclusion, and (c) citizens cannot influence policy.

Objection 1: People cannot learn to become active citizens. Most AIED researchers are optimistic about the potential for AIED techniques to provide instruction. While policy reasoning, journalism, and organizing are ill-defined domains, few AIED researchers would claim that these could not eventually be taught using AIED. In fact, the ill-defined nature of the domains contributes to their allure as research problems.

Typically, when critics argue against the possibility of an AIED for promoting an alert and knowledgeable citizenry, they mean that you cannot make all people into perfectly rational citizens who make all decisions based on evidence in the best interests of the public good. However, this is a straw man.

The claim is not that we will turn every student into a perfectly rational citizen and thus rid the world of political problems. The claim is that a sizable civic education effort can significantly impact social inclusion. An interesting exercise is to calculate the number of votes needed to swing the last 6 US presidential elections. In each case it is under 600,000 (2% of the US population, [15]). The point is that it might take far fewer informed citizens to change policy than might be imagined. To frame the point another way, the US would produce little scientific research if it provided no K-12 science instruction. One should assume that it is impossible to produce an engaged citizenry based on the current paucity of civic education.

If one believes in democracy, it is hard to argue that we should not train citizens.

Objection 2: Citizens will not care about social inclusion. A critic might argue that people are inherently selfish and unconcerned about social inclusion. This criticism raises a deep philosophical issue, but the objection overstates the case.

One can make the counterargument that it is not in our best interests to allow great inequality. For example, if my neighborhood is full of poverty and crime, it certainly affects me. If I live in a world where desperate people resort to terrorism, that affects me. Several economic arguments have been made about how large inequalities can harm the majority [16, 17]. The framers of the US constitution certainly recognized that it is in the interest of all to protect the rights of the minority.

A second counterargument is that people are not completely selfish; they do indeed care about social inclusion. The principles of nonviolent resistance used by Gandhi depend on appeals to conscience of one's opponent. Game theoretic experiments

show that people do not act as selfishly as predicted [18]. [5]This workshop would not exist if citizens and governments (in this case the EU) did not value social inclusion.

It's a peculiar feature of US political discourse that even activists feel compelled to justify their actions in terms of self-interest publically, while they confess being motivated by the public good privately [19]. In fact, it's unlikely that even the critic considers himself completely selfish. Perhaps he should give his fellow citizens the benefit of the doubt.

There are a number of people that do care about social inclusion. AIED for civic engagement would only expand the number of citizens concerned about social inclusion, or at very least make those citizens that already do care more effective.

Objection 3. Citizens cannot affect public policy. Critics, and those unfamiliar with history of social justice movements, might argue that citizens have no power to affect governments. This is clearly not so. While an individual citizen has little influence over policy, citizens can organize into movements that can influence policy [20]. For example in the US: the struggle of the labor movement to win the 8-hour day, the anti-slavery and civil rights movement, the Vietnam anti-war movement, and so on. The recent popular uprisings in the Middle East vividly demonstrate the power of popular movements. Certainly readers of this paper enjoy rights and opportunities that have only been won through popular struggle. While policy change may often come slowly, it does not come without civic engagement.

5 Conclusion

The contribution of this paper is to identify civic engagement as a means by which AIED can promote social inclusion. The civic engagement approach will succeed to the extent that it can promote an alert and knowledgeable citizenry that demand rich-country policies that promote development and equality at home and abroad. While AIED for civic engagement should be seen as a complimentary approach to the AIED export approach, it offers the advantage of technical feasibility, i.e., it can take advantage of existing AIED applications that require a rich-country technological infrastructure.

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Can Artificial Intelligence in Education Go Beyond Personalisation and Deliver Significant Levels of Empowerment?

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Abstract. The notion of personalisation pervades much of the discussion about how to improve education. The belief seems to be that personalisation will lead to empowerment. Empowerment may well, in its turn, lead to greater levels of social inclusion. Open learner modelling has a potential role in providing improved levels of empowerment but care needs to be taken. The discussion is organised around previous work on developing an open learner modelling system (xOLM) that can help learners have insights into the assessment process, and give them opportunities to challenge the system.

1 Introduction

Currently there is a growth in interest in both the possibilities to personalise the "student experience" and the various reasons why this should be done.

> The pedagogy of personalisation is distinguished by the way it expects all children and young people to reach or exceed national expectations, to fulfil their early promise and develop latent potential. Planning for progression and differentiation are fundamental. High expectations of progress apply equally to children and young people working above, at, or below age-related expectations, including those who have been identified as having special educational needs. There is an expectation of participation, fulfilment and success; and teaching and learning is characterised by ambitious objectives, challenging personal targets, rapid intervention to keep pupils on trajectory and rigorous assessment to check and maintain pupil progress. There are clear plans to support those who are struggling to maintain trajectory. [DCSF, 2008,p7]

Policy makers often seem to take the view that personalisation is pivotal but they tend to interpret personalisation is a somewhat cautious way. The practicalities of providing an education service lead them away from personalisation that involves the proposition that every student gets an individually tailored education since this may imply that we need many more teachers. Another underlying concern is about

assessment – if everyone has their own path to follow then how can we assess learners and ensure that standards are achieved and maintained?

From the perspective of those engaged in the design, development, deployment and evaluation of technology enhanced learning, personalisation is closely coupled to both adaptive and adaptable learning environments. Those involved with artificial intelligence in education (AIED) are especially well placed to help deliver systems which feature many, if not all, of the aspects of personalisation that can be captured in software. The hope is that if only we can capture sufficient information about the individual learner then we can tailor the learning experience sufficiently to provide some form of "optimal" learning.

Yet personalisation is recognised widely as only a means to an end. The real aim of education is the enhancement of the life of learners to its fullest extent – both individually and collectively. Such enhancement includes the development of both knowledge and skills in areas of human activity that include science, art, social sciences, personal development and so on. It certainly includes the art and science of managing our social responsibilities, and of learning how we can change the world.

If we have to choose to change the world for the better then we have to take a position about what needs to be changed. One aspect of the life of an individual that has come to the fore in educational circles is the notion of empowerment. Adams, for example, defines empowerment as "the means by which individuals, groups and/or communities become able to take control of their circumstances and achieve their goals, thereby being able to work towards helping themselves and others to maximise the quality of their lives" [Adams, 2003,p8]. So, if we believe that our school children need to gain some real sense of personal empowerment then the question is how to do this – not in an instant, but over the years that children begin their education to the time that they emerge from formal education.

Pease points out some of the subtleties in the notion of empowerment [Pease, 2002]. Those who use the term may only be thinking of very minor alterations to an individual's life; others may use the language of empowerment to obscure exploitative relations [Pease, 2002]. Others may be talk about empowerment as a wider social remit to combat injustice or to take control in their lives from socially oppressive powers.

The AIED community may be able to further the development of more extensive changes to society than so far considered but this needs to be explored further. Here, we look at change which has a much more constrained focus – though still a very complex matter. We look at the complex set of issues involved in assessment – issues that include the notions of empowerment, personalisation and, AIED.

Assessment of learning by third parties – i.e. not the learner nor their teacher – can be seen as a way of making the learner a passive partner. They "have no role other than to subject themselves to the assessment acts of others, to be measured and classified" [Boud, 2007].

So can AIED contribute to freeing up the process of assessment? What will it take to help the learner have a fuller participation in the assessment process? Perhaps more extremely, how can the learner obtain some real level of power sufficient to begin to change the assessment process itself? Such a task would be long and hard. Bourdieu pointed out that there are "extremely sophisticated mechanisms by which the school system contributes to reproducing the structure of the distribution of cultural capital

and, through it, the social structure" [Bourdieu & Passeron, 1990,introduction]. So, if Bourdieu is correct, then we need to enlist social scientists in our endeavours.

Bain, working in higher education, developed a model of assessment that "promotes assessment practice that must value and validate the experience students bring to the classroom" [Bain, 2010]. She argues that assessment "at the centre of classroom content and process to avoid oppressive needs to create "a negotiated curriculum, including assessment, equally owned by teachers and students."

Leach, looking at assessment within the context of teacher training, has developed an approach which uses a form of criterion referencing [Leach et al, 2010]. Learners can "select the evidence they will present in portfolios, choose and/or negotiate criteria, and have the opportunity to assess their own work. Learners can contribute to their grade in a negotiated process." Leach argues that this *is* empowering. While the data raised many questions – including the question as to how empowering the process was, the approach is a line of attack that AIED can take. It is a line that could have significant levels of support (and attack), but we have previously outlined an approach that is (still) worth exploring further [Brna et al, 1999].

2 Background: Previous Work on Opening Assessment up to the Learner

In a previous project (LeActiveMath), an open learner model was used to provide the learner with information about the system's assessment of their competencies amongst other things. The work included the design and implementation of xLM (eXtended Learner Model) and its associated Open Learner Model (xOLM) [Van Labeke et al, 2007].

The open learner model was intended to provide the learner with information that they could use both to understand their progress and direct their efforts to learn; opportunities to challenge the system's conclusions were given and, sometimes, the was able to give the learner sufficient reason for the learner to challenge their own conceptual understanding.

For our work on xLM, we defined a learner model as a collection of beliefs about the learner's states and dispositions arranged in terms of five dimensions (see Figure 1): the domain being studied, relevant competencies, motivational aspects, affect and meta-cognition. The xOLM, the eXtended Open Learner Model, was designed to expose some of the assumptions underlying the system's judgements of the learner's competence and knowledge.

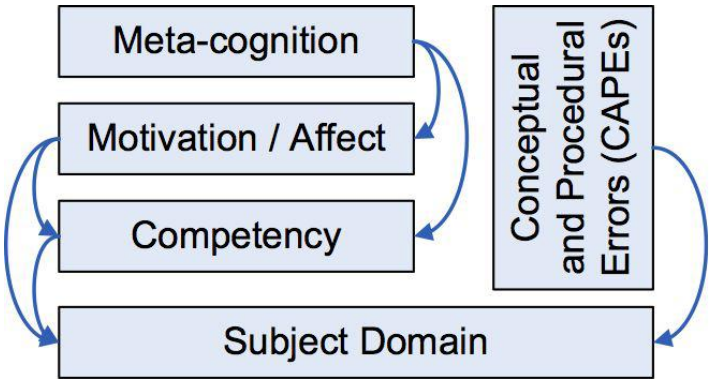

Figure 1: A multidimensional model for learners [Morales et al, 2006].

The xOLM's Claim View used is intended to provide the learner with a impression of how the system rates the learner's overall ability (Figure 2).

Such a system raises a number of educational and technical issues; here, we focus on whether it empowers the learner to any great extent.

The initial design of the xOLM allowed the learner to argue with the system's judgement. The system actually always "gave in" to challenges. We might have expected that to give some sense of empowerment to the learner but learners seem to have found this feature to be disappointing. Students – in this case, first year undergraduate mathematics students – seemed to want some argumentation. So the relationship between empowerment and "getting one's way" is a little more complex than it first seems.

3 The Development of Learner-focused Forms of Assessment and Feedback

Assessment goes hand-in-hand with feedback. That is, assessment without (constructive) feedback is a waste of one of the most valuable moments during which a learner may open themselves up to new ideas and new directions to take. Assessment's role can be deeply disempowering [Leach et al, 2010]. However, the move towards "Assessment for Learning" [Black & Wiliam, 1998] is having a significant influence on educational practices in the UK and elsewhere, and may be capable of delivering a greater degree of empowerment. The movement emphasises formative assessment – Black and Wiliam provide a definition:

> Practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited. [Black & Wiliam, 2009]

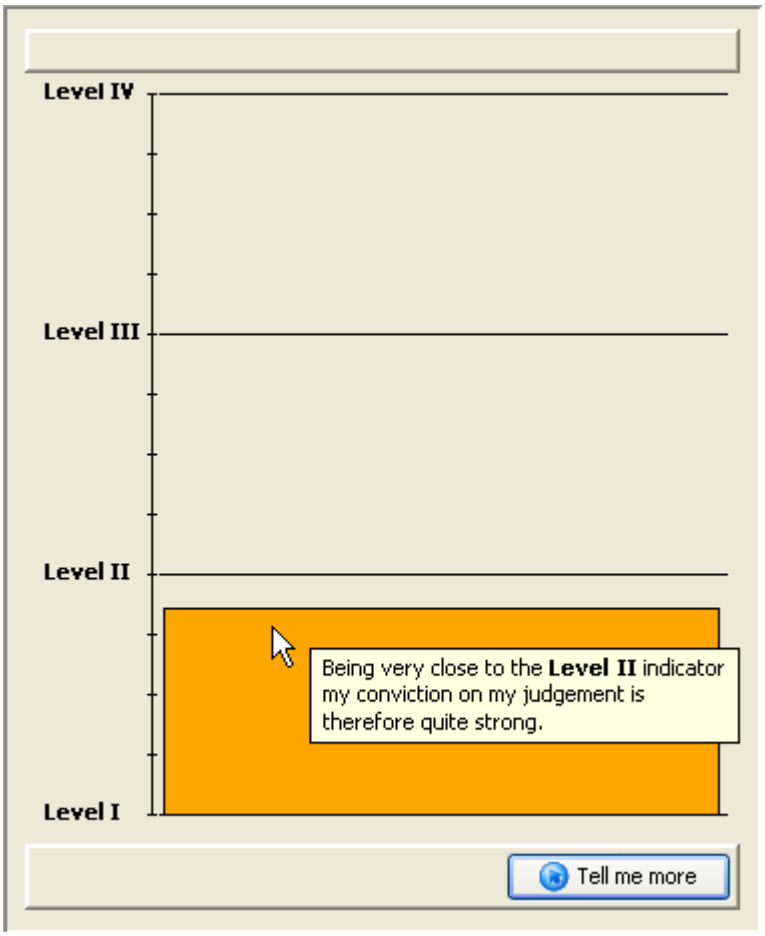

Figure 2: The Claim view displaying the system's estimate of the learner's overall ability

While members of the European Association for Research on Learning and Instruction (EARLI) argue that:

> Current assessment practices tend to focus on Assessment of learning. Such `testing' generally is summative, and drives the teaching (`teaching for the test'). It is also inauthentic, context independent, inflexible and uneconomical. Assessment for learning is generally formative, integrated into the curriculum, authentic, context embedded and flexible. In short, an assessment for learning model can serve as a framework for developing Integrated Assessment Systems (IAS) as ways of assessing today's learners. [Birenbaum et al, 2005]

Given the acceptance of assessment for learning, there is significant scope for the development of many learner-focused forms of assessment and feedback - of which

some may involve an greater degree of empowerment. Promising approaches include those known as self-assessment and self-monitoring, along with peer feedback. The Assessment Reform Group produced ten principles that incorporate learner-focused aspects of giving feedback including the need to be constructive, respect the learner's emotional state and help the learner to increase and retain motivation [Assessment Reform Group, 2002]. Perhaps the principle most obviously related to the empowerment of learners is "Assessment for learning develops learners' capacity for self-assessment so that they can become reflective and self-managing". This is close to arguing that assessment for learning promotes self-regulated learning.

Andrade and Valtcheva provide an analysis of criterion referenced self assessment with interesting implications for future uses of open learner models [Andrade & Valtcheva, 2008]. Boud produces a wide ranging review of how assessment should be considered [Boud, 2000]. He sees advantages in helping learners to self-monitor. The approach taken by the XOLMprovides the basis for self monitoring but more work needs to be done on goal setting (e.g. [Zhou & Winne, 2008]). Harm et al summarises work on assessment quality and note in their conclusion that there are advantages to making quality criteria explicit [Harma et al, in press]. Certainly this is an idea worth developing further.

Brna, Bull, Pain and Self suggested an approach to assessment that they termed "Negotiated Collaborative Assessment" (NCA), a process which opened up a discussion between the learner and the system about the results of the assessment through the use of an open model of the student's knowledge [Brna et al, 1999]. At the heart of this NCA process is the need to examine the raw data obtained directly (or indirectly) from the learner, interpret the data and then make a value judgement based on this interpretation. Work on the LEACTIVEMATH project involved the design and implementation of XOLM, a new open learner model, built on the need to "open up the interpretation process" as identified in the NCA model and as a contribution to the move towards assessment for learning.

Some aspects of assessment for learning are supported in a quite straightforward, if oversimplistic manner, by XLM. For example, the XOLMallows the learner to see the (fairly crude) system's assessment of the student's affective state. Providing a model of the emotional state of a student might help a tutoring system manage learning more effectively[1] but it is not so clear that this empowers the learner in any significant manner without some thought be given to how the student can learn to manage their emotions – i.e. they need to gain some of the so-called meta-emotional competencies.

4 Giving the Learner More Choice

If learners are to make informed educational choices – whether about assessment or not – then we certainly need to understand the scope of the choices that are available to the learner. The limitations of knowledge-based systems suggest that the choices

1 Current efforts are still pretty crude though efforts are being made to build sophisticated models of a learner's affective state and to utilise this information effectively in e-learning systems e.g. [Leontidis et al, 2008,Hernández et al, 2008,D^^d5Mello et al, 2010,Du Boulay et al, 2010].

available are all predetermined ones but this, in the context of assessment, suggests that the learner might not be able to influence the assessment criteria (other than accepting or rejecting). So we do not want to limit the nature of the dialogue with the learner to only choices proposed by the system. The aim is a much larger one in which there is a mixed initiative dialogic process during which system and learner formulate some agreement as to the choices actually made.

If personalisation provides the possibility for learners to make informed choices (of any sort) then it would seem that they will do this more effectively the better they are at self-regulation [Zimmermann, 2002]. There is an immediate issue – how do learning environments foster self regulation either as an aide to learning or, more explicitly, teach learners how to regulate their learning more effectively. This is an active area of AIED research.

Zimmermann regards self-regulation as a complex construct consisting of a number of component skills including setting specific goals that can be achieved in a reasonable time, monitoring performance for signs of progress and self-evaluating the methods chosen [Zimmermann, 2002]. Open learner models could support these particular component skills (and possibly the others). An open learner modelling system would need to represent the goals that the student is believed to have, open up the assessment of the learner's progress and – through opening the model – help the student to self-evaluate their progress. Judging the XOLM and the underlying XLM against such requirements suggests that opening up the assessment could be improved by representing the system's belief about progress – see section 3 for a brief discussion. The other two components seem to require an extension to the XLMin order to represent the learner's goals and the learner's methods. Representing goals could be relatively straightforward compared with representing the learner's methods.

Boekaerts, Maes and Karoly describe self-regulation

> as a multi-component, multi-level, iterative, self-steering process that targets one's own cognitions, affects, and actions, as well as features of the environment for modulation in the service of one's goals [Boekaerts et al, 1999].

The XLM represents something of the "cognitions, affects and actions" associated with the learner but it is currently up to the learner to consider complex patterns of these different kinds of entity. There is room for further work on representing connections that might be believed to hold.

Winne argues that rather than learners having some quantised amount of self-regulated learning, all learners are self-regulating – perhaps not well regulated but self-regulated in some form [Winne, 1997]. This has the interesting consequence that representing the learner's self-regulation back to them might result in increasing awareness of what is effective (and what is not).

Winne and his colleagues have recently been working on a collection of software tools to support self-regulated learners [Winne et al, 2006]. Their aim is to determine how learners can be supported in self-regulating their learning. They emphasise the importance of providing students with feedback about how they study to learn. The gStudy system includes a large number of aids including a note taking facility, a

concept map tool, an automated coach and a log analyser which infers, amongst other things, some notions of the learner's metacognitive monitoring.

The main aim of self-regulated learning is to help learners improve their own personal capabilities to learn. It would be helpful to add the aim of also helping learners to negotiate their relationships with the social forces present in their lives. Without this, it would seem that improving levels of empowerment through self regulated learning is a somewhat indirect process.

5 Conclusions

Can we really help learners to be all they can be?

- To become self-directed?
- To feel that their place in the scheme of things gives them rights that can be exercised?
- To enter into fluctuating dialogical relationships with the powers at work during learning?

We have looked at assessment as an area in which there is a real challenge to give learners some genuine level of empowerment.

So what prospect is there for new methods of assessment which are consistent with assessment for learning, provide an appropriate degree of personalisation and a level of empowerment for learners? The Artificial Intelligence in Education community is well placed, being at a level of maturity for supporting personalisation[2]. Can AIED technologies provide appropriate support for forms of assessment that empower the learner in non-trivial ways? The indications are promising but there are risks. Can we avoid the problem of learners feeling that their legitimate aspirations and concerns are not being heard with the consequence of their becoming disenchanted and demotivated with the new forms of assessment?

This paper has suggested that work on assessment for learning could lead to forms of assessment that do provide some level of empowerment. It is also plausible that open learner modelling is a key contribution from the field of AIED to make this a fruitful area of research. This paper has also suggested that self-regulated learning could also be an area that can be used to provide some level of empowerment. It so happens that self-regulated learning is a "hot topic" right now in AIED and its cognate communities so prospects are promising. However, the issue of empowerment does not appear prominently in the literature connected with technology enhanced learning environments and self-regulated learning – yet.

It is reasonable to hope that the Artificial Intelligence in Education community can go beyond personalisation and deliver significant levels of empowerment – but this can only be done, in the areas we have considered here, a) by taking a position on the need to actively seek to enhance the empowerment of learners, and b) by pushing into

2 See, for example, the TLRP Theme of Personalisation http://www.tlrp.org/tel/personalisation.

areas which have not featured sufficiently strongly in AIED so far – though usually for good reasons.

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Exploring Semantic Representation for t-learning on the ITV Platform

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Abstract. T-learning involves the set of technologies that supports a TV-based interactive way of learning. Several works have investigating models that can augment the t-learning idea, moving it towards a more engaged and effective approach to learn. This paper presents potential contributions that semantic representations can provide to the evolution of this approach. The principal idea is to provide content with meaning that enables, for example, the creation of learning groups, explanation of questions and different ways to represent answers. For that end, this paper describes an architecture that semantically extends the ITV platform, presenting its ontological models and services that support the specification of more powerful learning applications.

Keywords: knowledge representation, semantic web, ontology, t-learning.

1 Introduction

The metaphor of t-learning derives from the previous idea of e-learning, which means "learning through any electronic device", although it is most commonly used for computer-enhanced learning [1]. T-learning could be defined as any process of learning that uses the interactive digital television as platform. This technology has an important social role due to its ability to spread on a lager scale than e-Learning. This fact opens up new scenarios for teaching addressed to a broader number of potential users.

So far, learning via ITV has been more edutainment [2,3] likely, but new researches are changing this scenario through the creation of new models for effective learning implementations. Examples are the work in [4], which investigates solutions for personalized t-learning; and the work in [5], which examines the convergence of Interactive Television and e-learning, towards the establishment of t-learning as a value-adding service of digital television.

Considering this scenario, this paper discusses the opportunities for the use of semantic representations as a form to enhance the learning services that can be specified on the ITV platform. In fact, current computational processes that are intended to run on this platform only account for leading the information transport, so that they do not have access to the meaning of the ITV content. The main reason is the

form that the information is structured, which is not appropriate to computational processes. This limitation restricts the development of several learning applications. For example, it is not possible to represent the meaning of questions and further find the relevant answers. This could be carried out if the respective learning domain was based on a semantic representation, such as an ontology [6].

In this context, this paper presents the specification of a layer, based on the Web Semantic concepts, which provides services and supports the development of semantic-based applications on the ITV platform, such as t-learning applications. The resultant technology, which we call "Knowledge TV", brings significant advances to the ITV state of the art and involves several research areas such as ITV middleware specification, artificial intelligence, knowledge representation, semantic modeling and ontology. Using this layer, we discuss some opportunities for the development of t-learning applications, which use several aspects and advantages of semantic representations.

2 The Role of ITV/DTV on Digital and Social Inclusion

One of the principal challenging needs of our current society is to improve and create new forms of education. The use of Information and Communication Technologies (ICT) is the main trend in our age, once such technologies have opened up a variety of opportunities to enhance learning processes at individual as well as at organizational level, in terms of accessibility, flexibility, customization, collaboration, knowledge and sharing. Furthermore, the use of ICT enables a broader access to knowledge, which becomes equally available to several stratus of our society. This scenario represents a passive form to promote social inclusion. A good discussion about the technology and social inclusion relation is discussed in [7], where is also presented case studies from developed and developing countries, including Brazil, China, Egypt, India, and the United States.

An active form to promote social inclusion appears when we have environments and methods that support the manipulation of knowledge, generating more knowledge and/or leaning experiences. In this context, the ITV platform has a fundamental role in the process of social inclusion via its support for learning processes. As discussed in [8], the following factors contribute to the use of ITV as platform for learning:

- Usability: since it is a household appliance that has been in use for decades, the main functions of a television set (change channels, adjust volume, turn on and turn off) are already known by the population;
- Transmission Quality: important media in distance education, such as audio and video, are transmitted with quality to television sets. However, that same quality will not be acceptable for e-learning applications until wideband access is universally available;
- Information Vehicle: unlike the computer, that can be considered a work tool, people consider the television set an appliance for information and entertainment;

- Collaboration: watching a TV program can be considered a social experience, in which the television program acts as mediator for interaction and collaboration among the TV viewers.

In fact, t-learning can prove highly beneficial to regions where access to internet-enabled computers is significantly low. To this extent, t-learning is strictly linked to social inclusion issues. The results discussed in [9] also stress the importance of t-learning as a social inclusion platform. According to this work, the distance learning necessity has promoted significant development of Internet-based learning initiatives (e-learning). The Internet stands out for its flexibility, but its increasing use has shown several shortages related to difficulties in the use of the computer for some social sectors, limited penetration of computers in homes (ranging from 40% to 60% in Europe) and uneven presence of broadband infrastructure

Despite the importance of the ITV platform for social inclusion, it is still not offering appropriate support to the development of more advanced learning resources. For example, the work of Bates [10] analyses several t-learning applications with different interaction levels. The cases differ in terms of applicability, product, interactivity level and target audience. We can observe that such applications, and other discussed in the literature [11], are more edutainment likely and they do not explore the technological potential of the platform. For example, the application called *BBC Learning* presents various question and answer activities and revision notes covering different aspects of the English, Math and Science as required by the *National Curriculum*. Students can use the arrow keys on the remote control to select the correct answer to a question. However, the lack of a semantic structure hinders actions such as the recommendations of content that could improve the understanding of such a question, or formation of groups that are interested in the question subject. Limitations like that could be eliminated if the platform content is modeled via semantic representations. Next section presents a proposal in this direction.

3 The Knowledge TV Project

The computing platform that supports ITV has grown rapidly. Researchers and developers focus on issues of both hardware and software, as in the communication between these two aspects, which is currently solved with the development of an intermediate layer between them, called middleware.

An interesting aspect of the ITV platform is the strong connection between applications and hardware issues, so that developers cannot use more abstract approaches to the implementation of software. Thus, there is an important need to investigate better resources to be specified in the middleware layer. In terms of architecture, the Knowledge TV (KTV) [12] is inserted into this context. This means, KTV is mainly characterized by a semantic layer that runs on the middleware layer, extending such a layer with semantic resources. This new layer advances the state of the art of ITV development once it provides a rich description of resources and services via a semantic modeling approach. In this way, developers will be able to create more sophisticated services and application, such as to t-learning domain. In addition, this technology creates a convergence environment between Web and ITV.

The KTV architecture is composed by the following layers: Hardware, Middleware, Semantic and Services/Applications. The Hardware Layer concentrates all the aspects and physical devices that can operate in a ITV environment. The Middleware and Basic Software Layer accounts for abstracting particular details of hardware devices, supporting the communication between hardware and superior layers. The Semantic Layer accounts for providing a rich semantic modeling and knowledge bases that contain data descriptions, resources, services, applications and relationships among them. Each of these descriptions is carried out in a formal standard language, so that the descriptions can be automatically processed by computers. The Applications and Services Layer represents the services and applications that use the resources provided by the Semantic and Middleware layers.

Semantic Queries and Semantic Recommendation are two of the services, provided by KTV, which could support the development of more advanced t-learning resources. The technology provided by KTV enables the use of data in a structured and machine understandable form. This fact creates opportunities for users to employ semantic queries instead of simple keyword based ones. However, the construction of semantic queries is a demanding task for human users, as it requires mastering a query language as well as the schema which has been used for storing the data [13]. The basic idea that we are exploring is to use the semantic data structure to lead the definition of semantic queries. This can be carried out by the use of *Controlled Natural Language* (CNL) [14]. In order the use of a CNL is already used as a way for domain experts to build representations, such as ontologies [15]. In our work we intend to investigate the inverse way. Then, given a keyword, the system must semantically classify this keyword, find its semantic relations with other classes and present hits in CNL that indicate which are the semantic extensions that can be applied to the original keyword query. Note that this is a form to assist users during the construction of a query.

The KTV semantic recommendation module has as main function to receive instances of the users and IVT ontology, which is part of the KTV semantic representation, so that such instances can be applied to collaborative and content based filters and semantically grouped. After that, the module can produce final recommendations, which will be integrated to user profiles. One of the main components of this module is the *Provider agent* [12], which accounts for capturing information about the ITV programming. For that end, it can use two different sources. First, the metadata transmitted together with the audiovisual content. Second, information from web, which can be acquired via simple information search. Note that a semantic convergence between ITV and Web is only possible if both technologies are based on the same semantic principles. This is one of the main KTV motivations to use the Web Semantic concepts in its definition.

4 Possibilities of T-learning on the Knowledge TV Platform

This section discusses opportunities for advanced t-learning applications that could take advantages of semantic representations. Next subsections discuss some of these opportunities.

4.1 Extended Question and Answer Services

Traditional question and answer services are based on pre-defined sets of multiple-choice questions, where there is only one correct answer. An evolution of this kind of system allows open questions, where the answer can dynamically be created based on a knowledge base. Natural Language approaches can be used in these cases [16].

Question and answer services could be more flexible if they could refine the questions based on semantic description on a specific domain. This extension of the question is able to generate better answers and also related information on the principal topic of the question, once a semantic representation augments unstructured text with links to relevant concepts. A natural way to support this extension is to consider each question as a semantic query, which represents the student question (Fig. 1).

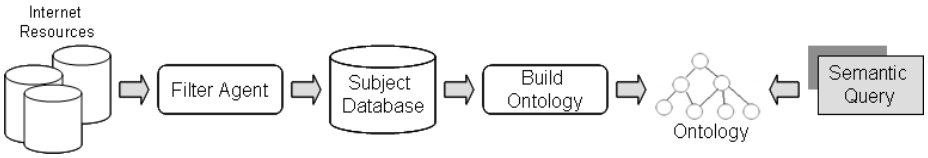

Fig. 1. Schema to prepare a semantic query, which represents a student question.

Consider a t-learning application focused on the British History subject. There are several pages in the Internet about that subject. However they do not provide information in a structured form (e.g., XML or RDF Schemas), so that it is necessary to organize the information retrieved from that sources in a database. The next step is to read the database information, transforming it in a particular ontology. Consider now that a student creates the following question: "Who built the Hadrian's Wall?". From simple keywords (Hadrian's Wall), which are part of this question, the semantic query module is able to extend this question via the relations between the keyword and other concepts in the ontology. For example, Hadrian's Wall is a human build that has a location, builders, data and purpose of construction. The purpose, for example, was to protect the Roman Empire against the Picts from Scotland. Then the system can rise up an important relation between Hadrian's Wall and Picts. Note that the specification of ontologies is fundamental for a correct performance and quality of semantic queries.

4.2 Collaborative Study Group Formation

While students are using t-learning services, such services can use descriptors to store and update features of students. These descriptors can be defined according to some ontology that considers, apart topics of interest, several other parameters that affect the group formation. Examples are age, learning evolution and period that students use to access t-learning resources.

Figure 2 illustrates the descriptors diagram in use by the KTV project, which can be adapted to t-learning implementations. The main descriptors are:

- User identity: uniquely identifies an user in the ITV domain. This description contains the User ID (a number or particular string that identifies an user) and an User Name (the name of an user that is been identified by the descriptor);
- User DS: facilitates the customized access and the information consumption of multimedia information, once it contains descriptors that identify the user preference and historic of use.

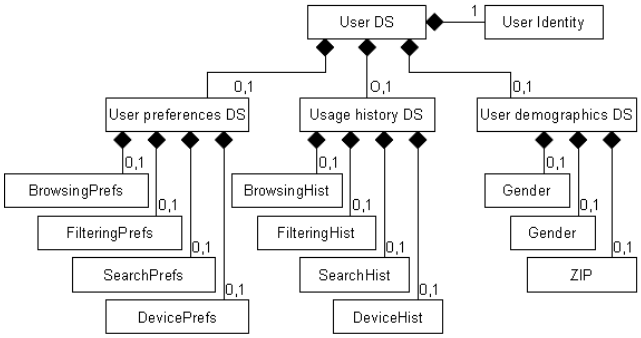

Fig. 2.Users Descriptors [17]

Note that, according to Figure 2, while *Users Preferences* are expressed via descriptors of navigation, filtering, searching and preference configuration; Usage History is described via historical information about navigation patterns, filtering and searches that were carried out by users along the time.

4.3 Study Material Recommender

The User DS, discussed about, is originally used to filter programs according to user preferences and provide suggestions to users about the availability of content that attends the users' preferences. The User DS enables, for example, the customization of the TV visualization, where movies, series and cartons are displayed in accordance with the current profile. Another example of use of the User DS is the intelligent recording of programs, based also on the user profile. All these features can be implemented on the perspective of t-learning applications. For example, rather than programs, the User DS can be used to qualify study material that could be recommended to students.

5 Conclusions

This paper has discussed the importance of ITV technology as platform for development of social inclusion applications and services. In particular, we have focused our analysis on the t-learning domain and concluded that this technology still needs more advanced resources and efforts to reach its fundamental aims. In this context, we show the role that semantic representations can play in the t-learning

evolution, once such representations and related technologies are able to support the development of more intelligent and semantic-based resources. The Knowledge TV is an example of effort in this direction.

The KTV project is being developed by a team of 9 researches/developers, which is mostly composed by master students, and it is characterized as a distributed work where four main modules (Semantic Data Warehouse, Data Mining Module, Semantic Query Service and Semantic Recommendation Service) are in ongoing evolution. This distributed development respects a previous architecture and interfaces definition, so that the specification and implementation of such modules can be carried out in parallel. The project has a total duration of about two year and is sponsored by the National Research Network (RNP) organization. At the moment we have completed the specification of the Semantic Data Warehouse and Data Mining modules. The recommendation module is also completely specified and already in phase of implementation. The Semantic Query module still presents some design challenges, so that its specification is not in a mature stage yet. The conclusion of these activities is essential to set up the environment where we intend to develop prototypes of t-learning applications and services.

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Understanding Social Inclusion Systems: From a Problem-Solution Approach to a Situation-Transformation Approach

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Abstract. Research on sustainability science has been concerned with pointing the way towards a sustainable society. On a global scale, sustainability is seen as depending on three systems: the global system, the human system and the social system. In the social system, the need to address issues of social sustainability, including literacy, education, malnutrition, child mortality, and gender empowerment, as well as its connections with human and global sustainability, has given rise to the eight Millennium Development Goals, which break down into twenty one quantifiable targets that are measured by sixty indicators. Although it is clear that the problems and issues associated with the achievement of these goals are very complex to be addressed by a single discipline, it is also clear that advanced learning technologies may have an important role to play in interdisciplinary efforts to address these goals. Against this backdrop, and looking at the large amount of research already developed in AIED, the first challenge is to find out in which ways AIED technologies can help. We believe that in order to do that we first need to put the notion of a social inclusion system in more precise terms, so that the issues addressed can be treated by AIED systems. In this direction, the purpose of this paper is to discuss and present an initial ontology to describe social inclusion systems. While ontological development in sustainability science has emphasized a problem-solution approach, we believe that the issues of social inclusion will be more naturally addressed by a situation-transformation approach, which is the focus of our ontology.

Keywords: social inclusion, ontology, formal models, social inclusion systems

1 Introduction

Social inclusion is a complex multidisciplinary many-faceted problem that is far from having the same kind of formal basis that other scientific disciplines have achieved. Nevertheless, the formal languages used by disciplines that address social issues with a rather formal approach, like cognitive science and artificial intelligence, can provide a starting point on which to build a formal basis to support the design and analysis of social inclusion systems.

Social inclusion systems involve processes of participation, mediation and interaction in which cognition and learning are situated in broader sociocultural

contexts and the notion of learning community becomes central. Taking this into consideration in the light of a conjunction of factors related to social, economic, technological, cultural, environmental and human conditions that characterize a social system, we are working on the definition of an ontology and models that can be used to make precise the design of social inclusion systems and support their analyses.

Exploring theoretical perspectives from social and psychological sciences we have defined an initial set of formal entities that can provide a foundation to make precise the design of social inclusion systems and support their analyses. These entities constitute a basic ontology which is based on five categories of concepts: social situation, social activity, social networking, social process and social affordance. While ontological development in sustainability science has emphasized a problem-solution approach [1], we believe that the issues of social inclusion will be more naturally addressed by a situation-transformation approach, which is the focus of our ontology. The ontology is being developed to drive the observations and analyses that we are carrying out in several projects of supporting social inclusion that we are currently developing. In the paper we present examples taken from one of these projects, which involves rural communities learning an internet language and using it to model their social context and address their opportunities for social inclusion. It includes a careful design of content and activity and consideration of the social context, and so addresses many issues related to the design of social inclusion systems [2][3].

This project is being developed in a region where the rural communities have a potential for the development of an agriculture that can be used for the production of biodiesel, which is viewed as a way of generating income and promoting social inclusion to these communities. A program of training farmers to cultivate plants that can be used to produce oil is being developed in the region as part of a government plan to increase the production of renewable sources of energy by small farms in order to provide social inclusion. This is the social context of the community in which our program of digital and social inclusion is being applied. The program includes the production and use of audiovisuals on subjects of the social context of the learners as a way of providing visual representations of aspects of this social context to be used in the projects that the students will develop for digital inclusion.

The project follows a view of learning that emphasizes the role of the context in learning and points to the importance of learning in authentic situations. Therefore, the project situates learning for digital inclusion in the social context of the learners and is based on authentic activities of project development that address issues of these social contexts. The focus is on allowing the children to address their social context in digital inclusion activities. To do so, the children of the community are involved in the development of small projects of learning portals in which the students learn the HTML language and use that language to create content for learning portals on subjects that are relevant to their community. These projects of learning portals provide the authentic activities that make learning for digital inclusion meaningful for the children.

In a workshop developed with students and teachers of isolated rural communities living in the banks of the Amazon River they produced the portals shown in Fig. 1. The students focused their portals on issues of the housing in their village, while the teachers addressed issues of the sanitarian infrastructure in the villages.

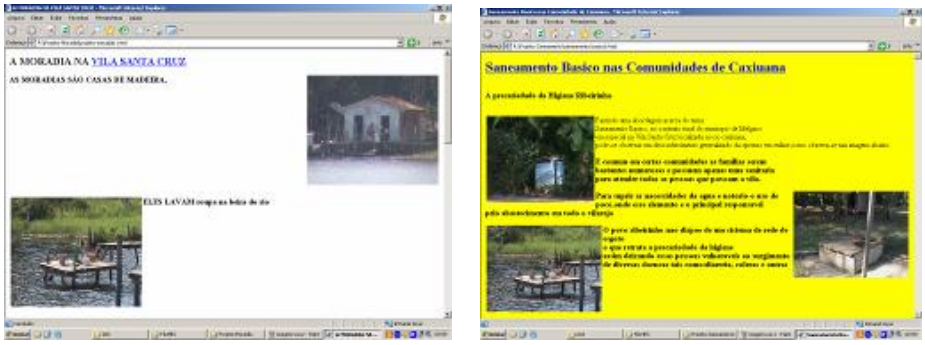

Fig. 1. Digital inclusion for social inclusion in isolated rural communities living in the banks of the Amazon River

Part of our work on this project involves eliciting the notions that arise, in the light of our ontology and models, so that they can be stated in precise terms. These notions will support the design of social inclusion systems and provide a framework for the development of units of analysis of social inclusion phenomena.

The next section presents a discussion of some theoretical perspectives from social and psychological sciences which can provide an initial set of notions that can constitute the basis for the formalization of social inclusion systems. Then, in section three we introduce the ontology that we have developed, and in section four we discuss its application, showing some examples. Overall, the aim is to identify and discuss the issues that arise in supporting social inclusion in individual and community contexts, and explore a way to express these issues in precise terms and models to lay the groundwork for the development of a formal approach to address and support social inclusion systems.

2 Theoretical Perspectives for Modeling Social Inclusion Systems

A theoretical perspective to support the modeling of social inclusion systems will come from the definition of the units of analysis of social inclusion phenomena. This includes assumptions about the role of the context, the people and the interaction between them in social inclusion systems, and considering issues of time, change and causation, as well as issues of physical and psychological phenomena related to social inclusion.

In formalizing social inclusion phenomena, a central issue to be addressed is the relation between people and their environment in social inclusion processes. In this regard, we follow Gibson´s theory of perception [4], which treats contexts and psychological processes as aspects of a holistic unit. According to Gibson, the organism and environment uniquely differentiate to fit one another forming a distinctive ecological niche, in such a way that the structure and functioning of the

organism implies the environment as well as the particulars of the niche imply the structure and functioning of the organism.

A fundamental notion of Gibson´s theory is the concept of affordances. The affordances of an environment are what it offers to an organism, such as the opportunities for actions or the dangers that exist in an environment for an organism. However, affordances are located neither in the environment nor in the organism. Instead, they are intended to capture units of analysis of perceptual activity that refer to both the environment and the organism in a complementary way.

Therefore, affordances can be interpreted as significances-to-the-organism in the environment, which lead to possibilities for action. An important aspect of affordances is its dynamic character, i.e., affordances that were not present at a certain point may become present after the organism grows, matures, and learns. In general, we can say that after certain interactions between the organism and the environment, affordances that were not present before might become present, as well as some affordances that were present might not be present anymore. In addition, there are positive and negative affordances. While positive affordances may be beneficial to an organism a negative affordance may not [5].

In our ontology, the definition of the affordances of a particular social context will provide the means to make precise the opportunities for social inclusion in that particular context, as well as those aspects of the social context that can preclude people from achieving social inclusion.

Another aspect of the relation between people and their environment that is relevant for modeling social inclusion phenomena is the activity that people develop in their social contexts. In this regard, we follow a view that also addresses the mutuality of organism and environment in development and is based on the notions of assimilation and accommodation [6][7]. According to this view, knowing and doing cannot be separated, and the activity and context of an experience become an integral part of the meaning of that experience. It follows that it is from the way people act and organize their activities in situations that they construct or revise their knowledge and views of their social context and of the possibilities to promote changes in this context.

In activity theory, Vygotsky also addresses the mutual involvement of the individual and the social context in development through the concept of activity, emphasizing holistic units of analysis [8]. According to activity theory, individual thinking is a function of social activity.

In terms of our ontology this raises the need to define modeling entities that address the interdependency between social contexts, states of social development (and knowledge) and social activity. These entities will provide the means to model aspects of social inclusion phenomena, that take their meaning from the interaction between these three factors, rather than from the factors alone.

Modeling these interactions will make it possible to capture the dynamics of social inclusion processes as activities occur in social contexts and transform social development states. It will also make it possible to capture how activity in social situations allow people to participate in a community of practice, accessing the views and practices of the other members of the community, and making sense of all kinds of information related to that community.

From this view it comes the notion of development as apprenticeship, which involves becoming a member of a community of practice as a way of moving from peripheral to full participation in the world [9][10], which is the ultimate goal of a social inclusion process.

In our ontology, in order to provide the means to model the dynamics of social inclusion processes, we also need to define modeling entities that address the temporal dimension of the interactions that occur between social contexts, states of social development and knowledge, and social activity.

To take this aspect into consideration in our ontology we follow the transactional perspective proposed by Altman and Rogoff [11]. This approach addresses not only the relations between individuals and their environments, but also the temporal qualities of these relations, considered as inherent aspects of phenomena, and embodying the flow and dynamics of the individual's relations to social and physical settings.

Therefore, considering the issues discussed above which emphasize the importance of the contextual and temporal aspects of phenomena, and adopt units of analysis that address the interaction between person and environment, we have outlined a theoretical view that emphasizes five aspects as holistically coexisting in any social inclusion process:

(a) **The social context**
(b) **The social development state**
(c) **The social activity**
(d) **The social interaction**
(e) **The social process**
(f) **The affordances for social inclusion**

The aim is to develop a theory that takes into consideration the current social situation of individuals or communities (the social context and the state of development of the social context - the social development state, including the state of knowledge that is relevant for the social inclusion of the community), and provide means to help determine how and which activity (the social activity) and interactions (the social networking) in this situation, and from situation to situation (the social process), may provide opportunities to individuals and communities for social inclusion (the affordances for social inclusion).

In order to develop such a theory we have developed an ontology and an initial set of models based on the ontology, which are briefly described next.

3 Ontology and Models

In the development of an ontology and models to provide a formal approach to social inclusion systems some of the research questions to be addressed are:

- How do particular aspects of an social situation affect how people (individually or in group) can achieve a social inclusion goal? (the role of the social context)

- What particular social development states allow people (individually or in group) to achieve a social inclusion goal from engaging in particular kinds of activities and interactions? (the role of social development states)
- What will people do in a given social situation to achieve a social inclusion goal? (the role of the social activity)
- What kind of interactions people will develop in a given social situation to achieve a social inclusion goal? (the role of the social networking)
- How do the particular ways in which activities and interactions can evolve over time allow people to achieve a social inclusion goal from engaging in particular kinds of activities and interactions at particular times? (the role of the social process)
- How do particular kinds of affordances of a social situation allow or preclude people (individually or in group) to achieve a social inclusion goal from engaging in particular kinds of activities and interactions at particular times? (the role of social inclusion affordances)

Addressing and integrating these issues we have arrived at an ontological perspective in which the elements of social inclusion systems are conceptualized and organized in terms of five main ontological categories: ***social situation*** (addressing issues of the social context in which social inclusion is to be promoted, including issues of the social development state and goals), ***social activity*** (addressing issues of the social activities and of the connections between the social context and the social development state through social activity), ***social networking*** (addressing issues of the social interactions and their connections to social activities), ***social process*** (addressing issues of the sequence and time-extension of social activities and interactions in a social inclusion process) and ***social affordance*** (addressing issues of the opportunities for social inclusion afforded by social contexts to people).

Therefore, these five ontological categories address the six aspects of social inclusion systems presented before. Social situation refers to the social context and the state of development of the social context. Social activity represents the activity developed in the social context and its connection to the social development state. Social networking represents the social interactions developed in the social context and their connections to social activities. Social process represents the way social activities and social interactions are connected in time, and social affordance refers to the potential of social situations to the development of social activities, interactions and processes in ways that provide opportunities for social inclusion.

4 Modeling Social Inclusion Systems

Our approach to the modeling of social inclusion systems is based on the five ontological categories introduced above. The first two of these categories are described in more detail in the following sections, presenting some examples of social situation and social activity which show how the models help to elicit issues of situations and transformations that are relevant to address in the analysis of the social inclusion project that is being carried out in rural communities.

4.1 Social Situation

In order to address issues of the social context in which social inclusion is to be promoted, we have developed a model to describe ***social situations***. According to this model, social situations are described in terms of their structure and dynamics.

The structure of a social situation is defined in terms of ***social components***, which are the units that constitute social situations, ***relations*** between social components, ***properties*** of social components, potential ***states*** of social components and possible ***transitions of state*** between them, and ***images*** of social components. The structure of a social situation also includes relations of ***abstraction*** and ***aggregation*** between social components. In addition, in order to describe more complex structures of social situations, we may also define hierarchies of ***abstraction*** and ***aggregation*** of social situations. Some examples taken from the project in rural communities, are:

social situation=*community of agricultural families*
social component=*income*
state of social component=*income(low)*
transition of state of social component=*income(low,higher)*
image=*people being trained in agricultural techniques*
abstraction of social component=*income is a kind of benefit*
aggregation of social component=*income is part of production*
abstraction of social situation=*community of agricultural families is a kind of rural community*
aggregation of social situation=*rural school is part of community of agricultural families*
state of social situation=*agriculture of vegetables*
state of social situation=*agriculture of oleaginous plants*
transition of state of social situation=*community of agricultural families(agriculture of vegetables, agriculture of oleaginous plants)*

The dynamics of a social situation is defined in terms of ***social actions*** and the ***agents*** that perform social actions in the social situation. The definition of the dynamics of a social situation includes the identification of the elements of the structure of the social situation that are the ***preconditions*** and ***effects*** of a social action, the ***causes*** and ***consequences*** of a social action, or the ***context*** of a social action. In addition, there can be relations of ***abstraction*** and ***aggregation*** between social actions. Some examples are:

social action=*plantation of oleaginous plants*
agent=*farmer*
precondition=*proper soil*
(in the complete model, to reach this condition it will be necessary a series of social actions, including the training of farmers in new agricultural techniques)
precondition=proper seeds
effect=*material for biodiesel*
cause=*need of income*
consequence=*family benefit*

context=*biodiesel production*
abstraction of social action=*plantation of oleaginous plants is a kind of agricultural activity*
aggregation of social action=*plantation of oleaginous plants is part of producing material for biodiesel*

4.2 Social Activity

The explicit account of the structure and dynamics of social situations makes it possible to characterize the occurrence of some higher-order aspects of social activity that social actions alone cannot characterize. For example, exploring the connections between aspects of structure and dynamics which have a meaning in terms of social inclusion phenomena we can describe the changes that are caused in a social situation by social actions.

In this regard, three aspects of a social situation that may be considered to provide an account of social activity that can contribute to the interpretation of social inclusion phenomena, are:

- the structure of the social situation in which the social activity occurs,
- the nature of the activity that is developed by the people in the social situation, and
- the state of social development of the people involved in the social activity.

The relations that develop between these three aspects of a social situation, as social actions occur, may give rise to ***patterns of social activity*** that can denote, for example, aspects of what has been achieved in terms of changing social development sates to promote social inclusion. In order to support this kind of analysis, patterns of social activity are defined in terms of the concepts that constitute our model of social situations.

For example, the action 'plantation of oleaginous plants' per se has no meaning in terms of social inclusion. However, if we consider the structure of the social situation, the nature of the activity, and the state of social development (in which particular kinds of seeds are to be planted to generate material for the production of biodiesel as a way of increasing income), we may be able to identify the occurrence of some patterns of social activity that can be described as follows:

An agent of a social situation (the farmer) ***uses*** components of the social situation (the seeds and soil available) to ***generate*** a new component of the social situation (material for biodiesel) that ***changes*** the state of a component of the social situation (increase the farmer´s income) promoting social inclusion. In this example, ***uses*** and ***generate*** are patterns of social activity, while ***changes*** will characterize an issue of the social process.

In more formal terms, we can have the following definitions for these patterns:

pattern of social activity=uses social component (an agent uses a social component through a social action)
agent=farmer

social action=plantation of oleaginous plants
social component=seeds of oleaginous plants

pattern of social activity=generates a social component (an agent generates a social component through a social action)
agent=farmer
social action=plantation of oleaginous plants
social component=material for biodiesel

These patterns of social activity are the more basic ones. Other more complex patterns may be modeled in similar ways to represent other aspects of social activities that are relevant to consider in the analysis.

For example, in order to characterize the social process ***changes*** we need to consider the way in which the social activity affects the state of social development, producing a transformation in the social situation, given by a transition in the state of the social situation from the state of "agriculture of vegetables" to the state of "agriculture of oleaginous plants". This can be modeled in terms of the following patterns of social activity, which involve the previously modeled patterns:

pattern of social activity=generates transition of state of social situation (a social action generates a transition of state of a social situation)
pattern of social activity=generates social component (farmer generates material for biodiesel through the plantation of oleaginous plants):
agent=farmer
social action=plantation of oleaginous plants
social component=material for biodiesel
social component=transition of state of social situation=community of agricultural families(agriculture of vegetables, agriculture of oleaginous plants)

pattern of social activity=generates transition of state of social component to higher (a social action generates a transition of state of a social component to a higher value)
social component=income
state of social component=income(x)
agent=farmer
social action=plantation of oleaginous plants
state of social component=income(y)
transition of state of social component=income(x,y)
relation between social components=greater than(income(y),income(x))

Therefore, the purpose of the patterns of social activity is to provide units of analysis of social inclusion phenomena centered on the social actions performed in the social context (as shown in the example, from patterns that provide an explicit account of the use and generation of components of the social situation to patterns that provide an explicit account of the generation of transitions in the state of the social situation).

5 Conclusion

In this paper we have presented an approach to support the formalization of social inclusion systems. The ontology and models presented are intended to provide a precise basis to support the design and analysis of systems created to promote social inclusion. The approach addresses five main ontological categories: social situation, social activity, social networking, social process and social affordance. The main characteristic of this approach is its focus on the integration of the various aspects involved in creating and analyzing systems to promote social inclusion, addressing at the same time the social situation, the social activities, the social interactions, and the social processes that are present in any social inclusion context.

The concern with the context of social inclusion pointed to the need of addressing in precise terms the notion of social situation, including the consideration of its structure and dynamics, leading to work on the development of a social situation theory in a way that is similar to work on situation theory [12]. This is the basis for the development of theories of social activity, social networking, social process and social affordance, that complete the model. Further work includes the advance of these developments and their application to support the analysis and creation of social inclusion systems. Our long-term goal is to provide a precise basis on which to analyze, understand, and improve systems to promote social inclusion.

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6 References

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